SIXTH FRAMEWORK PROGRAMME

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PRIORITY A.2.3.: Managing Arid and Semi-arid Ecosystems

Third Periodic Activity Report
(01.01.2009 – 31.12.2009)
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ANNEX 2-3-3: Report on potential projects for financing support
Deliverable D2.6 (Lead contractor: Utrecht University, Due date: June 2009)

COMPETE

Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems - Africa

Responsible Partner:

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Project Partners

Partici-pant role	Partici-pant number	Participant name	Participant short name	Country	Date enter project (month)	Date exit project (month)
CO	1	WIP – Renewable Energies, Germany	WIP	DE	1	36
CR	2	Imperial College of Science, Technology and Medicine	Imperial	UK	1	36
CR	3	Utrecht University	RUUTR.STS	NL	1	36
CR	4	Stockholm Environment Institute	SEI	SE	1	36
CR	5	Austrian Biofuels Institute	ABI	AU	1	36
CR	6	Höhere Bundeslehr und Forschungsanstalt für Landwirtschaft, Landtechnik und Lebensmitteltechnologie Francisco Josephinum	FJ BLT	AU	1	36
CR	7	ETA - Energia, Trasporti, Agricoltura s.r.l.	ETA	IT	1	36
CR	8	European Biomass Industry Association	EUBIA	BE	1	36
CR	9	Practical Action	Practical Action	UK	1	36
CR	10	Consiglio Nazionale delle Ricerche	CNR	IT	1	36
CR	11	E+Co, Inc. (not funded)	E+Co	USA	1	36
CR	13	Institute for Sustainable Solutions and Innovation	ISUSI	DE	1	36
CR	14	AGAMA Energy (Pty) Ltd	AGAMA	ZA	1	36
CR	16	Center for Energy, Environment and Engineering Zambia	CEEEZ	ZM	1	36
CR	17	Environnement et Développement du Tiers-Monde	ENDA-TM	SN	1	36
CR	19	Food, Agriculture and Natural Resources Policy Analysis Network of Southern Africa	FANRPAN	ZIM	1	36
CR	20	FELISA Company Limited	FELISA	TZ	1	36
CR	21	Mali-Folkecenter	MFC	Mali	1	36
CR	22	MOI University	MU	Kenya	1	36
CR	24	Tanzania Traditional Energy Development and Environment Organisation	TaTEDO	TZ	1	36
CR	25	UEMOA - Biomass Energy Regional Program (PRBE)	PRBE	BF	1	36
CR	26	University of KwaZulu Natal	UKZN	ZA	1	36
CR	27	University of Cape Town - Energy Research Centre	UCT, ERC	ZA	1	36
CR	28	Chinese Academy of Agricultural Sciences	CAAS	CN	1	36
CR	29	Centro Nacional de Referencia em Biomassa, Brazil	CENBIO	BR	1	36

Project Partners (continued)

Partici-pant role	Partici-pant number	Participant name	Participant short name	Country	Date enter project (month)	Date exit project (month)
CR	30	Indian Institute of Science	IISC	IN	1	36
CR	31	The Energy and Resources Institute	TERI	IN	1	36
CR	32	Universidad Nacional Autonoma de Mexico	UNAM	MX	1	36
CR	33	Universidade Estadual de Campinas	UNICAMP	BR	1	36
CR	34	Winrock International India	WII	IN	1	36
CR	35	Interuniversity Research Centre for Sustainable Development - University of Rome "La Sapienza"	CIRPS	IT	1	36
CR	36	Universitetet i Oslo	UiO	NO	1	36
CR	37	University of Bristol	UNIVBRIS	UK	1	36
CR	38	University of Botswana	UB	Botswana	1	36
CR	39	University of Fort Hare	UFH	ZA	1	36
CR	40	TWIN	TWIN	UK	1	36
CR	41	Joint Graduate School of Energy and Environment	JGSEE	TH	1	36
CR	42	African Development Bank Group (not funded)	AFDB	Int.	1	36
CR	43	Energy for Sustainable Development Ltd.	ESD	UK	1	36
CR	44	Eco Ltd.	Eco	UK	1	36
CR	45	Chinese Association of Rural Energy Industry	CAREI	CN	1	36
CR	46	Food and Agriculture Organisation of the United Nations (not funded)	FAO	Int.	1	36
CR	47	Conservation International Foundation (not funded)	CI	USA	1	36
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1 Introduction

This work has been conducted in the framework of the project COMPETE (Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems - Africa), co-funded by the European Commission in the 6th Framework Programme – Specific Measures in Support of International Cooperation (Contract No. INCO-CT- 2006-032448).

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A direct link exists between energy use and human well-being. Energy provides critical services such as light, heat, power, transport and communication. Access to reliable and affordable sources of energy resources is a pre-requisite for human development. Increasing the availability, accessibility and acceptability of sustainable energy brings about new and better development options and opportunities to humanity. This is particularly critical in Africa given that access to basic energy forms or services by the majority of the population is still very limited.

On average, people in Africa use about 15% of energy consumed by their counterparts in developed countries. The main energy source for more than 70% of the continent's population is traditional biomass energy forms like fuelwood, animal and crop waste. Furthermore human and animal power still plays a significant part in the transport systems and other activities like farming.

Africa is however endowed with vast renewable energy resources that are still to be exploited. These resources include biomass energy, solar energy, wind energy in coastal regions, hydroelectricity and geothermal energy.

Multilateral and bilateral agencies’ traditional strategy of supporting large-scale investment in incremental grid-based power generation, transmission and distribution has not been significantly translated into increased access to energy by the majority poor. Given the prohibitive cost of connecting low population areas such as rural communities to the power grid, renewable energy and energy efficient technologies that make use of local resources become a realistic option. In the case of biomass energy also the production and use or export of untreated biomass or processed biomass, such as liquid biofuels for transportation, is a potentially interesting option.

Several projects and programs have been implemented in Africa to try and promote the dissemination of modern biomass energy and improved traditional biomass energy technologies. Analysis shows that these initiatives faced a host of barriers that are related to developing and sustaining a market for these technologies. Two of the main barriers encountered are the absence of appropriate policy and regulatory frameworks to promote these technologies and the lack of capacity to make a business case for such technologies.

In 2002 the African Development Bank (AFDB) launched the Financing Energy Services for Small-Scale Energy Users (FINESSE) Africa program. Funding for the FINESSE programme came from the Dutch Government and was in total US$ 5.3 million for four years. The FINESSE programme ended in 2006. The goal of FINESSE was to assist countries in Africa to formulate appropriate policy and regulatory frameworks and to develop capacity to generate a pipeline of investment projects in renewable energy and energy efficiency, including biomass energy. More specifically, the following program objectives were formulated:

- Increase capacity of African Development Bank staff to deal with alternative energy.
- Establish African countries' ownership and commitment to alternative energy programs.
- Operationalise renewable energy and energy efficiency in African Development Bank's projects and programs.
- Identify and develop alternative energy components to be included in the Bank's lending portfolio.
- Increased economic and employment opportunities.

The original goal of the Compete deliverable D2.6 was to identify project concepts having the potential for financial support through the AFDB FINESSE (Financing Energy Services for Small-scale Energy Users) programme. However, the FINESSE programme ended in 2006. Therefore, after consulting with the project coordinator, it was decided to identify and describe several projects that are potentially promising for financing through financing mechanisms such as the AFDB FINESSE programme, but also other relevant financing mechanisms are considered. In total four distinctive projects are selected and described that vary with respect to the scale, the type of biomass and the type of technology that is used. These projects are:

- Mali Jatropha electrification
- Bioethanol production in South Africa
- Biodiesel production in Ghana, Kenya and Tanzania
- Tanzania sisal biogas

These projects are analysed in terms of their economic viability, whereby specific attention is paid to the advantages and disadvantages of different financing mechanisms and to the impact that financing mechanisms might have on the economic viability.

2 Case 1: Mali Jatropha electrification

2.1 Introduction

Mali is among the poorest countries in the world. The country is facing a huge energy bill due to rises in world oil prices while at the same time, the main export of the country, cotton, is hindered by subsidies allocated by Northern countries, particularly the USA. This situation has an impact on poor communities who are facing increased energy costs and decreased income due to low cotton prices. A large number of farmers have given up cotton production and, as a result, have no more or very little cash income from agricultural activities. Further, 99 % of the rural population in Mali lacks modern energy services such as electricity and LPG. It is becoming increasingly clear that improvement of living conditions of the rural population cannot be based only on service provision from the state and parastatal budget and initiatives. For these reasons, the national energy policy strongly supports development of Jatropha for energy end uses.

Therefore, in 2006 a project started that was aimed at producing Jatropha seeds that can be used to produce vegetable oil for electrification in rural parts of Mali. An overview of this project is shown in Table 1.

Table 1: An overview of the Garalo Jatropha electrification project.

Initiative Name	Mali Jatropha Electrification - Small-scale Jatropha plantation for Rural Electrification of Garalo Commune
Location	Garalo Commune, capital of Garalo, Mali, West Africa
Initiation Date and Duration	1 August 2006 (36 months)
Funder(s)	AMADER, MFC, FACT Foundation (Fuels from Agriculture for Communal Technology), Stichting het Groene Woudt (SHGW)
Project Initiator	Mali Folkecenter (MFC)
Overall Budget	$756,000
Output	300 kW (3 units 100 kW) Electrical
Area of Land	Potential of 10.000 ha out of which over 600 ha currently cultivated
Beneficiaries	More than 300 farmers (326), 247 electricity subscribers currently with a potential for more than 10,000
Source	FAO (2009). The text in the remaining of this section is taken directly from this report and supplemented where necessary

The Garalo pilot project is aimed at addressing these challenges at a community level. In total three 100 kWe generators are installed that run on locally produced Jatropha oil. Jatropha is chosen because this is a model in which village natural resources (land and Jatropha) are processed and used locally, contributing thus to energy security and increasing the added value for local communities. Further, the inter-cropping model (Jatropha in association with crops for food) which is being largely used contributes to limiting the negative impact on food security. If proved successful the pilots can be scaled up given the huge land potential.

2.2 Jatropha seed production

To encourage ownership of the Jatropha production system by the rural communities, the social and business model was developed with strong involvement of the local authorities. For instance, given the competition regarding Jatropha seeds, local authorities have prohibited their sales outside the commune to secure a sustainable supply for the hybrid power plant. Currently the supply at national level is very low compared with demand. A by-law was passed to ensure that local production is entirely devoted to the power plant. Jatropha production village committees were set up in 33 villages including 30 in the commune of Garalo and the three others are in another commune (Sibirila) close to Garalo. A co-operative of producers (CPP) encompassing all the villages has been set up for the purchase, commercialisation and processing of the Jatropha seeds by a co-operative owned press. The CPP deals at the "commune" level with all issues regarding Jatropha seeds, pure vegetable oil production and sale as well as residues (oil cake) used as fertilizer. In order to operate efficiently in all the villages, farmers have set up Jatropha producers village committees (CVPP) with the support of Local Authorities in order to deal with the key activities at the village level such as seeds collection and transport to the cooperative. Out of a forecast of 10,000 ha of Jatropha, 600 ha, involving 326 rural families, are already under cultivation. Many plantations are on land previously allocated to cotton. Farmers have opted for the intercropping production mode to ensure food security at least at the village level. The residues of Jatropha seed processing can be used as a fertilizer. It is also envisaged to make an energy use of the oil cake to produce biogas.

The co-operative is also responsible for the distribution to its members of the revenues generated by these activities on average twice a year. The agreed current price is currently 9.8 cents per kg, which should allow both a reasonable margin for the farmers and a competitive selling price of Jatropha oil. The seeds will be processed by the co-operative and sold to ACCESS. There is not yet an agreed price as oil production is marginal given the time it takes between plantation and seeds production. ACCESS, the power company, is a MFC subsidiary with a commercial status, thus management and procedures (accounting, VAT, etc) are completely different from MFC which has NGO status. MFC and Fact Foundation are providing technical support to the power plant operator ACCESS and to the Jatropha producers' co-operative.

The whole model is based on the land ownership of small-scale farmers and the availability and status of the land. Even if the quantities cultivated remain modest, the Jatropha plantation growth rate is fast both at national level and in this commune. This is mainly due to the prospects raised by some large foreign companies, as well private entrepreneurs, to buy and process the seeds to produce biofuels either for the local market and/or for exports. As a result, there is a significant demand from many farmers to plant Jatropha, collect and process seeds for energy purposes. The main socio-cultural constraint is the status of the farmers and the land. Some have only the right to cultivate (usufructuary or tenants for life) either collectively or individually but they are not fully-fledged owners. As long as the usufructuaries only grow non perennial short rotation plantations, the possible conflict between owners and usufructuaries is low because the investment is made on a short-term period. However, the plantation of trees is an investment over several decades. In Mali, according to customary law, it is considered that land planted with trees definitively belongs to the person or community who planted the trees. This explains the opposition of landowners to authorize migrants to plant trees including Jatropha as they may lose their landlord status. The co-operative (CPP) is responsible for all the technical, commercial and financial issues in the supply chain from the raw material (Jatropha seeds) to processing to obtain biofuel. Currently, co-operative members are benefiting from guaranteed although fixed prices for seed production. In a region with little opportunities for cash generation, this is an important economic and social safety net. In the unlikely event of a sharp fall of oil prices and diesel oil, the farmers might encounter some difficulties to sell their seeds. On the other hand, an increase of oil prices may give some margin for the co-operative to negotiate higher prices with the power plant's owner.

Increasing financial capital is a key component of this initiative as it allows the generation of new cash flows to rural farmers which dried up with the cotton crisis. The farmers have now a secure local market and a guaranteed cash income. It has also been noted that new income-generating activities have developed related to electricity usage and a decrease in the selling prices of some basic products in rural areas has occurred.

2.3 Electricity generation

The energy component of the Garalo project has been largely funded by a grant from AMADER – a parastatal company in charge of rural electrification – and an international non-governmental organisation, the Fuels from Agriculture for Communal Technology (FACT) foundation. The Jatropha supply chain is being developed by two main institutions: The Garalo Jatropha Producers' Cooperative (CPP) and the power company ACCESS. The private power company ACCESS is also responsible for generation and electricity sales. ACCESS has a capacity of 300 kW with a distribution network of approximately 13 km with the prospect for an extension of 3 additional kilometres. It is envisaged that 5% of PVO will supply the plant in 2009 which will increase rapidly over the next years to reach almost 100% by 2013. Currently 247 households are connected to the micro grid after a payment of $30 as a contribution to the connection costs. As for electricity consumption, there are two broad tariffs categories. Subscribers with 50, 150 and 300 W are paying a monthly lump sum for their electricity consumption which is respectively $5, $12 and $24. In addition, there is a modest monthly contribution for street lighting which is 0.07 cents, 0.16 cents and 0.30 cents according to the power. Other subscribers with higher power and theoretically higher purchasing power are billed according to their metered consumption at a tariff of 38 cents/kWh. In addition, they have also to pay fixed charges and higher contribution to street lighting. It is worth mentioning that the first 100 kWh are exempted from the VAT payment. The tariff structure is largely due to AMADER which provides a large grant (approximately $379,750) and is concerned by the power plant sustainability. Despite these relatively high prices, the recovery of the bills is over 90 % which demonstrates the willingness to pay for modern energy services. Customers who do not settle their bill on time were offered the option to delay the payment till their financial situation improves. Currently ACCESS has been able to recover almost 100 % of the recurrent costs.

In order to limit the monopolistic situation of ACCESS, an Electricity Consumer Association (ECA) was set up to look after the rights of the consumers and acts as an interface between the consumers and ACCESS. Although ECA does not have a legal status, it is recognised, de facto, by local authorities and attends the meetings to discuss the tariffs alongside with the key stakeholders, particularly local authorities, AMADER and ACCESS. It is AMADER’s responsibility to ensure that the subsidies are being used efficiently and according to the procedures, including tariffs, by the recipients.

One of the key objectives of this project is to generate financial benefits, directly or indirectly. Indirect financial impacts at the macro level are the substitution of diesel oil with renewable energy that is generated locally. This will reduce fossil fuels imports, even though the impact at national level is negligible due to the small scale of the project. The revenues from these indirect effects are not relevant for commercial investors, but these effects might justify financial governmental support schemes.

2.4 Financing mechanisms

This fairly large-scale and complex pilot project would clearly not have been possible without the financial support from various organizations. The different financing mechanisms that are applied in this project are shown in Table 2.

Table 2: Financing mechanisms used in the Mali Jatropha electrification project.

Organisation	Type of financing mechanisms	Target
ADAMER (rural electrification organization)	Subsidy/grant;	To reduce the electricity price for consumers.
Mali Folk Center (NGO)	Subsidy/grant	To improve the technical skills of farmers and workers and to improve progress of the project.
State	Tax scheme	To reduce the electricity price for consumers.

Crucial for the project was the subsidy of ADAMER of 380 k US $ of the total project budget of 756 k US $. This subsidy is used to reduce the costs of the electricity to a level that is affordable for the electricity consumers. Without this subsidy the electricity would be prohibitively expensive. The subsidy provided by ADAMER is covered by a grant from the World Bank, other donors and the state. The state provided a VAT exemption for the first 100 kWh of electricity that is consumed.

Further, the NGO Mali Folkecenter (MFC), apart from its coordination and mediation function, has been supporting the Jatropha committees by, setting up nurseries and distributing Jatropha plants through the village committees (CVPP), training etc. This is a crucial technical and financial input to the farmers. For the follow-up and evaluation, the FACT foundation is providing its services to MFC. Other supporting services include the hybrid power plant equipment provided by a Dutch company and the locally manufactured press.

This example clearly shows that a tailor made subsidy scheme can be crucial to turn a small-scale, but complex, economically unattractive bioenergy project into a viable and successful project.

3 Case 2: Bioethanol production in South Africa

3.1 Introduction

South Africa has a low population density, spread-out cities and a major industrial and mining region that lies more than 500 km from the coastal port areas. As a result, transport costs amount to approximately 20 % of gross domestic product (GDP) or US $ 30 billion; and the cost of transport energy accounts for about half of it i.e. 10 % of GDP. While highly dependent on the use of petrol, largely for personal transport, and diesel, predominantly for industry, mining and transport of goods, South Africa has limited production and reserves of crude oil. This led the government – vulnerable to oil sanctions – to develop large plants that converted coal and gas to liquid fuels and more recently to develop the production and use of liquid biofuels for transportation. Further, South Africa has excess of sugar cane and maize production and therefore has available bioethanol feedstock. Therefore, in this section the economics of bioethanol production in South Africa are investigated, with specific attention to the role of financing. The text is taken from the original article of Singh (2006) and adjusted when necessary.

3.2 Bioethanol production costs

For liquid transportation fuels produced from fossil oil, the oil represents about 90 % of product cost. For bioethanol, feedstock costs also represent the major portion of product costs. In South Africa, the key parameter is thus the cost of sugar cane and maize. The pricing to the growers for initial volumes is based on local food use and is an import parity price plus import duties. Once local food demand is met the products have an export parity pricing based on world markets less transport costs. The sugar cane growers receive a mixture of import and export prices as an average price less transport costs from the mills. Ethanol production should not compete with the local food market, so only export (excess) volumes should be used, and the price should thus be based on world prices. Hence in the longer term the cost (price) of ethanol must be linked to the price of the feedstock in the alternative world food market.

The key then remains to ensure that maize, sugar cane, or other competing crops, are grown and hence available at these prices. If such prices cannot be sustained then South Africa is not a competitive producer of bioethanol and should rather import it. South Africa is however an exporter of ethanol produced from sugar cane molasses, and has typically had excess production of maize and sugar cane over the period 1997-2005. The ethanol yield from maize is about 400 l/t and the average excess maize would enable production of 650 million l (Ml) of ethanol per annum. The ethanol yield from sugar is about 65 l/t, so the excess (export sugar) could enable production of 800 Ml per annum.

The agricultural market in South Africa, as in most other countries, is distorted by protection, and it is thereby difficult for non-agricultural specialists or operators (farmers) to determine whether maize and sugar cane growing at world (export) prices are ultimately viable. If this is not the case, then South Africa, given straight commercial economics, should not grow these crops. However, given that such large excesses exist and that South Africa has a warm climate, the assumption is made that excess maize and sugar cane is available at world prices, i.e., at export parity. In this case, South Africa should then also be a world-competitive producer of ethanol, and if ethanol is used locally then the transport or location advantage applies.

3.3 Fuel ethanol market and value

The petrol market alone in South Africa is 11 billion l (Gl) per annum, and as 10 % blends into ethanol are equivalent as regards use in vehicles, there is no reason why South Africa could not replace 10 % of petrol by ethanol. An ethanol market of about 1.1 Gl/year is thus available. Given that a world-scale ethanol plant produces around 80-150 Ml/year, about 6-12 plants could be accommodated. The issue is thus not one of technical suitability or market size, for the first 6 or more plants, but rather one of economics. From an investor point of view the ethanol plant must make a positive return given the risk profile, and from a national macro-economic viewpoint, the country needs to be better off.

The most critical factor regarding economic return is the fuel ethanol value and this is roughly equal to the petrol value. The petrol value is directly related to the cost of crude oil, and this is known to be the most volatile of commodities. The uncertainty of the crude oil or petrol price means that there is much uncertainty in the value of fuel ethanol and hence the commercial risk or variance is high. It can be expected that this risk is expressed into high(er) interest rates, which can hamper the realization of bioenergy projects. Under a true production cost comparison, bioethanol cannot compete with crude oil from many oil-rich, low-cost, nations. Hence, it may require support from host governments in a low crude oil price scenario.

The price of crude oil should reflect its true resource value, as it is not renewable, but at times the value has been low in comparison to current prices and may not fully reflect the dwindling resource opportunity cost and value to future generations. Given this potential for wide swings in the price of crude oil, and the cost of petrol for South Africa, an issue arises, in the first instance, to what extent bioethanol production is in the national interest, and the associated subsidies or incentives that should and can be applied.

3.4 Bioethanol investment economics

The profitability of a bioethanol plant in terms of the IRR (internal rate of return) or NPV (net present value) is determined largely by the difference between the fuel price (revenue) and the feedstock price (major cost), plus any incentives. Owing to the great volatility in the oil price, and to a lesser degree in the South African rand exchange rate and the world maize and sugar prices, profitability can vary greatly. The range in NPV for a single maize bioethanol plant investment of R 400 million for a greenfield plant with a capacity of 150 Ml/yr for 500 random scenarios of oil price ($ 25-50/b), exchange rate (R 5-10/US$), and maize price (R 600-900/t) is shown in Figure 1 as a probability curve. A fuel levy reduction of 30 %, as is current, and of 100 %, as is justifiable based on job creation (or preservation), is shown.

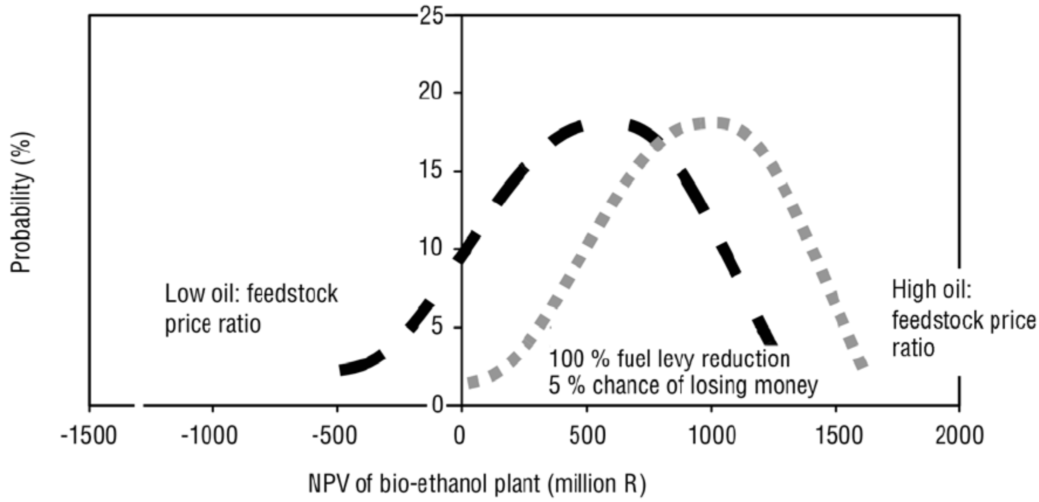

Figure 1. Investment risks of a maize bioethanol plant (capacity of 100 Ml ethanol per year)

This shows that there is about 20 % probability of losses for a 30 % fuel levy reduction. Typically, no bank will invest if probability of losses exceeds 5 %. For a 100 % fuel levy reduction, the probability of losses reduces to 5 %. It thus appears that for the assumed range of scenarios, and without any hedging or synergy effects or other subsidies, that maize bioethanol plants will not yet attract investment in South Africa unless a 100 % fuel levy reduction applies. It is noted, however, that the trend is for oil prices to increase relative to feedstock (Figure 1), and thus at some point it is likely that bioethanol for fuel will become an attractive investment. For sugar cane bioethanol plants, the largest factors influencing profitability are again the crude oil price and the cost of the sugar cane feedstock. Owing to the regulated nature of the sugar industry it is difficult to determine what is an acceptable (sustainable) sugar cane price, and hence difficult to determine return and risk. Nevertheless, sugar cane appears marginally more attractive than maize.

3.5 Hedging aspects

Clearly a high oil price has a negative effect on a number of parties, e.g., oil-importing nations such as South Africa, and oil consumers in general. For such parties an investment in fuel bioethanol serves as a hedge against high prices and if prices are low, then they could more likely afford the hedge. For low oil price scenarios the carrying cost of the fuel bioethanol investment could be considered an insurance policy against a possible change to high prices. It is thus likely that subsidies to maintain a bioethanol plant during low oil price scenarios can be justified, and these could perhaps be linked to a payback scenario for high prices. Such a head-and-shoulders support set-up is not unique, as it was applied successfully before in South Africa to establish and privatise the oil-from-coal (Sasol) synfuel plants in Secunda in the 1970s. Of course, if government initially takes all the equity, as occurred for the Sasol plant in Sasolburg in the 1950s, then this is not necessary as it can take more risk than private investors, especially considering hedge and job creation benefits.

The investment and scale of a single bioethanol plant, of about $ 100 million and 3000 b/d, is of course orders of magnitude less than what was invested by the apartheid government in the plants in Secunda in the late 1970s and Mosselbay in the early 1990s of about (2006) $ 30 billion (1/300th) and 50,000 b/d (1/20th).

3.6 Carbon credits

Carbon credits under the Kyoto Protocol's Clean Development Mechanism (CDM) do not apply where projects are carried out under "business as usual" scenarios and can "stand on their own feet", i.e., are commercially attractive, and thus would probably not apply to bioethanol plants for (current) high oil prices. In addition, the current level of carbon credit price of US$ 7/t CO_2 amounts to about 35 SA¢/l for an extremely efficient sugar-cane-to-ethanol plant such as in Brazil with a greenhouse gas reduction of 5 times compared to petrol from crude, based on LCA (life-cycle analysis). For maize, the greenhouse gas reduction is typically 25 % of that of sugar cane, and thus about 9 SA¢/l, which is low in comparison to fuel levy reductions. Nevertheless, carbon credits can be significant amounting to about R 9 million/year for a 100,000 l/year maize bioethanol plant, or about 20 % of capital repayments on a R 400,000 investment.

3.7 Capital investment incentives

South Africa currently allows accelerated depreciation of biofuel investments: 50 % in Year 1, 30 % in Year 2, and 20 % in Year 3. Assuming a R 400 million investment means that R 200 million can be deducted from profits in Year 1, and with an effective corporate tax rate of the order of 30 %, this equates to a saving of R 60 million, or 60 SA¢/l in Year 1. Recently, to support investment in renewables, the Department of Minerals and Energy has created a subsidy office that will provide a maximum capital subsidy of 16.7 SA¢/l for bioethanol plants. A limitation of R 100 million total capital project cost however applies, and given that world competitive fuel bioethanol plants need to be of the order of 80,000 l/year capacity, an investment of about R 400 million is required. There is no doubt that further negotiation on this new scheme as regards bioethanol plants will occur. Thereby, crucial for the government are also the indirect economic advantages and disadvantages, which may justify the accelerated depreciation of biofuel, and which are discussed in the following section.

3.8 Macro-economics, job creation and subsidies

A macro-economic model that was developed for the Department of Minerals and Energy (DME) to examine the South African oil industry was extended to include ethanol production and substitution of petrol supply, so that the national effects of bioethanol substitution for petrol could be examined. On the basis of South Africa's current balanced petrol-refining capacity (supply equalling demand) and excess capacity for other products (supply exceeding demand and leading to exports for distillates, LPG, fuel oil, and bitumen), the impact was examined of reducing petrol-refining and reducing crude oil imports through substitution by ethanol from maize. It is important to note that the scenario was based on additional maize production without reducing other crop production. This assumption is made, as to simply use existing crops, i.e., diverting export maize to ethanol production, has little additional effect, as 90 % of the jobs are generated in the agricultural sector. However, in the long run this assumption is probably right, as it protects against reduced crop-growing and job losses rather than providing new jobs, i.e., would be defensive rather than offensive as to the provision of needed employment. A similar scenario was also generated for ethanol from sugar cane, and the results and findings are similar. The results are shown in Table 3.

Table 3: Impact (million R/yr) of 1 % ethanol in national petrol volumes (100 Ml/yr) in South Africa.

Impact on	Average	Minimum	Maximum e.g. for $ 50/b
Balance of payments	260	85	550
GDP	300	230	450
Fiscus[1]	-45	-75	-10
Labour[2]	50	50	50

Notes:
0. All figures in million R/yr based on 30 % fuel levy reduction for biofuels (versus petroleum fuels) and 500 random scenarios based on ranges of oil price (25-50 $/b); exchange rate (R 5-10 = $US 1); and maize price (R 600-900/t)
1. This refers to impact on tax revenues of the state.
2. This is as wages earned, so reflects impact on earnings.

The results are estimated using a model in which 500 random scenarios are examined based on oil prices from $ 25 to 50/b; an exchange rate varying from R 5 to R 10/US$; and maize prices from R 600 to 900/t. The (positive) impacts are as follows:

- GDP: 0.025 % increase (growth), so 10 % ethanol in petrol would give 0.25 % increase in GDP that is roughly equal to 8 % of the desired GDP growth rate of 6 %.
- Jobs: 3000 jobs are created (or protected), and the job intensity in jobs/l is about 100 times that of refining imported crude oil.
- Capital expenditure in the ethanol plant is R 100,000 per job. This is 2.5 times lower than the IDC (Industrial Development Corporation) target of R 250,000 per job.
- Fuel levy reduction support of a job is R 10,000/annum. This cost of a job is 10 times less than the average South African job, and 20 times less than the Motor Industry Development Programme (MIDP) cost of a job based on import duty of 35 % on new cars, and that equates to support of a local motor industry job of average of R 200,000/annum. Hence, based on job creation (alone), support of up to 10 times the current fuel levy reduction (30 %, 35 SA¢/l or US$ 0.06/l) is justifiable. This level of subsidy for ethanol is well within the WTO permissible limit of 100 % fuel levy reduction.

3.9 Conclusions

The financial model of investment in a maize-to-ethanol plant showed that to make the risk of losing money acceptable at a probability of 5 % maximum requires a fuel levy reduction of 100 % (116 SA¢/l). There is an accelerated depreciation allowance for tax deductions that would lead to a saving of about 60 SA¢/l in Year 1, 36 SA¢/l in Year 2, and 24 SA¢/l in Year 3. The South African government is currently introducing a renewables capital subsidy of a maximum of 16.7 SA¢/l, or about 15 % of the fuel levy reduction for one year, subject to certain conditions.

Given the South African government’s target to increase the use of renewable energy, the increasing ratio of the prices of oil products to those of food, the increasing demand for transport fuels, it appears likely that it is not a case of *if* bioethanol will replace some 10 % of petrol usage in South Africa, but rather of *when.* The timing will be largely determined by the level of support provided by the government. The government needs to ensure that the level of support is such that the interests of bioethanol investors and feedstock providers are balanced with those of fuel consumers. Crucial thereby are the direct and indirect benefits in terms of reduction of GHG emissions, employment, trade balance of payments and GDP. Analyses showed that 1 % bioethanol (one plant of 100 Ml/yr) saves about R 300 million on balance of payments and contributes a similar amount to GDP, such that 10 % ethanol in petrol would give about 8 % of the targeted 6 % economic growth in one year. The jobs for bioethanol, of which 90 % are for growing the feedstock, are approximately 100 times more/l than for petrol refined locally from crude oil. The fuel levy reduction cost per job is R 10,000/year, or 1/10th of the current cost of a job in South Africa, such that a fuel levy reduction of 10 times the current 30 % [7] could be justified. The maximum fuel levy reduction allowed under WTO is 100 %, so a threefold increase in the fuel levy and a 100 % exemption for biofuels could be justified on job creation considerations.

Yet, for commercial investors, even a probability of a loss of 5% might be unacceptable considering the different risks associated with this type of large-scale bioenergy projects. These risks include, among others, the risk that the VAT exemption will be reduced in the future, the risks associated with the potentially unstable, unsecure costs and supply of energy crops, the general risks associated with investing in South Africa. These risks are translated into high(er) interest rates compared to other regions and well-established energy production systems. Therefore, South Africa currently allows accelerated depreciation of biofuel investments: 50 % in Year 1, 30 % in Year 2, and 20 % in Year 3. Moreover, to support investment in renewables, the Department of Minerals and Energy has created a subsidy office that will provide a maximum capital subsidy of 16.7 SA¢/l for bioethanol plants. A limitation of R 100 million total capital project cost however applies, and given that world competitive fuel bioethanol plants need to be of the order of 80,000 l/year capacity, an investment of about R 400 million is required. There is no doubt further negotiation on this new scheme as regards bioethanol plants will occur. Further, recently a national biofuels policy was approved that includes a target of 2 percent of fuel supply from biofuels by 2013. This policy excludes corn as a feedstock, restricting the 2 percent target to biodiesel made from soybeans, canola or sunflower oils, or ethanol from sugar cane or sugar beet. The policy also will implement a 50 percent fuel tax exemption for biodiesel and a 100 percent exemption for ethanol.

Carbon crediting through the Kyoto Protocol’s Clean Development Mechanism (CDM) is not likely. Reasons are that the carbon credits do not apply where projects are carried out under “business as usual” scenarios and can “stand on their own feet”, i.e., are commercially attractive, and thus would probably not apply to bioethanol plants for (current) high oil prices. In addition, the current level of carbon credit price of US$ 7/t CO_2 amounts to about 9 SA¢/l for maize ethanol, which is low in comparison to fuel levy reductions. Nevertheless, carbon credits can be significant amounting to about R 9 million/year for a 100,000 l/year maize bioethanol plant, or about 20 % of capital repayments on a R 400,000 investment. This would require further investigation by investors in potential plants, and would depend on whether energy is exported or imported, and on which system is replaced.

These results suggest that the production of biofuels in South Africa is hampered by limited commercial investments. Commercial investors are reluctant to invest in biofuels production, mainly because of the risks associated with the production of biofuels. Examples of these risks are the risks that the VAT exemption or other biofuels promoting policies will be reduced or changed in the future, the risks associated with the potentially unstable costs and supply of energy crops and the general risks associated with investing in South Africa. The African Development Bank or other international organisations could assist the development of biofuels in these regions especially by reducing the risks for commercial investors. Especially the additional benefits from these projects in terms of the improvement of the trade balance, the increase of GDP and taxes and the employment effects, make these projects potentially interesting for organisations such as the African Development Bank. Potentially useful financing mechanisms are carbon credits, low interest rate loans and various other financing mechanisms that alleviate negative impacts of price fluctuations and other risks, thereby reducing the risks for commercial investors. Also the accelerated depreciation of biofuels investments, which is allowed by the government in South Africa, could benefit from a higher maximum total capital project cost. At this moment a limitation of R 100 million total capital project cost applies, which is well below what a large-scale, commercial, 80,000 l/year capacity plant would require, which is R 400 million. The African Development Bank and similar bodies could thus potentially play a role in increasing this threshold.

Case 3: Biodiesel production in Ghana, Kenya and Tanzania

3.10 Introduction

Over the past decade, consumption of transport fuels in Sub-Saharan Africa has increased at a rate of about 7% per year in line with increased economic activity. A problem thereby is that some 39 countries in Africa are net oil importers. This results in a negative balance of payments and exerts a heavy burden on public finances, ultimately to the detriment of public services and profitability of oil-consuming businesses.

In recent years, there has been much discussion about substituting petroleum diesel with biodiesel. Whereas using domestically produced biodiesel was only an insignificant phenomenon some decades ago, it has now been introduced in the policies of countries and financial institutions as a way to mitigate the impact of high oil price. With large landmass for farming, Sub-Saharan Africa is increasingly being viewed as a region with a fairly high potential for biofuels production.

In this section the focus is on the potential for biodiesel in Sub-Saharan Africa, using three cases: diesel produced from palm oil in Ghana, Jatropha diesel in Tanzania and castor oil diesel in Kenya. The analysis will look at country specific issues in relation to biodiesel production as well as carrying out a comparative economic analysis and greenhouse gas (GHG) emissions analysis of blending 20% of the total consumption with biofuels. Also the implications of a large-scale biodiesel programme on land use, food supplies and poverty reduction is included, as well as an evaluation of different financing mechanisms. The text in this section is based on the publication of Mulugetta (2009).

3.11 Economics of biodiesel production

In this section the economics of substitution of 20% of petroleum diesel with biodiesel (also known as B20) using a different feedstock in each of the three countries is investigated using the data in Table 4.

It is estimated that diesel consumption will increase at an annual rate of 5% into the foreseeable future, indicating that in order to maintain a 20% biodiesel blend the amount produced and sold would need to increase every year. However, the analysis in this paper will be restricted to capture the substitution of biodiesel for the baseline year of 2004 in order to have an appreciation of the long-term economics of meeting today's 20% share of diesel consumption. The financial analysis for each country was carried out using 5%, 9% and 12% discount rates over 15 years of the biodiesel plant life. The results are shown in Figure 2.

Table 4: General data and assumptions used in the cost calculations.

	Ghana	**Kenya**	**Tanzania**
Diesel consumption in 2004 (l)	524,000,000	574,938,000	599,781,000
10% biodiesel blend (l)	57,000,000	62,500,000	65,000,000
20% biodiesel blend (l) (incl. thermal conversion)	114,000,000	125,000,000	130,000,000
Feedstock	Palm oil	Castor oil	Jatropha
Yield (in kg/ha)	23,700	4700	7000
Yield (in litres oil/ha)	5000	1700	2100
Energetic equiv. (kWh/ha)	178,000	60,520	74,760
Oil seed price ($/1000 kg)	120–210[(3),(5)]	300–500[(4)]	180–400[(6)]
Oil price ($/1000 l)	25–44	108–180	54–120
Price ($/ha)	2840–5000	1400–2350	1260–2800
Oil seed amount (t) 20% blend	540,390	345,213	434,310
Meal amount (t) 20% blend	443,121	286,075	356,135
Land area required			
At 10% blend (in ha)	11,400	36,765	30,950
At 20% blend (in ha)	22,800	73,530	61,900
Capital cost ($) (excl. crushing plant)	18,150,000	19,510,000	19,544,000
Pre-design ($)	405,000	417,000	425,000
Buildings ($)	2,000,000	2,000,000	2,000,000
Equipment ($)	8,950,000	9,740,000	10,165,000
Contingency (10%) ($)	1,650,000	1,773,000	1,840,000
Construction management ($)	855,000	930,000	970,000
Engineering and design ($)	2,855,000	3,100,000	3,230,000
Operation and start-up ($)	1,425,000	1,615,000	1,615,000
Crushing plant ($)	14,575,000	15,990,000	15,990,000
Operating cost ($)	112,620,712	124,914,400	111,280,400
Raw materials			
Oil ($)	86,463,000	103,564,000	86,862,000
Methanol ($)	4,180,000	4,668,800	4,810,000
Catalyst ($)	2,171,500	2,388,700	2,497,000
Crushing charge ($) ($30/t)	16,212,000	10,357,000	13,029,000
Transport ($) ($0.013/l oil)	1,710,100	1,873,000	1,954,300
Energy ($) ($0.014/l oil)	1,596,100	1,748,000	1,824,100
Management/maintenance ($)	287,700	314,900	304,000
Income ($)	125,671,000	135,096,000	132,353,000
Sale of biodiesel ($)	92,300,000	113,725,000	105,485,000
Sale of glycerin ($) ($200/t)	137,000	150,000	158,000
Sale of meal ($) @ $75/t	33,234,000	21,231,000	26,710,000
Discount rates	5%, 9% and 12%	5%, 9% and 12%	5%, 9% and 12%
Current cost of diesel in domestic market (US $)	0.88	0.99	0.88

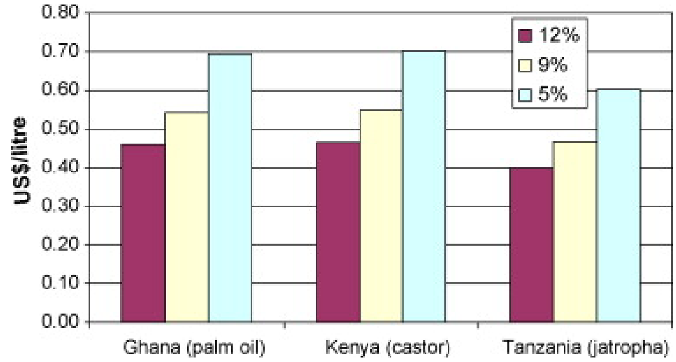

Figure 2. The levelised costs of biodiesel production for different discount rates.

Figure 2 shows that the levelised cost of biodiesel production falls in the range of \$0.40 and \$0.70 per litre. The calculation shows that Jatropha in Tanzania performs better production cost than biodiesel from palm oil and castor. Overall, as long as the price of diesel remains under \$0.70 per litre, biodiesel can be regarded as an acceptable investment, particularly for oil-importing countries that face foreign currency shortages.

A crucial aspect for investors is the risk that is associated with the investments. There are various risks associated with this type of biodiesel investments, which results in relatively high interest rates compared to established energy technologies. Further, also the risks associated with investments in developing countries are typically higher. These risks are quantified below by means of a sensitivity analysis.

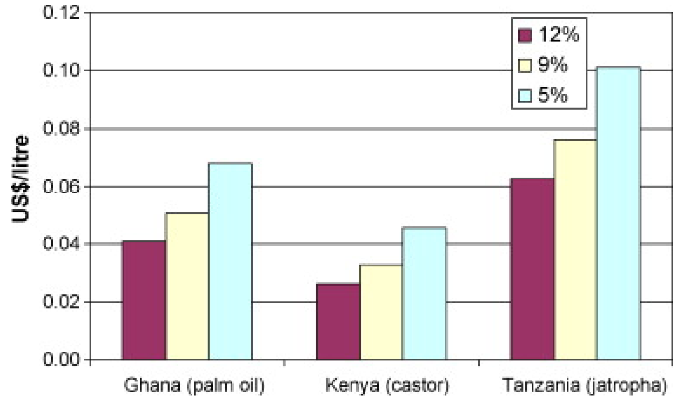

Figure 3. Sensitivity of the levelised income from sales of biodiesel for the discount rate.

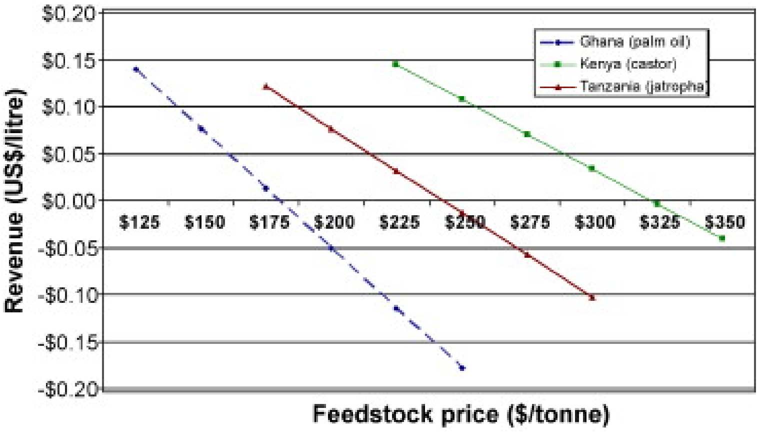

Figure 4. Sensitivity of the revenues for the feedstock price at 9% discount rate.

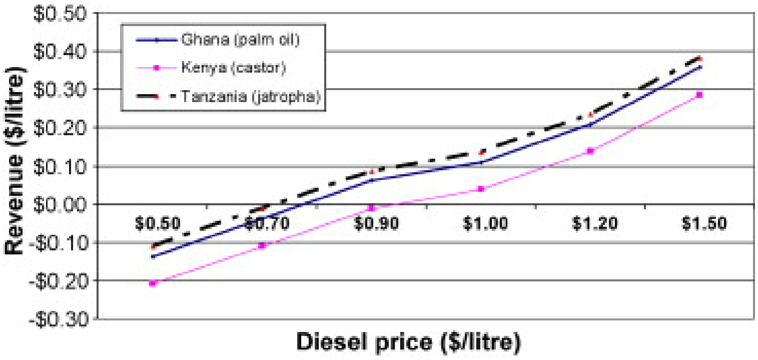

Figure 5. Sensitivity of the revenues for the diesel price at 9% discount rate.

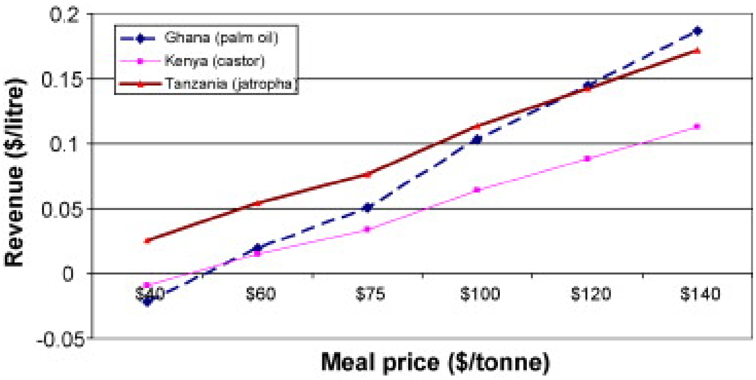

Figure 6. Sensitivity of the revenues for the meal price at 9% discount rate.

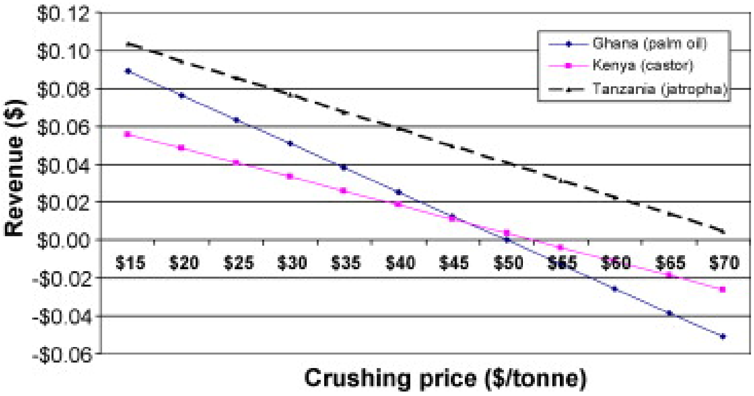

Figure 7. Sensitivity of the revenues for the crushing price at 9% discount rate.

The cost of feedstock is the dominant factor in determining final production cost given that it accounts for over 75% of the total cost. For example, at current price of palm seed of $160/t, the total annual operating cost of producing biodiesel in Ghana amounts to about $112.6 million (Table 4). Of this total, the price of oil palm accounts for over 85% of the cost, indicating the significance of feedstock as a decisive factor in determining the viability of biodiesel programmes. In the sensitivity analysis of feedstock costs illustrated in Figure 4, the break-even cost of Jatropha (Tanzania) and castor (Kenya), assuming all other costs remaining constant are shown to be approximately of $240 and $325 per ton, respectively.

When the price for feedstock is above this figure, operating losses would compromise the cost-effectiveness of biodiesel as an alternative fuel. For biodiesel programmes to create a positive net return, it is therefore imperative to acquire low-priced feedstock, which means identifying ways in which the oil plants that can be grown cheaply and reliably.

Another source of risk involves changes in the retail diesel prices. Uncertainty in the world oil market over the past 5 years has created some alarm about the implications this will have on countries that are strapped for cash.
Figure 5 shows the relationship between the net return (revenue) per litre against a range of diesel prices. The break-even cost of biodiesel from Jatropha and palm oil, assuming all other costs remaining constant, follows a similar pattern of about $0.70 and $0.78 per litre, while the minimum selling price of castor-based biodiesel would need to be around $0.93 per litre. When the price of diesel goes above these thresholds, the programmes in the respective countries create positive net returns, but when the price of diesel comes down, it means that the cost effectiveness of the biodiesel programme is in question.

The revenue earned from the crushing and refining process (from vegetable oils to usable energy) makes a crucial contribution to the overall viability and competitiveness of biodiesel programmes. Here, the price obtained for the meal (co-product) is an important cost factor, but is dependent on the local market, which means that the price for the meal is commensurate to the monetary value the end-users attach to it. The sensitivity analysis, presented in Figure 6 shows that there is a considerable variation in revenue in function of meal price. For the three cases in this paper, every $10 difference in meal price represents on average of about $10 to $20 per 1000 l difference on revenue, hence illustrating that the business case for biodiesel initiatives would need to incorporate analyses of market for co-product. Extraction of oil from oil seeds can be carried out by mechanical means or by using a solvent extraction stage into the process. Prior to the removal of the crude oil from the seed by crushing or pressing, there are a number of preparation stages including seed cleaning, removal of seed coat, flaking and heating of the flaked seed. Each of these stages is labour and energy intensive and adds to the operation and maintenance costs in addition to the potentially high-capital outlay for the oil seed crushing equipment. Figure 7 shows the sensitivity analysis of crushing price per ton of oil seed. A range of crushing price from Canada ($70/t, Government of Alberta), UK ($40/t), India ($30/t) and Brazil ($15/t) are used to illustrate the effect crushing price will have on overall economics of a biodiesel programme.

3.12 Financing mechanisms

When the biodiesel production costs are offset by the income from biodiesel sales in the market, potentially substantial revenue can be generated in all three countries (Figure 2). The revenue from using Jatropha feedstock in Tanzania shows profits between US$0.06 and US$0.10 per litre of biodiesel. Investors willing to take risks in this type of venture are likely to do well in both Tanzania and Ghana. Revenue for biodiesel obtained from castor oil in Kenya shows positive results, although not quite as attractive as in the other two cases. A combination of three factors can explain this discrepancy. First, the yield per hectare from castor oil is about 194% lower than palm and a modest 25% lower than Jatropha, and if the value of land is incorporated into the calculation, the figure could even be less favourable to castor. Secondly, the price of castor seed in the market place of $108–180/1000 l is significantly higher than that of the other two feedstocks, largely because castor is a highly sought after commodity for a range of industrial purposes and productivity of castor seed per hectare is relatively low. Thirdly, the price for the meal co-product is an important in determining the economics of a biodiesel programme. In this case, the amount of meal obtained from castor is considerably lower than the yields from palm and Jatropha, which can influence the overall level of income from biodiesel. Every year, there would be a difference of between $5 and $10 million provided the price of meal from the different feedstock in different countries remains the same.

Overall, given stable macro-economic conditions, biodiesel can become a competitive source of fuel. It could also offer lucrative business opportunity for those willing to invest and absorb the relatively high risks involved in the business of cash crops. For the three countries presented in this paper, which are net importers of petroleum fuels, it means two things. First, it means an increased level of energy security as a result of increasing domestically sourced diesel, hence limiting the shock felt from petroleum price fluctuations. Secondly, it enables countries to save their hard earned foreign currency to devote it to other development priorities that require the outlay of internationally tradable currencies.

However, there are important factors that need to be kept in mind while looking at the results of this study.

First, the calculations carried out do not take into account tax on fuels. The results assume that the governments in the three countries considered in this study would give tax exemptions for domestic sales in order to stimulate the biofuels market and to facilitate return on investment.

Secondly, the sensitivity analysis shows that the revenues are highly dependent on, among others, the diesel price, the meal price and the feedstock price. The development of these factors is uncertain, which is a risk for investors. Tailor made financing mechanisms can be a way to reduce these risks, or the risks for one of the other stakeholders (e.g. farmers), e.g. through guaranteed tax exemptions, grants, low interest loans, minimum and maximum prices for feedstocks.

Thirdly, the factors of production in Sub-Saharan Africa and elsewhere in the developing world are bound to be different from those in industrialized countries for reasons of differences in technological and managerial skills and labour costs. Further, at present, oil palm and castor are only grown at a small scale in parts of Sub-Saharan Africa where productivity per hectare of land area is likely to be lower than used in this study. The feasibility of biodiesel programmes is therefore dependent on the benefit and costs at each stage on the commodity chain, i.e. from feedstock productivity up to the biorefinery stage. It means yield would need to be improved with improvements in inputs and management for the crops, as well as state-of-the-art technology for pressing oil and larger scale production.

Finally, it is important to remember that the principal driver of the discussion to consider biofuels in Africa is energy security. Oil importing countries would like to reduce their dependency by using substitutes for fossil fuels from indigenous sources, and given land is 'readily available', biofuels represent a logical option towards energy independence. While this may be true to a certain extent, there is also an argument that the linear extrapolation of diesel demand may mask the shape of real demand, which may be suppressed by limited supplies and high prices. In other words, market dynamics include other non-linear behaviours such as 'feedbacks' as in the example of increased supply of biodiesel reduces fuel prices. The effect of lower prices reduces the per-kilometre cost of driving which may lead to an increase in the total number of kilometres driven. The economic principle that leads to increased levels of consumption as a result of actions that improve technology and reduce consumer costs is widely known as the 'rebound effect'—an extension of the 'law of demand'. While there is a net increase in energy security after the rebound effect occurs as well as increased consumer benefits from increased vehicle travel, the rebound effect can significantly change the nature of the benefits from the original plans. It is therefore important to take into account the degree of the 'rebound' when evaluating a biofuels programme by surveying the level of suppressed demand in the diesel market.

Based on the previous sections, it can be concluded that, given stable macro-economic conditions, biodiesel can become a competitive source of fuel. However, it remains highly uncertain if commercial investors would be interested in these projects, because of the various risks and uncertainties associated with investments in biofuels. Therefore, financial support from the World Bank, African Development Bank and similar organisation production of biofuels might be essential. Due to the high risks associated with investments in biofuels in Africa countries, commercial banks typically charge high(er) interest rates. The results in this paper show the discount rate has a large impact on the production costs (Figure 3). This is therefore one of the targets that might be essential for financial support from these international organisations. Especially low interest loans or other loans with favourable lending criteria seem potentially effective strategies to stimulate investments in large scale biofuels production. Further, the results are also sensitive to other parameters, such as the price of the co-product (meal) and that of the feedstock. Other potentially effective financing mechanisms could thus be targeted at reducing these risks and ensuring stable markets and prices for these commodities.

4 Case 4: Tanzania sisal biogas

4.1 Introduction

The population of Tanga Region has been increasing since 1957, and as a result of high population density, forests have become endangered and wood scarce. The increasing need for income and food is not matched by increased economic development or food production. Sisal is the most important cash crop, used to produce yarns, ropes, carpets, clothing and composites, and sold to the domestic and international markets.

Since 1999, Katani Ltd, a sisal growing and processing company, has developed a system of smallholder and out-grower sisal farming, on the company land and in the surrounding areas. Using current production methods, only 4% of the actual plant is recovered as fibre, the residue is either burnt, producing carbon dioxide, or rotted naturally, producing methane. At Katani Ltd this residue is now converted to biogas. The biogas is used to run electricity generators and the excess electricity produced is supplied to out-growers/smallholders homes, schools and hospitals. An overview of this project is shown in Table 5.

Table 5: An overview of the Tanzania sisal biogas project.

Initiative Name	Katani Ltd SISO Project and Cleaner Integral Utilisation of Sisal Waste for Biogas and Biofertiliser
Location	- SISO Project located on all 5 estates owned by Katani, all within 150km of Tanga City, Tanga Region, Tanzania - Cleaner Integral Utilisation of Sisal Waste for Biogas and Bio-Fertiliser located at Hale Estate.
Initiation Date and Duration	- SISO Project initiated 1999, 9 years duration - Cleaner Integral Utilisation of Sisal Waste for Biogas and Biofertiliser subsequently initiated 2005, 4 years duration
Funder(s)	- SISO Project: Katani Ltd (Private Company), no external funding. - Cleaner Integral Utilisation of Sisal Waste for Biogas and Biofertiliser: CFC, UNIDO, Tanzanian Government, Katani Ltd.
Project Initiator	- Both projects initiated by Katani Ltd and Tanzania Sisal Board.
Overall Budget	- SISO Project: Predominantly financed by Katani Ltd and farmers - Cleaner Integral Utilisation of Sisal Waste for Biogas $1,503,312
Output	Production of sisal, with sisal waste used to power the biogas plant at Hale, which has an output of 150kW. The biogas plant is to be replicated on all estates, to produce 6MW of electricity.
Area of Land	By end of 2007, 4500 ha planted with sisal with total land allocation of 12000 ha.
Beneficiaries	- SISO Project: 2000 Families – Income and electricity through local grids. Though not yet beneficiaries it is intended that local communities, outside the SISO scheme, will benefit from the provision of low cost access to energy in the future.
Source	FAO (2009). The text in the remaining of this section is taken directly from this report and supplemented where necessary

4.2 Sisal production

Out-growers and smallholders sub-lease land from Katani, on which they produce sisal under contract for sale to Katani Ltd. Planting and harvesting takes place all year long, so there is no seasonal effect on earnings. The farmers are paid monthly, and they are guaranteed a market for their product. There is little vulnerability to environmental shocks since sisal is drought resistant and provides an income even if food crops fail, thereby increasing financial security. Further, Katani Ltd provides a guaranteed market for the sisal.

Food security is assured through intercropping and continued growth of food on traditional land in the village, reducing the likelihood of any food versus fuel conflict. The introduction of the sisal programme typically gives rise to increased yields for crops grown alongside it, e.g. an increase in maize yields when grown alongside sisal from 400 kg per hectare (the average for Tanga Region prior to the programme) to 1,200 kg per hectare after the programme was noted in a UNIDO and CFC report (2006).

Both out growers and Katani Ltd are linked to the Sisal Value Chain which includes the international market; they are therefore at risk from changes in international markets and finance. Katani has overall responsibility for production and sale of sisal. Katani Estates pays primary producers US$ 370 per tonne of fibre while they get US$ 850 per tonne covering processing costs and Katani Limited gets US$ 85 per tonne. The revenues continue throughout the year. Katani buys farm inputs and sells the sisal through well established marketing channels worldwide. Katani receives the revenue from these sales. All other providers of services for Katani are under contractual arrangements and receive income for the work carried out. The Sisal Association of Tanzania, NSSF and TSB are bodies established by Acts of Parliament.

Further, it is crucial that land taxes, taxes on labour, and taxes on production need to be reduced to encourage farmers to expand their holdings. Investment funds for investment in agriculture in Tanzania are still hard to access; only firms those from overseas or with foreign connections have been able to get all the financing they require. Farmers on their own cannot afford to venture into adopting new technologies. Transport costs locally are very high due to fuel costs. At present, a financing window for agriculture has been opened at the Tanzania Investment Bank.

4.3 Electricity generation

At this moment, only 4% of the actual plant is recovered as fibre. The residue was either burnt, producing carbon dioxide, or rotted naturally, producing methane. The use of sisal waste for bioenergy is thus environmentally beneficial. Converting the waste to biogas increases the profit to farmers, since 80% of the plant mass is suitable for biogas production.

At this moment, the biogas is used to run two 150kW electricity generators for a rated total electricity output of 300 kW, with an intended output of 500kW by the end of 2009. The electricity is used mainly within the decortication plant and some of the excess is supplied to the domestic quarters within the estate. The excess biogas can also be distributed to surrounding communities to cover cooking and lighting requirements. The planned Phase 2 of the biogas project involves a scale up from 150kW to 300kW. Phase 3, in 2009, involves developing biogas for vehicles and piping fuel to households, which will cost US$ 100,000. Nine other commercial-scale plants will be established at the other nine factories owned by the company, each with the capacity to produce 1 MW of electricity. This will give Katani an overall output of 10 Megawatts of electricity with a similar amount of process heat.

The excess electricity is used to provide light for work during non-daylight hours, and to run small-scale industries, which can subsequently increase their incomes. Katani provides energy services to the local schools and hospital. It is difficult to assess the full impact of the Cleaner Integral Utilisation of Sisal Waste for Biogas and Biofertiliser as only phase one has been completed. However, higher standards of living, alongside increased levels of employment have already decreased rates of migration from rural to urban areas.

4.4 Financing mechanisms

Several financing mechanisms are applied in the sisal biogas project. Several international organisations financed this project, in collaboration with governmental bodies and private parties. Similar support mechanisms are also potentially useful for the African Development Bank and related organisations.

First of all, the investments for this biogas project came from The Common Fund for Commodities (UN Body) US$ 927,712; UNIDO US$ 225,600; and the Tanzanian Government US$ 350,000, during phase one of the pilot plant. Ongoing financing is received from government and external agencies. The project is managed by UNIDO and a 16-member coordinating committee with representation from the FAO, CFC, UNIDO, TSB, Katani Limited, the Sisal Association of Tanzania (SAT) and relevant government ministries. These figures indicate that substantial investments and support schemes from the African Development Bank and related organisations are essential for this type of sisal biogas projects, since commercial investors would not be interested in this project.

Further, the planned Phase 2 of the biogas project involves a scale up from 150kW to 300kW, requiring US$ 472,026 in funds. Phase 3, in 2009, involves developing biogas for vehicles and piping fuel to households, which will cost US$ 100,000. Nine other commercial-scale plants will be established at the other nine factories owned by the company, each with the capacity to produce 1 MW of electricity. This will give Katani an overall output of 10 Megawatts of electricity with a similar amount of process heat. However, funding is not yet available to install the 10 MW capacity. Moreover, the biogas project is now profitable and Katani Ltd plans to provide local access to low cost bioenergy via a system of mini grids from their biogas plants. Funds are being sought to undertake the work and plans are under development.

Further, Katani Ltd assists the farmers in forming registered community-based operations and accessing loans, and, grants to pay for services; and facilitates the repayment of loans to financiers. In 2006 Katani Ltd mobilised US$ 1.2 million in loans for farmers and is presently negotiating a further US$3.3 million. The firm has set up the Mkonge Umoja Savings and Credit Co-operative Society with a capital of around US$ 500,000**.** Katani are assisting farmers in strengthening community based organisations so that they provide the full range of production and delivery of services.

This example clearly shows that a tailor made financial support scheme can be crucial to turn a small-scale, but complex, economically unattractive bioenergy project into an economically viable and successful sustainable energy project. Without the substantial investments from various (inter)national organisations these projects would not have been realised. Commercial banks and other private parties typically consider this type of projects as too risky or they charge high interest rates. Further, it should also be noted that the additional benefits, such as the higher standards of living, the increased employment and the reduced migration contribute to the success of the project. These are additional benefits that are very much in line with the development goals of the World Bank.

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