Liquid Biofuels Strategies and Policies in selected African Countries

A review of some of the challenges, activities and policy options for liquid biofuels

WORKING PAPER

June 2011

Prepared for PISCES by Practical Action Regional Office for Eastern Africa in collaboration with Pipal Ltd

Although this research is funded by DFID, the views expressed in this report are entirely those of the authors and do not necessarily represent DFIDs own policies or views. Any discussion of their content should therefore be addressed to the authors and not to DFID.

Author: Sue Canney Davison PhD., Pipal Ltd
Contributors: Steven Hunt, Colin Pritchard, Tom Moloney, Shaun Ruseynaar, Ewan Bloomfield, Francis Xavier Ochieng and Tameezan wa Gathui
Editors: Steven Hunt, Colin Pritchard, Francis Xavier Ochieng, Tameezan wa Gathui

Cover Images: Main Image: Jatropha Plant, India (Photo: Raffaella Bellanca), Inset: Jatropha Farming (Photo: Practical Action)
All images: Practical Action (unless otherwise stated)

List of Figures

Figure 1	Demand for water in utilisation of biofuels in motor vehicles	7
Figure 2	Data from BP Statistical review of world energy 2010	8
Figure 3	Jatropha Plant, India	13
Figure 4	Ethanol Stove, Madagascar	21
Figure 5	Community-owned micro distillery of ethanol	28
Figure 6	Pedal-driven biodiesel reactor	30
Figure 7	Biodiesel Production from Jatropha	31
Figure 8	Stove user talking about the CleanCook stove	33
Figure 9	Woman cooking on clean ethanol stove, Kenya	34
Figure 10	Palm oil processing	41
Figure 11	Strategic national choices on biofuels development: A Decision Tree	50

List of Abbreviations

ACTS	African Centre for Technology Studies
BAZ	Biofuels Association of Zambia
CBRDP	Community Based Rural Development Project
CDM	Clean Development Mechanism
CEF	Central Energy Fund
COMPETE	Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semiarid Ecosystems – Africa
EU	European Union
FAO	Food and Agricultural Organisation
FDI	Foreign Direct Investment
IDC	Industrial Development Co-operation
NEPAD	New Partnership for African Development
NGOs	Non Governmental Organisation
OPEC	Organization of Petroleum Exporting Countries
R&D	Research and Development
TaTEDO	Tanzanian Traditional Energy and Development Organisation
U.S.A	United States of America
UNCTAD	United Nation commission for Trade and Development
UN-REDD	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
WWF	Wild Wide Fund for nature

Contents

List of Abbreviations		2
FOREWORD AND ACKNOWLEDGEMENTS		4
ABSTRACT		4
1.0	**The global context of energy and biofuels and how it affects Africa**	**7**
1.1	Current global perspective	7
1.2	Africa's energy poverty	9
2.0	**The risks and opportunities of biofuels development in Africa**	**12**
2.1	Opportunities	12
2.1.1	The current case for *Jatropha Curcas*	13
2.2	Risks	16
2.2.1	Risks from knowledge gaps and climate change	16
2.2.2	The risks of depending on Climate Change Market Systems and Foreign Direct Investment	16
2.2.3	Risks from large scale commercialisation	18
2.2.4	Risks from failure	19
2.2.5	Risk of increased vulnerability of women and children	20
2.2.6	Risks from migrant harvesting populations	22
2.2.7	Risks from competition for natural resources	22
2.2.8	Risks from lack of inter-ministerial integration	22
3.0	**Economic and policy drivers and responses in biofuels development**	**23**
3.1	Best practice aspects/ingredients in developing a national biofuels industry	23
3.2	Approaches to Supporting the industry to become sustainable	24
3.3	Government programmes for financing the industry	25
3.4	Environmental safeguards	25
4.0	**Review of biofuels development experiences**	**26**
4.1	Non-African Countries	28
4.1.1	Brazil	28
4.1.2	China	29
4.1.3	India	30
4.1.4	Malaysia	31
4.1.5	European Union (EU)	32
4.2	African Countries	32
4.2.1	NEPAD	33
4.2.2	Angola	33
4.2.3	Ethiopia	33
4.2.4	Ghana	34
4.2.5	Kenya	37
4.2.6	Malawi	36
4.2.7	Mali	37
4.2.8	Mozambique	38
4.2.9	Nigeria	39
4.2.10	South Africa	40
4.2.11	Tanzania	40
4.2.12	Uganda	41
4.2.13	Zambia	42
4.2.14	Zimbabwe	43
5.0	**Conclusions and Recommendations**	**45**
BIBLIOGRAPHY		51

FOREWORD AND ACKNOWLEDGEMENTS

Biofuels policies and activities in Africa are in constant change and development as the industry starts to settle into its first major explorative phase and critical mass. This report therefore represents no more than a snapshot in time. By the time it is published, many things will have moved on or changed, and we hope the report will continue to evolve in some form.

Many reports are written from different angles and viewpoints on a monthly basis. Some are based on newspaper evidence and some are confirmed at the field level. Some are vehemently against large-scale biofuels development in Africa and some are supportive of it. In this report, this can colour how a reader interprets what strives to be a neutral, balanced approach. If, on reading, you, the reader, find that we seem to have fallen on one or other side of the central beam, this is an error on our part. We have strived to stay within the middle ground and report only factual information. Even if the information is interesting, we have done our best to remove any contentious or unsubstantiated comments.

Both Practical Action and Pipal Ltd, with PISCES/ ACTS, have been deeply engaged within the draft Kenyan National biofuels policy process. Pipal Ltd is a private project finance company, and a representative for the private sector on the Kenyan National Biofuels Committee (KNBC). As well as through Practical Action, their contribution to this review was also supported by the DEG Jatropha Support Programme (DEG-JSP), a private public partnership between nine East African companies and the German Ministry of Cooperation and Development through DEG. Thanks and acknowledgements go to these participating partners listed on www.degjsp.com.

Thanks to go to Francis Xavier Ochieng, a consultant with Practical Action for his comments and careful review.

ABSTRACT

The current global crises of peak oil[1], greenhouse gas emissions, and food and water security have generated a wave of ‘Trade not Aid’ for large scale investments in Africa’s land and natural resources. Many foreign governments and companies, from China, Asia Pacific, Middle East, Europe, and North and South America, are investing in Africa to meet their own needs and self-imposed biofuels quotas, as well as to develop favourable business opportunities. At the same time, there is a very urgent demand for Africa’s rural populations to have increased access to modern energy services. There is a need to move away from the current unsustainable use of woody biomass, which is causing alarming levels of deforestation and environmental degradation while the health of (particularly rural) people suffers.

This wave of investment is impacting on some already stressed environments, in particular natural water resources, soil nutrients and habitat loss from deforestation. In such environments, the margin for error is very small, and yet some biofuels feedstocks are being introduced without adequate research and development. As the ball in this instance is in Africa’s court, evidence-based cautionary policy and legislative approaches are more likely to lead to sustained success, which is what this report hopes to address.

While some view Africa’s natural resources as key to their technological and industrial development, the uniqueness and extent of its flora and fauna also underpins a successful tourist industry in, for instance, South Africa, Botswana, Namibia, Madagascar, Mauritius, Rwanda, Uganda, Tanzania, Kenya and Egypt; with others such as Sudan, Democratic Republic of Congo (DRC) and Ethiopia having very high potential. Food production based on rain–fed African agriculture, serviced by minimal infrastructure, is vulnerable to changing weather patterns and extreme events such as droughts and floods. Food security requires growth and investment from the smallholder farmer upwards. Deforestation, land use change and/or intensive agriculture to produce biofuels can release increased amounts of CO2, taking the focus away from indigenous development and adding to the mix of conflicting interests and demands.

It is within this setting of unknowns about the impact of large scale intensive agriculture across Africa, and the commercial viability of emerging crops such as jatropha, that each African country urgently needs to develop a multifaceted and robust policy framework. Such a framework needs to maximise the benefits of the current investment opportunities, while simultaneously building modern, locally owned and managed rural agro-energy systems, and without compromising food production, natural resources or the rights of the population.

Over the past 30 years of bioethanol development, more experience has been gained in bioethanol technologies that include new and/or improved plant varieties with much greater efficiencies. As with any new untested technology, experience has shown that it’s advisable to start small, as well as to create robust safeguards in case experiments fail or don’t turn out as expected. This is particularly important when fragile ecosystems are at stake which cannot be recovered once lost. Given the great range of climatic conditions, cultures, historical factors and biodiversity across Africa, each country needs to make its own unique response. Each country requires mapping of all regions and microclimates in order to assess the exact ranges of in which current biofuels feedstocks can be commercially viable, while protecting valuable ecosystems and food supplies and building on existing livelihoods. Sustainability, innovation, efficiency, transparency and inclusiveness are key principles that need to underlie and drive successful biofuels policies and their subsequent implementation. Some of the emerging cautionary examples of failure, including their impacts and repercussions, need to be captured and shared to ensure decision makers are aware of the risks and ensure the right decisions are made.

In development of the biofuels policy, the process will need to listen to all voices and innovative ways of doing things, not least to be flexible, to keep adapting and learning. Further an opportunity will need to be provided for all relevant sections of the government to work together to create a successful and sustainable development model in the long term. The end result of such a policy development model is a sustainable and robust biofuels policy. Such policies will need to support creative models, such as linking smallholders to larger markets and vice versa, as well as enabling modern energy to enter rural areas to support biofuels based electricity generation, small-scale irrigation, communications, health and education facilities, and much more. Given the infrastructural weaknesses in many African countries, such as insecure land tenure, inadequate infrastructure and limited rural access to education and modern technologies, only well resourced, intentional national programmes can ensure that all sectors of society benefit from, as well as have ownership in and choice about, the biofuels industry.

Using examples from a number of African countries, this review looks at some of the opportunities and risks, as well as the current progress, of developing policy frameworks. It outlines some of the increasingly innovative tools already adopted to create national biofuels industries, develop value chains, finance the industry and create robust environmental safeguards.

In addition, after briefly outlining the activities and priorities in a number of countries, the review concludes with some recommendations for the consideration of, and processes that can assist in, effective policy making, and increase the probability of success in developing a sustainable and effective biofuels industry. It also builds the justification for ensuring that policies are more integrated into and coherent with the agricultural, environmental and social needs of each country. This entails developing institutional mechanisms to ensure that the biofuels industry includes commercial opportunities for all sectors of society, as well as meeting national policy targets.

Terms of Reference (TOR) for undertaking the review

Due to increased foreign interest in using African land, water and labour, as well as the uncertainties concerning the price and availability of fossil fuels, many African countries are now actively involved in developing biofuels policies and strategies. This study will review the existing policy framework in some African countries and briefly compare it with Brazil, India, China and the EU.

The specific tasks relating to this study are as follows:

- Investigate key drivers and recent biofuels development experiences in developing economies, particularly in the African region, highlighting key issues and lessons learnt.
- Provide an overview of biofuels development experiences in Ethiopia, Ghana, Malawi, Mali, South Africa, Tanzania, Uganda and Zambia in the last decade, highlighting the contribution they have made to the total energy mix and national energy portfolio.
- Analyse key policy, technological and implementation status of biofuels development strategies adopted in Ethiopia, Ghana, Malawi, Mali, South Africa, Tanzania, Uganda and Zambia, and draw key lessons from these experiences.
- Recommend policy, tools, human capacity development, R&D strategies as well as business models for supporting biofuels policy development.

Report Structure

This report is organised as follows:

Chapter 1 provides a brief overview of the global context of energy and biofuels and how this is currently affecting Africa.

Chapter 2 presents the risks and opportunities for biofuels development in Africa.

Chapter 3 contains economic and policy drivers of biofuels development and lists how some countries have responded to them.

Chapter 4 picks up some key details of experiences and policy regimes in a range of African and other countries.

Chapter 5 concludes with a summary and recommendations.

1. The global context of energy and biofuels and how it affects Africa

1.1 Current Global Perspective

Humanity's current demands on the Earth's bio-capacity to provide resources and absorb CO2 is currently estimated at 44% more than it can provide. The US and China are together using half the world's bio-capacity. Africa is perceived to still have abundant natural energy resources that the rest of the developed world would like access to, partly due to the fact that access to energy is a major driver of economic development. Current scientific understanding states that the burning of fossil fuels is a major contributor to climate change through the emission of greenhouse gases (GHG). To counteract this, as well as to meet increasing demand for energy, countries are increasingly interested in exploiting renewable energy sources, which increases environmental and economic benefits as well as improving nations' energy balances.

In developed countries, the addition of small percentages of biofuels (with "neutral" (zero net) CO_2 emissions) to currently utilised fossil fuels, without the need for major technological changes, was sold by car manufacturing lobbies as a 'low hanging fruit' for meeting CO_2 reduction targets. As a result, mandatory transport fuel blending targets for plant- or waste-derived ethanol blended with petrol, and/or bio-diesel blended with diesel, have been adopted by many developed countries. This trend is also being followed by a number of developing nations. However, with the exception of Russia, Brazil, US, Germany (Franco et al, 2010) and to some extent India, many developed countries do not have the available land and/or natural resources to satisfy their own projected or mandated biofuel needs (EU 2010). This has created a mandatory (and often subsidised) biofuels market searching for cheap supplies. Africa is perceived as a continent with available land, cheap labour and highly suitable climate. An increase in intensive biofuels farming will still use some fossil fuels, create large scale land use changes, alter food production and ecosystems and is also likely to greatly increase the demand for water (Figure 1).

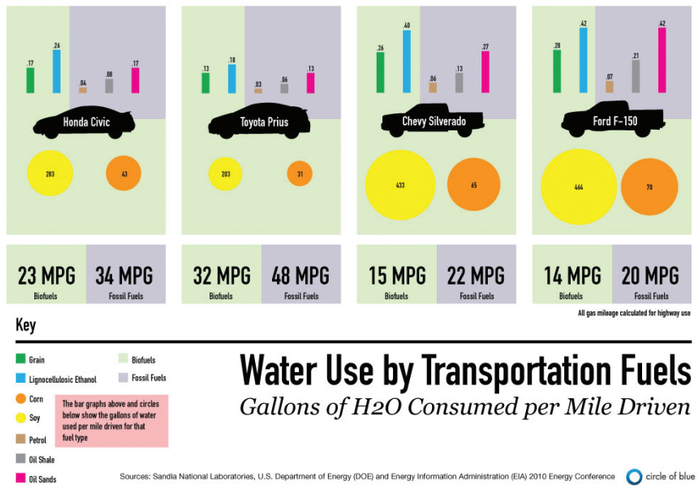

Figure 1: Demand for water in utilisation of Biofuels in motor vehicles

Currently the two main liquid biofuels in production are ethanol and biodiesel. The World Energy Outlook bases its projections on two different scenarios (WEO, 2009) and predicts biofuels demand growing to meet 5% of global liquid transport demand by 2030, up from the current 2%, with second generation (non-food) biofuels coming into play between 2020 and 2030. Currently 90% of liquid biofuels are ethanol based and 10% bio-diesel. The USA is the main producer of Bioethanol from corn (Figure 2), followed closely by Brazil's sugarcane-based ethanol. China, India, and Europe (Europe's production is based on grain) are also increasing production. Global ethanol production grew to 38m tonnes of oil equivalent in 2009, and this growth is expected to continue as many other countries, including those in Africa, set up production facilities.

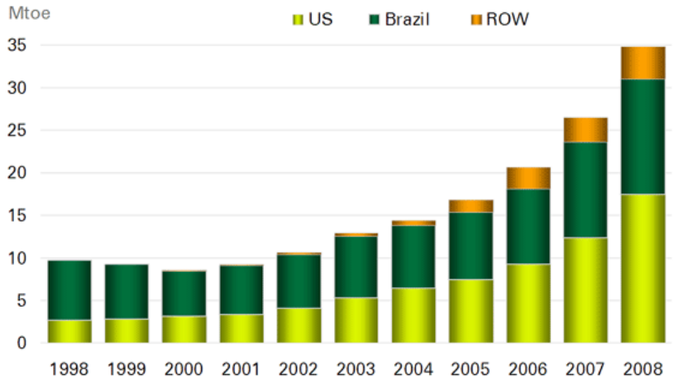

Figure 2: Data from BP Statistical review of world energy 2010 (BP 2010)

Although new technologies, such as deriving ethanol from wood waste and diesel from municipal waste and plastic, are expected to open up production in more northern latitudes by 2020, the advantage of sugarcane-based production is that ethanol is derived from the molasses by-product of sugar extraction; the remaining bagasse can also be used for additional co-generation to supply electricity to national grids and vinesse for fertilizer. Sugarcane has high water requirements, and a much lower carbon footprint than food based crops such as corn. Brazil is the only country to produce ethanol at unsubsidised market rates and is keen to export its success, recently signing four agreements: with Nigeria, Benin, Mozambique, and Ghana.

Further, Brazilian companies in partnership with the Brazilian development bank are supporting many new and existing sugarcane based projects in Nigeria, Benin, Ghana, Mozambique Angola, and Tanzania. Current figures for ethanol production in Africa are hard to extract. While some nations such as Malawi have had small-scale blending for decades, Nigeria (through the exploitation of sugar cane and cassava), Mozambique, Zambia, Zimbabwe and Angola are currently investing heavily in new ethanol industries with cassava and sweet sorghum also being explored as potential main feedstocks.

Biodiesel, providing only 10% of global biofuels (compared with ethanol's 90%), is developing more slowly. Traditionally Europe has led global output based on rapeseed and other plant based crops, but this is changing as the world's top five soybean and palm oil producers - Malaysia, Indonesia, Argentina, the US and Brazil – are likely to account for 80 percent of the potential global bio-diesel production in the future. This may change with the development of untapped potential resources across equatorial Africa, including the reinstatement of palm oil plantations in Nigeria, China's ZTE's interest in palm oil production in DRC and ENI also in DRC. Interestingly Brazil's biodiesel has been dominated by tropical soya (around 80%) and animal waste from food production (around 17%), with very little currently coming from oleaginous (oil bearing) trees.

Three main sources of biodiesel can be identified in Africa; from oil crops such as soya, rapeseed, canola, safflower, sunflower, castor, crambe and others; oleaginous trees, such as palm oil, jatropha, croton, pongamia, cape chestnut (perhaps most importantly for arid and semi arid countries), and agricultural and municipal waste. It is noteworthy, however, that the understanding of bio-diesel crops such as soya and rapeseed is more advanced than for most oleaginous trees except palm oil. With India's strong focus, jatropha is receiving the most international research and attention but understanding its full potential will still take many more years of research and development.

1.2 Africa's energy poverty

With over 80% of the population depending on inefficient, unsustainable traditional biomass to meet its primary energy demands, Africa especially Sub-Saharan Africa (SSA) faces a severe cases of energy poverty. This is also highlighted by studies indicating that for instance SSA has the lowest measure of energy production accounting only 6.4% of the world energy output, yet it boasts of 16% of the world's total population. In addition the energy use per capita is very low, almost eight times less as compared to other regions of the world. Further still, it has been noted that on average, per capita annual growth rate of energy use was static during the 1990 – 2004 period for SSA, compared to about 1% for high income and 0.2% for other countries of the world (OFID, 2010).

In 2007 it was estimated that Africa met 47% of its total energy demand from biomass and waste compared with 3.5% in the US, 5.7% in the EU, 6.9 in China, 19.6% in Latin America and 27% in India (World Energy Outlook, 2010). So while Africa as a continent is the 'cleanest' continent in terms of low carbon emissions per head, its reliance on biomass is leading to alarming deforestation and high rural health risks, especially due to smoke inhalation; and there is a distinct shortage of well distributed, cheap modern energy, especially in rural areas - all of which dramatically impede economic growth.

Added to this inequality is a situation where many of the countries with a high level of access to modern energy (based on fossil fuel exploitation) are looking to benefit from the exploitation of Africa's biomass, on which the majority of Africa's population currently relies. In addition, the future of liquid fossil fuel supply and pricing is highly uncertain. The US projects that by 2015, it will import 25% of its oil from Africa's main oil exporting countries; but to date, and such oil purchases have not proportionally benefited the populations of the supplying African countries. Angola, the world's eighth largest oil producer and a member of OPEC, is currently ranked 146 out of 182 countries on the UNDP Human Development Index (UNDP 2010). This demonstrates that access to modern energy sources will not necessarily benefit African populations, unless there are adequate processes to distribute the benefits. Some argue that it seems as if the 'North' is 'rearranging' the ' South' to suit its own large scale business needs and that the onus of regulating negative impacts is increasingly falling on the already under-resourced 'Southern' smallholder farmers (Franco et al 2010). Even so,

the case for indigenous biofuels development within Africa is strong. Aside from the potential to create a sustainable rural energy supply, most African countries are still net importers of fossil fuels, (a process often controlled by a select few,) which puts a high burden on their limited foreign exchange earnings and exposes their emerging economies to fluctuations beyond their control.

This has led to a scenario where simultaneous to the emergence of global food and water crises, there is a sudden and strong push from large-scale international investors to obtain the rights to exploit large acreages of African land. Some reports estimate that up to 50 million hectares are currently being negotiated or have already been leased in the last few years (Cotula 2008, Friends of the Earth 2010). Although the exact figures are hard to verify, the main target of these companies is the export market, with many European companies seeking to help meet the EU 10% blending targets by 2015 (Laishley 2010). Again, while some African countries have developed specific biofuels policies (e.g. Ethiopia and Mozambique) and strategies (e.g. South Africa), it is the on-the-ground governance structures and processes that will determine the extent to which those already living on this land are consulted or will benefit. Historically in Africa, strong decentralised governance and the rural infrastructure to support it, have been weak, with many decisions being made by central government far from the affected regions.

In this current scenario biofuels represent a double-edged sword. Rural populations' wood biomass dependence is leading to increased environmental degradation and poses a serious threat to soil fertility and water catchment areas. Even though rural use of wood fuel seldom destroys a whole tree, the production of charcoal to 'upgrade' the energy resource, and often to meet the demands of peri-urban and urban populations, often reduces a tree to its stump, stripping whole areas of tree cover. If they are well planned, then resilient, community-owned, integrated, agro-energy farming systems could serve to protect remaining forests and trees, as well as provide more sustainable rural incomes, and support increased food production and increased farming success in more marginal areas. However, the challenge is funding the training required to change the mind-sets of mostly poorly resourced populations who often have insecure land tenure, to develop integrated rural biofuels use.

Parallel to this challenge, highly resourced export-focused foreign companies are securing large to very large tracts of land, either for free or cheaply leased (e.g. $1-2 per hectare/year) (Ndurya 2009). This often results in the 'resettling' of thousands of people who have existed on extended farming practices in these areas, limiting their access to natural resources. They are often required to choose between leaving the land or becoming farm employees for the foreign investors. As many of these new large plantations use intensive agricultural practices, including mechanisation, fertilisers, pesticides and large water resources, the indigenous flora and fauna in all these areas is likely to be dramatically changed or destroyed. Any livelihoods or animal species that depend on these resources are likely to be compromised, including indigenous hardwoods, medicinal plants, wildlife and wildlife dependent tourism and pastoralism.

Climate scientists generally agree that Africa is likely to be hit worst by sudden rainfall and weather pattern changes induced by climate change, with 40% of all development projects being climate vulnerable (Oxfam 2009). The 2009 Economic Report on Africa (ECA/AU, 2009) published jointly by the AU and the UN's Economic Commission for Africa (ECA), cautions that rapid expansion of cultivated land should not be a priority, given the environmental degradation that Africa already faces. The AU expresses concern that this new development will not increase national agricultural productivity.

The choices African governments are making now are determining the future adaptability, food and energy security, and patterns of future development of Africa. In particular, with the threat of climate change already looming in the form of changing weather and rainfall patterns, governments need to appraise critically whether indigenous African populations will benefit or suffer from the proposed solutions, and to make decisions that are pro-poor.

The key perceived benefits of biofuels as strong drivers of potential agro-energy development include:

- Decreased reliance on polluting fossil fuels
- Increased energy independence
- For many countries, lower fossil fuel import bills
- Greater diversity of both the source and type of energy supply, especially in rural areas
- Financial benefits for rural and/or poor communities
- Jobs relating to energy

The potential challenges include:

- Escalating competition for natural resources including land, water and forests
- Environmental damage and loss of biodiversity
- Increased food insecurity for indigenous populations
- An increased number of internally displaced populations
- Increased unplanned urbanisation

Depending on how they are implemented, large-scale plantations can have multifaceted positive and negative social and environmental impacts, which will largely depend on the relevance and implementation of the country's legislative context and each project's response to:

- The original land tenure
- The type of land use change
- The use of local resources and ecosystems already being used for other commercial or livelihood purposes
- The timing and degree of local government and community involvement
- The plantation design, execution and intensity
- The expected national or international uses of, and markets for, the products and by products

The first step in ensuring that the development of the biofuels industry in each African nation is beneficial to its overall growth, richness and sustainability is the drafting of policies and legislation that maximise the probability of success and sustainability across a number of key principles.

The next step is creating the institutional capacity, strength, integrity and frameworks to successfully implement the policies on the ground. Successful implementation of well thought through policy can provide increased and more decentralised energy security; create numerous employment opportunities and reduce deforestation; as well as eventually decreasing the country's dependence on oil imports.

2. The risks and opportunities of biofuels development in Africa

2.1 Opportunities

Many have passionately argued that the more than one trillion US dollars of 'Aid not Trade' over the last 50 years (Thompson 2009) has not lifted Africa out of poverty, with some very poor countries even exhibiting lower GDP's than in the past (Lapper R 2010). Different patterns of global, regional and local agricultural subsidies and direct or indirect trade barriers have probably also exacerbated this situation. As previously mentioned, many Sub-Saharan African countries depend entirely on imports for their oil requirements. Recent increases in world oil prices have also had negative impacts on importing economies through inflation, which has disproportionately impacted on the rural poor. In many agricultural based economies in Africa, liquid biofuels production has the potential to create jobs within a labour-intensive agricultural sector, improve energy security and diversify rural livelihoods. The opportunities for Africa to become significantly more energy self-sufficient, while simultaneously increasing industrial and agricultural development through biofuels, are significant. Many even see Africa and Latin America as the two most likely sources of much of the world's future natural resources.

Thus the new thrust for 'Trade not Aid' may possibly provide a growth stimulus for Africa to develop its agricultural potential where aid has failed. Trade from Africa to Brazil has risen from $3 billion in 2000 to $18.5 billion in 2008, albeit mostly from oil exports from Nigeria, Algeria and Angola (Tralac 2009). Some large investment projects claim to improve food security by setting aside some land and investing in local food production, creating local employment and assisting in infrastructure development (Biofuel Africa 2009). These investments also have the potential to improve agricultural practices including the training of local workforces, which can have a knock on effect in other rural areas. Responsible projects should aim to act as a hub for increasing the availability of work and for the surrounding smallholders to become agro-energy entrepreneurs, creating jobs throughout the value chain. The extent, to which Africa's natural resources are either mostly exported without benefit to the majority of Africans, or are rather used to develop the continent as a whole, will depend on the choices African Ministers are making in the very near future. Ministers need to engage with what is happening on the ground and make the effort to understand the consequences, international or otherwise, of certain centralised decisions or indecision.

Opportunities will be realised primarily by the right choice and availability of feedstocks. Ethanol technology, adopted 30-40 years ago in Malawi, Kenya and Zimbabwe, is a tried and tested process, into which Brazil and others are investing a lot of technical research. Most believe that despite sugar cane's high water demand, it is more environmentally friendly and less controversial than ethanol derived from maize and other food crops. Brazil and others continue to invest significant research funding into:

- Improving feedstocks such as sugar cane, sugar beet, cassava and sweet sorghum
- Using the whole crop for follow-on activities such as fertilizer, co-generation and biogas production
- Mechanising harvesting and improving processing

Bio-diesel is a much newer technology and Europe and Brazil's success is based on annual oilseed crops such as rapeseed, canola and others, as well as tropical soya and, in Brazil's case, tallow and animal waste. Countries such as the Netherlands are setting up large waste vegetable oil collection schemes and processing plants.

2.1.1 The current case for *Jatropha Curcas*

Future productivity from newly exploited crops such as jatropha is much more uncertain. In less favourable agro-climatic conditions and with no support and back up, smallholder farmers are reporting very low yields of jatropha, typically less than 0.5 kg per tree in the early stages (GTZ 2009). Others report that on small to medium scale production, in favourable regions, often with high levels of pest and weed control and fertilisers, yields can be up to 3kg per tree (Clayton 2010).

Figure 3. Jatropha Plant, India (Photo: Raffaella Bellanca)

Africa's policy makers can take note of Brazil's actions after 20 years of jatropha research. They are beginning to plant three carefully bred and chosen jatropha varieties in non-agricultural areas such as railway tracks and under power lines, and one 5,000 hectare mechanised experimental farm in a favourable area, which they will assess over four years. Fact foundation, a reputable Dutch based renewable energy organisation, which has been deeply involved in jatropha production in Africa, responded to an in-depth report on jatropha citing quite a few farm failures in Mozambique, in the following way:

'First of all, FACT agrees that many unsubstantiated claims have been made on jatropha, such as high yields on marginal soils, low water and nutrient requirements, and high resistance to pests and diseases. These claims have already been falsified some years ago (e.g. Jongschaap et al 2007), but it seems difficult to convince all practitioners and policy makers of the facts. Despite the slowly increasing body of knowledge on jatropha cultivation methods, the agronomy of the plant is still largely unknown, and the risks of disappointing yields are substantial.

Furthermore, the report describes how large biofuel companies have engaged in large-scale jatropha cultivation in rural Mozambique, making promises to the local population that could not be kept because of disappointing yields and financial crisis. Sadly, this corresponds to FACT's opinion that large scale jatropha production contributes little to economic development, is subject to large risks, and often leads to land ownership disputes and corruption' (Fact Foundation 2009).'

FACT goes on to say that the findings on irrigation, pest and diseases and food competition when jatropha is planted in hedgerows and by smallholder farmers need more investigation. After supporting over 1,500 well organised farmers in Cabo Delgado for three years, FACT still see a potential in developing useful local markets for 'straight vegetable oil' to run generators, although they conclude that more R&D is required (Fact Foundation 2009). Yields are being estimated from very immature plants that usually take 6 years to mature. Companies such as SG biofuels, DI oils plant sciences and others

are investing heavily to breed more reliable, fast and high yielding jatropha varieties and to understand the best agronomic management practices. The extent to which this will involve genetically modified plants and intensive agricultural practices is still unknown. What it adds up to is an example where the lack of knowledge about and research into *Jatropha Curcas* allowed for persistent and quite extraordinary hype from those who planned to benefit. Thankfully, jatropha is no longer viewed as a wonder plant, and much is still unknown. It is still likely that at some point, in suitable agro-climatic areas, jatropha may become commercially useful as it yields a highly suitable biodiesel product.

Currently the opportunity exists for African policy makers to formulate clear policies based on current scientific evidence and experience. No scientific or experimental evidence exists to develop or promote large scale jatropha plantations over 5,000 hectares on un-cleared communally-owned new land or in sensitive areas. A cautionary approach would be wise and policy guidelines need to focus on creating inclusive, intercropping and minimal input plantations, with wildlife corridors and stands, and only consider expanding allocated land after proof of commercial and sustainable productivity has been established, preferably after at least four years.

A cautionary approach also needs to support and fund on-going research and experimentation by NGOs and small and medium-scale farmers to continue to trial and test plots of all possible bio-diesel feedstocks and resources. This is especially necessary to minimise the risk to food security through using rotational farming methods, intercropping, inclusive plantation models, and experimentation with indigenous, well adapted, species.

At the rural level, using low entry cost projects, with minimal management and long term potential, biofuels from productive oil seed trees can be well suited to small-scale rural farming enterprises. Locally grown plants such as sorghum, sugarcane or fruit trees, that produce feedstock for small-scale ethanol production, might be promoted for supplying clean, locally produced fuel for ethanol stoves. This type of rural biofuels production would help tackle the crisis of unsustainable and unhealthy wood biomass use.

National policies need to focus on enabling smallholders to participate fully in the biofuels value chain; and India, with its high population, rural poverty and relatively small land mass, has led the way, by focusing on small-scale farmers and initially banning the export of biofuels. Ghana has set up a fund to ensure rural participation and Zambia is looking for funding to follow suit. It is still to be seen whether rotationally intercropping oil-seed crops and planting hedgerows and small plantations of jatropha and other indigenous oil seed trees can create enough critical mass in marginal areas to support rural energy needs, but the more support and planning it is given the more likely it is to succeed. It can be argued that any replacement of wood biofuels whose use threatens existing tree cover is beneficial in the absence of any immediate alternatives. If ethanol production is centralised, policy makers need to give serious thought to dedicating a percentage of ethanol for household cooking needs.

Waste products may also become a significant feedstock for biofuels in Africa, especially in water scarce, arid and semi-arid regions. Emerging technologies that recycle plastic and municipal waste into ‘eco-diesel’ might allow countries like Kenya to provide a large percentage of their annual diesel demand just from plastic waste (e.g. Global Finest, 2010; Renewable Energy Focus, 2010). Another example is from Liberia which is using woodchips from redundant rubber trees to generate electricity. Other examples that are still undergoing investigation include the ‘gribble’ which is a small insect that can assist the breakdown of wood waste and different enzymatic solutions to produce ligno-cellulosic biofuels, and bio-algae research to produce other forms of biofuels. While many of these more centralised 2nd, 3rd and 4th generation biofuels processes are still in R&D phases, it is likely that some of them will break through in the next decade or so to meet the growing world demand for “green” fuels.

Biofuels development has the potential to produce a paradigm shift in agriculture and rural development, with sustainable biofuels production providing up to 1.1 million jobs in SSA (De Keyser and Hongo, 2005). Brazilian ethanol production in sugarcane-producing regions has been shown to stimulate other food crops and income generation from agro-industrial activities related to sugarcane, as well as improving agricultural techniques and conditions for other crops (Raswant et al, 2008).

With informed and well thought through policies and strict implementation, Africa could benefit from biofuels investment as long as it does not compromise its indigenous populations, threaten its unique biodiversity and ecosystems, or lose related ecotourism potential or ownership of its natural resources. Governments have the opportunity to add value to their natural resources by creating sustainable income from global schemes such as REDD (Reducing Emissions from Deforestation and Forest Degradation), and through investment in improved tourist facilities and infrastructure.

While biofuels can be grown anywhere, Africa has a unique wealth of biodiversity and natural beauty that tourists are increasingly paying to visit as long as it continues to be well managed. Examples from South Africa (Kuiper 2010) , Kenya and Uganda (Musamali G 2010) demonstrate that well managed forests, game parks and wetlands can bring up to 4 to 5 times the revenues of large scale biofuels production and generate up to 90% more wages for local communities. In the Porini reserve in Kenya, one previous charcoal producer earning $25 a month working from dusk until dawn now earns $250 a month leasing his land to the reserve and being employed as a game warden (Greives-Cook 2010). With EU sustainable practice certification gaining popularity, and other countries likely to follow suit, taking care to meet the required sustainability criteria from the outset will not only strongly improve the export potential and investment climate for serious companies, but also sustain Africa’s biodiversity for its future generations.

As far as first and second generation biofuels are concerned, current activities can be viewed as part of an interim period, with many foreign companies developing large-scale experimental projects on African soil, while continuing to look for alternative oil sources. Africa needs to create alternative rural energy sources and to slow down deforestation if it is going to adapt and grow with climate change. Biofuels development on the continent presents an opportunity for Africa to achieve greater energy self-sufficiency; develop agro–energy productivity; create and distribute wealth and employment; as well as to become a major food and biofuels exporter - as long as it is fully aware of the risks.

2.2 Risks

2.2.1 Risks from knowledge gaps and climate change

Most of the potentially high risks related to introducing biofuels on a large scale are based on huge gaps in knowledge concerning the actual viability of (often new) crops on the large scale and their impact on land use change. This is exacerbated by often inadequate land tenure, management and decentralised governance systems that are needed to ensure the inclusion of local populations and the protection of current ecosystem services.

The emerging African biofuels industry is also at risk from the impact of the changing weather patterns that they are meant to mitigate. Some climate models predict increasing drought or flash flooding, particularly across the whole of the Sahel and down the Eastern Coastal zone. Increased deforestation, with loss of well-adapted indigenous species, the consequent increased pressure on water resources and loss of traditional drought pastures and wetlands, can greatly increase the vulnerability and accelerate the demise of whole communities, ways of life and ecosystems.

Comparisons with Brazil seldom account for the amount of available land in Brazil, or its currently stable climatic conditions. On the other hand, India, subject to the increasing vagaries of monsoonal patterns, has failed to achieve either sugarcane-based ethanol targets or its original jatropha biodiesel production targets (Iiyama M, Odongo F. 2009). In addition, many Sub-Saharan African countries are water scarce.

These risks can be partly mitigated by following Brazil's example of implementing agro-climatic zoning to reduce food for fuel competition and ring-fencing areas of high conservation value, which had already been started in Kenya.

2.2.2 The risks of depending on Climate Change Market Systems and Foreign Direct Investment

Whether many people at all levels of society in Africa benefit, or are left at an even greater risk, and in deeper poverty, will in part be determined by funding. How much is available to do what? When the potential threat of climate change finally started to be taken seriously at a global level, the aim was for (mainly developed) countries to cut back on their usage of fossil fuels and become much more energy efficient. This has been met with strong resistance, particularly from the US and China. The original UN Framework Convention on Climate Change set future trends by designing a market-based approach which does not, in reality, slow the amount of fossil fuels used and the amount of GHGs released into the atmosphere. Countries or corporations are able to reduce emissions by buying "carbon credits" from low emitting countries, as well as by investing in projects that allegedly store carbon.

Similarly the Clean Development Mechanism (CDM) was developed to allow polluters to offset their emissions by investing in Carbon saving projects located in developing countries. In essence this was meant to further promote sustainable and "clean" development to African countries, while at the same time allowing the emitting country to attain its emission targets.

One of the most popular market-based schemes is the use of biofuels as an alternative to petroleum as part of mandatory blending targets set by the EU, US and others. Currently there is a huge, and possibly insatiable, gap between demand and supply. The vision promulgated by countries, multilateral funding institutions, the UN, and the private sector (including private banks and bilateral donors) has been to promote and support financially a large-scale agro-industrial biofuels production model with foreign owned plantations across the tropics feeding developed countries needs.

To confuse matters even more, biofuels have enabled some multinational corporations to lease or buy large tracts of African farmland in the name of 'green eco-fuels' and part of the fight to 'slow climate change, and so potentially gain additional revenues from the carbon offset markets. Whether or not they are green or do slow climate change is becoming increasingly controversial.

It is clear that mandated biofuels blending targets in the EU / USA and other large markets has driven much biofuels investments through incentives, an assured market and tax incentives. As the scale of African 'land grabbing' or investment has become apparent, advocacy groups call not only for strong sustainability criteria to become law, but also for the EU to scrap biofuels blending targets (Friends of the Earth 2010). It may stop a few projects, but stricter biofuels import criteria could also push food production onto more vulnerable land. Given that, so many players and markets are increasingly involved, it is unclear that tighter criteria in one region would have much effect.

This intense political will and substantial financial and technical support greatly intensifies the pressure on indigenous lands and resources, as well as decreasing the capacity and will of governments to regulate corporate behaviour strongly. With new financial mechanisms strengthening the carbon market, huge loans have been provided to the private sector to expand biofuels production, and, as with oil production, some key stakeholders stand to greatly benefit financially.

In a common sense world, the need to develop more profit for investors from these huge financial resources would be balanced with equity and inclusion to create integrated, innovative, efficient and sustainable solutions that benefit many people rather than just a few. At the moment, whether this happens or not is completely reliant on incumbent ministers and governments. There is currently little or no comparable funding or technical assistance to help countries implement laws that protect indigenous peoples' rights to lands; protect natural resources; meet obligations to international human rights conservation; or support treaties to reform existing land tenure systems that can create clear land demarcations, land titles for indigenous communities, and insist on integrated development projects (Taukli-Corpuz, 2007).

If local people, who best understand the land and conditions, are consulted, it is rarely on an equal footing with heavily resourced companies, backed by large multilateral funders and potentially vested local interests. Current ways of life, such as forest dwelling or pastoralism and their contribution to national economies are not factored in. They are often seen as mostly dispensable and backward and their contributions, such as to dairy and beef industries, are often forgotten or poorly valued. At one recent meeting in Kenya, those opposing the possible destruction of a forest rated as an 'important bird area' were described by the investors as 'against development' and 'enemies of the local people' (Gatonye G 2010). Several Ugandans died in the struggle to reverse the de-gazetting of part of Mabira Forest Reserve for a sugar plantation in 2007 (Barry, 2007) with President Museveni stating at the time that 'conservation is the privilege of the rich'. The decision was reversed when it was demonstrated that the commercial value of tourism and carbon capture in Mabira was estimated at more than $316 million (£154 million) a year, whereas sugar cane production would be worth less than $20 million. The expansion of sugar production was moved to areas that were perceived as less valuable.

Concern has been raised recently that many of the companies investing in biofuels are structuring their finances or being given tax breaks which allow them to avoid paying tax in the countries of operation (Kar, 2010). Thus African countries as a whole gain relatively little benefit from the use of their land, water and labour. Controls and an integrated vision have to come from within. It is up to African governments to ensure that developed countries do not export their worst unsustainable practices to Africa or allow Africa's natural resources to be exported without also creating real growth for their rural populations. With so many people ready to invest, the ball is firmly in

Africa's court to insist on the best, cleanest and most efficient technologies available, to demand their share of benefit and to choose very carefully and wisely.

2.2.3 Risks from large scale commercialisation

Large scale, mostly foreign owned, biofuels production is a huge untested experiment on an unprecedented scale, besides bringing in intensive farming methods. Rampant unplanned industrial development by a few can lead to the unintended rapid decline of food security and overall growth, and to the demise of other industries and livelihoods based on other natural resources, such as tourism.

The myth that some favoured new crops, such as jatropha, would be immediately commercially productive on marginal land is now being realised to be predominantly false. Biofuels development companies are now often providing considerable fertiliser, insecticides, pesticides as well as full-scale irrigation from adjoining rivers, lakes and boreholes in arid and semi-arid areas. This is often in areas where populations are going hungry due to the lack of such agricultural development. The AU has suggested that African countries should invest 10% of their budgets into agricultural development and only four have realised this (UNIDO 2010).

If large plantations opt mainly for mechanisation, then rural populations may be displaced to urban centres, creating rapid and unplanned urbanisation with all its associated problems. Such issues as pollution run off, stress on communal water resources and loss of biodiversity and livelihoods are risks that each nation must assess. Some projects such as Biofuel Africa in Ghana have adopted a 'food first principle' aiming to expand the food production by 10% throughout the area of their 60,000 acre jatropha project. However the same company was equally criticised over the "back door" manner it gained access to the land and the felling of over 2,000 hectares of indigenous forest, eliminating the sustainable livelihoods of many local women, through the harvesting of forest products such as Shea butter.

Another risk of commercial production is that the net gains made by the burning of less carbon-emitting fuels will be more than lost by either intensive, high carbon emission, intensive agricultural practices (which currently contribute 20% of global GHG emissions) or in the CO_2 released during the clearing of the forest for the required land. Recent scientific reports suggest that currently only ethanol from Brazil and Malaysia has a lower carbon footprint than diesel (Euractiv 2010), with North American soya oil having a carbon footprint four times greater than diesel. The extent to which more ecological agricultural approaches can give commercial yields is still being explored.

Mounting evidence is emerging on how intensive agriculture, involving the usage of mono-plantations, pesticides and insecticides, is inherently unsustainable. In the winter of 2009 the US lost almost one third of its remaining bee population, seriously threatening $14 billion worth of agricultural production and one third of all food plants, as well as all wildflowers and many trees. 50% of biofuels crops, such as jatropha and croton, are completely dependent on bee pollination. Along with other factors, mono-plantations, the spraying of weed killers, insecticides and pesticides kills bees. Furthermore many biofuels crops are genetically engineered to improve productivity and expand their current ranges. For instance, Israeli firms have doubled the chromosomes of *Castor Ricinus*, which might well lead to unknown problems if crossed with indigenous African species.

Importing intensive agricultural methods without strong punitive controls, could seriously threaten African biodiversity and environmental sustainability. Although developed countries are portrayed as wealthy, their sustainability is not taken into account, particularly in relation to their agriculture practices which are gradually being recognised as unsustainable, as well as mounting debts and unsustainable energy practices. It is precisely because the natural resources in countries and regions such as the US, EU, China and the Middle East have been exhausted or fully utilised that companies are coming to Africa in such numbers. Africa could learn a lot by studying countries such as Holland, who, forced to rely on densely populated land and being at a high risk from climate change, are developing the most innovative ways of exploring different renewable energies, efficiencies, recycling and reuse of all waste products.

These potential risks can be mitigated through research into the most climate friendly, environmentally and socially inclusive production and plantation designs, and their subsequent implementation. Africa can also focus on biofuels from municipal and biomass waste, algae and other sources that pose little competition for land, water and nutrients, and that fit under an umbrella of "renewable and efficient energy", such as solar, LED lighting, wind, hydro and geothermal.

2.2.4 Risks from failure

Given the many unknowns, by welcoming large scale biofuels projects, African governments risk displacing indigenous populations, agricultural productivity and ecosystems for crops that may, in some cases, fail. Newer biofuels crops such as castor, crambe and in particular those that have not been fully tested, such as jatropha, are inherently more risky. More tried and tested feedstocks, including sugarcane and oil palm, may initially be appropriate until water shortages, soil degradation or the impacts of climate change makes them un-commercial.

Perhaps this risk of failure is also exacerbated by the perceived easy flow of investment funds available for large projects in Africa. This has led to a pattern of some private investors coming to Africa to first secure a cheap large land deal and then going back to raise money on the basis of the land deal. The danger is that the companies start with inadequate funds to service the full costs of the 4/5 years' set up phase, even while the agronomical or commercial success is untested and unknown.

Many such land-deal seekers have eschewed real marginal land for richer coastal forest or in one case, a forested elephant sanctuary, seeking to raise initial income from logging before planting jatropha, castor or other crops (Simbeye F W 2009). Recent examples include FloraEcoPower, allocated the Babile Elephant sanctuary in Ethiopia; Bioshape and BioMassive, and allocated coastal forests in Tanzania; and Kenya Jatropha Energy Company and NII of Italy allocated land within the Dakatcha woodlands in Kenya. More seriously FloraEcopower has not paid its employees for five months of late 2010, and is reportedly '70%' bankrupt; and there are rumours that they have actually shut down after felling 10,000 hectares of indigenous forest. In Tanzania, Bioshape stopped operations after logging significant amounts of coastal forests in an area of high conservation value. Biomassive are seeking funds and the outcome of NII/ Kenya Jatropha Energy Company in Kenya is yet to be ascertained.

Anecdotally, from a total of 26 biofuels companies that started in Tanzania a few years ago, reputedly allocated a total of 614,000 hectares, only six or seven currently remain active. Some have relied heavily on international grants and are not yet independently

commercial. Other jatropha projects that did not go 'according to plan' or that are looking for reinvestment in East and Southern Africa include Energem, CHEMC Agri, Bachir Jatropha (Mozambique), Icecap (Namibia) and ESV Bioafrica, who were not able to pay wages for 9 months, and, required by the local councillors to appease the workers, was sold to two Italian companies, Api Nova Energia SrL and Seci Energia SpA, in November 2009. They still claimed 'success', however, even after laying off all of their workers, and some left local partners and farmers with acres of non-productive trees and dying seedlings (ESV Group PLC, 2009; Ribiero and Matavel, 2009). As with many emerging crops, untested expectations of jatropha's wild seed, limited capacity on marginal soils and specific preferred agronomical conditions (all of which are still under investigation), as well as underestimation of its pests and diseases, have meant jatropha has not lived up to its 'expected' yields (Friends of the Earth, 2009). Only well-financed firms have continued to develop long term exploration and experimental projects.

Also as with many more 'opportunistic', rather than well planned ventures, while often reported in the press, some come to fruition, while others do not evolve. This is illustrated by the recent Friends of the Earth report "Africa; up for grabs" where many 'reported' examples given do not reflect actual companies or hectares on the ground (Friends of the Earth 2010). Using only newspaper reports to write advocacy reports weakens their credibility and does not assist in the need to understand just what is happening on the ground, and/or the impact that it is having, positive or negative, on the majority of African people.

The risk of failure is being enhanced by the fact that in most countries large scale land use changes are being driven more by case by case opportunistic large scale investments, rather than developed as part of an overall nationally coherent natural resource and ecosystems management plan brokered between all the different ministries, vested interests. Governments can mitigate the negative social and environmental impacts of failure by first zoning areas of high conservation value as unavailable for biofuels, so they are not compromised in potentially unsuccessful commercial experiments. As demonstrated in the Mabira example, if these areas are forested, governments can gain more income from the UN REDD programme and ecotourism than from biofuels plantations. African governments can actively support projects setting up on old plantations, such as Sun-biofuels in Mozambique, or on degraded land through EIA's, and hold all projects to internationally agreed sustainable biofuels standards.

Secondly, when consensually allocating large acreages that involve local populations, local or national governments can release land on a proof of productivity and inclusivity basis, such as limited development to 5,000 hectares for the first four years, and asking the company to pay a bond upfront covering the cost of rehabilitating the land in case of failure.

2.2.5 Risk of increased vulnerability of women and children

Land inheritance in Africa is almost exclusively through the male line. While women spend proportionally much more time as subsistence farmers than men, they have secure title of a very tiny proportion of land (FAO, 2002). As a result they have little collateral to raise loans for agricultural inputs, often sold in large bulk. While men tend to get more involved when there is a cash crop, women usually focus on raising traditional crops for household use, which besides maize are often vegetatively propagated staples outside of a formal commercial agri-business system, such as banana, cassava, yams and increasingly sweet potato (Arndt et al 2010).

These staple food crops, which are most responsive to often simple pest and disease control measures, receive minimal research and development investment, especially from the private sector, compared with the more profitable seed-propagated food crops such as maize and vegetables. That said, cassava is now being developed as a large scale biofuels feedstock (e.g. in Nigeria, Kenya, Tanzania).

In large scale commercial activities, feedstock production accounts for 70% to 80% of biofuels production demanding huge economies of scale (FAO 2008). The conversion of private, public, community or so called "marginal" lands to large scale plantations for biofuels production is more than likely to cause the partial or total displacement of women's agricultural activities, pushing them even more towards increasingly marginal lands (Ibid.). Even if the large commercial plantations set up an outgrowers scheme, evidence from other large scale agricultural activities has shown that it is often men that take control in perceived new commercial cash crops or activities. They often do the land preparation and planting, with more control over crop choice, while the women often do crop maintenance, weeding and harvesting (Arndt et al 2010).

This also has a very high risk of biofuels replacing land use in small-holdings that predominantly women use for vital household food security (FAO 2008). In promoting agro-energy security at the village level, NGOs, CBOs and extension services need to be aware of the impact on gender roles and control of land use and ensure that food security takes equal priority. Some theoretical analyses suggest that relatively small increases in education and access to affordable inputs (such as FIPS programme in Kenya) can create increased food yields that could offset projected biofuel impacts (Arndt 2010).

Figure 4: Noro and her younger daughter Jenny with their ethanol stove in Ambositra, Madagascar (Credit: Ewan Bloomfield)

Experts project the African population can double by 2050 (Elmissiry 2010). With most countries lacking any centralised rural energy supply, most African countries are already facing extensive wood biomass deficits. While some countries may set targets of 10% reforestation (e.g. Kenya), the current institutional means to bring it about, or to keep pace with population growth, is limited. As part of mixed renewable energy platforms, biofuels have the potential to lessen the deforestation that results from rural household wood biomass use. Replacing kerosene lamps and wood fuel fires with biofuels lamps and stoves will also significantly increase women and children's health. Respiratory infections cause by household wood smoke is reported to claim as many lives in Africa as Malaria and HIV - of which 50% are children under 5 years of age (estimated at I million children a year in Africa) (Madhi and Kugman 2006). Easily accessed biofuels will reduce the long marches and burden of fetching firewood and its by–products such as soap and briquette making, beekeeping (apiculture), poultry feed, as well as providing supplementary income.

It would however take nationally implemented, well funded and serious efforts to deliver these smaller scale benefits. As smallholdings decrease in size due to sub-division between siblings, some form of sustainable collective agreements or institutional arrangements are probably needed to get sufficient economies of scale to make hedgerow or biofuels intercropping viable at the village level.

Most biofuels policy frameworks in Africa are still to be adopted and implemented. The first wave of activity is focusing on large scale production driven by foreign direct investment. Resolving the current rural energy supply deficit on the scale and at the speed needed is not yet the most active focus of many African Governments. This is currently leaving most rural populations (and in particular women, children and youth who are dependent on access to land, water and traditional agricultural practices to sustain themselves), very vulnerable.

Biofuels policies need to be developed and implemented to work in tandem with the millennium development goals. Government can usefully focus on adopting sustainability criteria, taking an integrated approach, ensuring women and men small holders are equally included in the biofuels commercial chain, building on their existing practices, knowledge and skills rather than demolishing their livelihoods (FAO 2008).

2.2.6 Risks from migrant harvesting populations

Current social and environmental impact studies of large scale hand-harvested projects usually overlook the impact of thousands of migratory workers, with their corresponding fuel and water needs, for the short three month harvesting seasons. These populations often stay in the area, creating increased pressure on and conflict over scarce resources, as well as indirect impacts on the environment. In contrast, increased mechanisation will decrease these problems but reduce the, often promised, local employment benefits.

2.2.7 Risks from competition for natural resources

The growth of the biofuels industry, especially ethanol production from corn, wheat and soya beans, has generated controversy for arguably undermining food security by converting food crops into energy crops, thereby creating conflict between people's need for energy and their need for food (Hazell P and Pauchari R.K. 2006). Furthermore, biofuels production may also deplete valuable water resources, degrade soils (quality and fertility), increase deforestation, and reduce both crop and indigenous biodiversity, especially when a framework for enabling smallholders to fully participate in their value chains is either non-existent or inefficient. However, in contrast typical biomass crops pose a different challenge for good soil management because the plant material is often completely harvested, leaving little organic matter or plant nutrients for recycling back into Africa's already nutrient poor soils. Tree based biofuels do not suffer so much from this problem.

2.2.8 Risks from lack of inter-ministerial integration

Characteristically many African governments have a number of different ministries which don't always communicate with each other. There is a danger that if biofuels fall under the control of Ministries of Energy, the overall agricultural, social, and environmental potentials and risks may not be fully appreciated from the outset. Opportunities could be lost, such as creating biofuels from municipal waste, and controversies may arise later. Land acquisitions have been reversed in Mozambique, Ethiopia and Uganda and a moratorium put in place in Tanzania, all of which have affected investor confidence. Biofuels provide a huge opportunity for new forms of well-planned and integrated natural resource management and governance; what is needed is the political will to grasp the opportunity to evolve into pro-active governance.

3. Economic and policy drivers and responses in biofuels development

As outlined above, the main global drivers fall into four main categories:

Energy security and diversification: Ever increasing global human populations and demand for cheap energy, added to the imminent threat of 'Peak Oil', the political instability and oil-induced wars in many oil p sroducing nations, as well as rapidly fluctuating oil prices, have all stimulated a serious drive in research and investment into alternative energy sources, as well as energy efficiency. As prices fluctuate, fossil fuel importers seek to reduce their import bills and develop greater energy diversification and self-sufficiency.

Slowing climate change: The majority of scientists are in agreement that the burning of fossil fuels and land use changes are actively contributing to rapid climate and weather pattern changes, which is also driving the search for 'renewable' energy and the stimulation of potential carbon markets.

Sustainable rural and agricultural development: In developing Africa, the drive to develop biofuels is also being fuelled by the realisation that unsustainable dependence on wood fuel is leading to rapid deforestation, seriously threatening water catchment areas and land productivity, as well as wildlife and biodiversity. The greatest challenges are, and will be, in the arid and semi arid lands of the many African countries.

Economic drivers: As stock exchange markets develop, more and more investors are turning to the Energy sector as an investment opportunity. This has led to development of varied investment opportunities particular in African Countries. The issue with economic drivers is not so much the fear of climate change or energy insecurity but rather the need to make a return on the investment done. This has had both positive and negative impacts.

Many countries have responded to these drivers and challenges with either biofuels Policies, or at least government supported strategies. Key approaches identified from national policies and strategies include:

3.1 Best practices aspects/ingredients in developing a national biofuels industry

- Large-scale public investment into coordinated National research and development programmes on feedstock development and distribution to farmers, including certifying institutions/organisations (e.g. EMBRAPA Brazil, Indian Government centre for biomass research (over 400 species under investigation), BDFZ Germany, Nigeria.
- Large-scale public investment into coordinated research and development of each section of the value chain with close linkages to the private sector producers and distributors to improve efficiencies and bring down production costs to be competitive with fossil fuels (e.g. PROALCOOL in Brazil, India, USA and Canada).
- A national registry of feedstock availability, processing facilities and up-take to provide necessary data for price reviews to avoid a mismatch between supply and demand (example of what happened in India).
- Focus on pro-poor rural development led by small-scale farmers; models of

clustering to reach critical masses; encouraging contract farming; incorporating biofuel production into a National guaranteed rural employment programme in biofuels development; supporting extraction of bio-oil at village level and encouraging development of rural energy centres with biodiesel powered generators for agricultural services, battery charging and public lighting (e.g. India, Mali, Ghana, Zimbabwe) or transportation to larger industrial refineries (India); and active national promotion of bioethanol stoves (e.g. Ethiopia).

- Multiple small-scale plantings to reach national self-sufficiency and critical mass on biodiesel production (e.g. India, Myammar).
- Allocation or leasing of large tracts of previously public, community owned, trust, or private land to encourage foreign or local investment, sometimes with additional tax incentives (e.g. Ethiopia, Malawi, Mozambique, Ghana, Tanzania, Kenya, Sudan, DRC, Zambia).
- Graduated tax schemes for national or international producers (e.g. Brazil, Ethiopia).
- Development of Regional and National Biofuel standards and certification requirements based on other global standards such as ASTM–D-6751 and EN-14214 (e.g. Brazil, India, EU, Malaysia, South Africa Mozambique, Nigeria).
- Multi-stakeholder taskforces and/or Ministries of Energy/Renewable Energy to undertake policy development and financing of research and development and tasks allocation concerning the development of the biofuels sector to all other ministries involved (e.g. Zambia, Kenya, South Africa, Uganda, Malawi, Tanzania, India, Brazil).
- Set up a National Biofuels Coordinating Committee with specific sub-committees (e.g. India), Biomass Research and Development Board (e.g. USA).
- Enforced jatropha planting by decree (e.g. only as hedgerows on any plot over one acre in Myammar 2006 and some alleged incidents in Chattisgarh, India).

3.2 Approaches to supporting the industry to become sustainable

- Minimum support price for non-edible oil seed (e.g. India).
- Long term (over decades) graduated production and supply targets fitting into graduated mandatory fuel blending targets (e.g. Brazil, EU, Mali, Ethiopia).
- Guaranteed purchase at agreed prices of biofuels by state owned fuel companies (e.g. Brazil, India, Zimbabwe).
- Graduated or set mandatory blending targets (e.g. EU, Malaysia, Brazil, Ethiopia, Malawi, Mozambique, with more proposed in Africa. India has an indicative target of 20% by 2017) in some cases leading to mandatory flex-fuel transport vehicles (e.g. Brazil) or trials on government cars (e.g. Malaysia).
- Differentiated and graduated economic and tax incentives as well as subsidies for producers and distributors as the value chain and markets develop into potential profitability. These range from agricultural aid for energy crops (e.g. EU) to tax exemption of bio-diesel (particularly at the beginning of its development), VAT waivers, concessional excise taxes on bioethanol, and concessional custom and excise duties on imported machinery for the biofuels sector, as well as local and/or international tax breaks for biofuels investment (e.g. North America including Canada, EU, Brazil, India, Germany, Nigeria, Ethiopia).
  Setting up of companies to issue large matching grants for importing biomass (Netherlands).
- Initial lowering of ethanol prices at the pump well below gasoline prices (e.g. Brazil).
  Vehicle taxes based on carbon dioxide exhaust emissions (e.g. UK, Denmark).
  Compulsory grid connections and feed in tariffs (e.g. Germany, Kenya, Ethiopia).
- Biofuels exportation only permitted after national requirements have been met, and decided by the National Biofuels Coordination Committee (e.g. India).

3.3 Government programmes for financing the industry

- Renewable energy funding programmes (e.g. Germany).
  Grants, cooperative agreements, continuation renewal awards (e.g. EU-ACP, EU Intelligent energy, Energy Efficiency and Renewable Energy, American Recovery and Reinvestment Act USA).
- Investors Tax Incentives (e.g. North America National Biofuels board, Nigeria ‘pioneer status’, Ethiopia, South Africa).
- All aspects of the Biofuels sector declared as a priority for the purpose of lending and financing from the banks and financial sector (e.g. India).
  Establishment of a National biofuels Development Agency and/or Fund (e.g. India, Mali, Ghana, Mozambique).
- Environmental degradation Tax on National oil and Gas facilities to fund cheap biofuels loans (e.g. Nigeria).

3.4 Environmental safeguards

- National eco-physiological zoning to exclude areas of high conservation value, especially existing forest, water resources, high biodiversity and other agricultural, industrial and economic activities (e.g. Brazil, (Uganda, Kenya, Senegal)).
- Agro-climatic mapping of areas of optimal suitability of each potential feedstock followed by extensive trials and research (e.g. Brazil, India, Uganda, Kenya, Senegal).
- Consultative creation of sustainable production practices and principles to increasingly inform policy on sustainable sources (e.g. EU, USA).
  Setting and enforcing guidelines for sustainability (e.g. EU) (European Biofuels Technology Platform 2010, European Commission 2010).
- Mandatory adoption of these sustainability rules beyond the existing legal frameworks of the country and bio-diesel standards (no known examples).
- Use of national and regional biomass and biofuels policies and regulations, as well as import and export rules to track and support sustainability of production (e.g. EU, Indonesia, USA).

4. Review of biofuels development experiences

Biofuels Development in Africa is being driven as much by external factors as by needs within the continent. For example, the Kenyan Biofuels policy committee started by looking as deeply as possible into other countries policies and drivers in order to understand their needs as much by comparison as by differentiation and elucidating what was different for Kenya. For this reason, this chapter looks first at some other countries approaches without seeking to be comprehensive. The purpose is to look at some key drivers and responses. Chinese, Brazilian and Indian national and private investors and technology transfer schemes are also the main players in driving some of the larger scale investments in Africa. This section on some key non Africa countries is then followed by a review of what could be established for 13 African Countries. Again it has not taken a standardised approach but seeks to illustrate some of the main activities and lessons from each country as there is as yet no uniformity in activity, government response or approach throughout Africa.

A recent report 'Mapping Food and Bioenergy in Africa' (FARA 2010) takes a standardised case study approach to 6 African countries with Ghana as an added benchmark. Institutional arrangements are mapped and generalised comments made. What is not brought out is the extent of effectiveness of and between the different institutions or bodies, and their ability to develop or influence the adoption of policy. This report provides useful general background data while not giving extended details of actual current activities on the ground.

As identified in Chapter 2, areas that require frameworks and legislation in first and second generation biofuels include:

- Land and water ownership, tenure and use rights.
- Land, forest, water, biodiversity and wildlife management plans; environmental conservation; protected species and habitats; conformity with protected areas and deforestation legislation.
- Water resource allocation and abstraction laws.
- Air, ground and water pollution, and compliance with pesticide and fertilizer use restrictions.
- Greenhouse gas mitigation measures.
- Seed and plant breeding, seed selling and phyto-sanitary requirements.
- Provisions on the use of genetically modified plants and organisms.
- Environmental impact assessments.
- Social impact assessments: zoning, urban and rural planning considerations.
- Public health and sanitation covering collection of and use of municipal waste as well as waste management and disposal provisions.
- Community participation: protection of indigenous peoples, local communities and women.
- Labour rights: minimum wage, job stability and the prohibition of child labour.
- Worker health and safety, in agriculture and in production facilities.
- Import and export laws.
- Credit financing.
- Tax laws and other industry fee regulations.
- Processing, sales, transportation and shipping laws.
- Product marketing and certification regulations.

Many of the above issues are covered in greater or lesser detail in existing different legislation and ministries in many African countries, in particular those that cover agricultural development. As a result very few countries have seen the need or urgency to create a separate 'Biofuels Policy'. This is despite the fact that, along with increased Chinese and other new sources of investments and development projects, they are acting as one of the largest agents of change in rural African landscapes. Some National governments have created facilitative tax and investment regimes, designed strategies based on intent or added sections on promoting renewable energy to existing Energy laws. Nevertheless the sudden growth of Foreign Direct Investment in Africa is challenging the coherence and adequacy of existing legislation covering all these many areas impacted by intense biofuels development. Sometimes Ministries of Energies, who are often given the lead, are often concerned with how many litres of biofuels can be generated to replace imported fuels, without viewing the related social and/or environmental impacts of producing such quantities of biofuels as being part of their mandate or concern. As is becoming clear, success in meeting all the potential national benefits biofuels can offer, while avoiding the many pitfalls, requires a well thought through strategy bridging a wide range of integrated and inter-linked issues. It could be fair to say that Africa has never faced a challenge or opportunity quite like this before.

These attitudes and approaches mean that planning to mitigate risks through a well-planned integrated approach is often missing, and problems, even if identified and addressed at all, are often done so only afterwards. Forests are being cut down, farmers and families are being forced to move, prime agricultural land is being acquired, intensive use of fertilizers is taking place and water resources are being diverted. Currently there tends to be two polarised views; those of governments who seldom see the problems; and those of NGO's who raise all the concerns. What is missed in this polarisation is in-depth analysis and political framing of the whole picture. While often focusing on the negative aspects of the introduction of large-scale biofuels into Africa, international organisations and NGO's seldom analyse what will happen to Africa's forests, landscape and wildlife if biofuels and modern agriculture are not introduced.

It might be argued that poverty, insecure land tenure and almost total reliance on wood fuel biomass for cooking and rural charcoal incomes and in some cases, bush meat for protein are also the some of the environmentally destructive forces in Africa, both in environmental destruction as well as the toll on rural health.

To get the balance right, dedicated biofuels and emerging crops policies, aligned with agricultural and environmental legislation are required. However, it is not always easy for Energy Ministries to develop the best strategies on their own from the start. In a number of cases in Africa, such as in Ghana, Kenya and South Africa, draft policies and strategies respectively have been created but have not yet been passed into law. Policy makers quite rightly argue that there are too many unknowns, such as eventual jatropha yields, changing EU certification rules, unpredictable ethanol markets and unknown tax and excise implications, to base such policies on evidence and experience. Nevertheless there is a case for developing and then testing draft policies based on what is known while further research is carried out to ensure that the most inclusive and effective decisions are made.

As such, the implementation of biofuels programmes in one African country can benefit from experiences and current strategies adopted by other countries. This section very briefly presents some of the biofuels activities and programmes in a number of selected countries. The aim is to give a snapshot of a fast evolving industry rather than a scholarly or comparative review of individual country legislative frameworks.

4.1 Non-African Countries

4.1.1 Brazil

Figure 5: Community-owned micro distillery of ethanol (Photo: GAIA Association)

Brazil is the fifth largest country in the world with a total area of 8.5 million square kilometres with much of the country lying between 600-800 metres above sea level. It has a dense and complex system of rivers and a very long coastline. Unlike most countries in the world Brazil still has more bio-capacity than is being used. Brazil is the world's largest producer of ethanol from sugarcane, mainly based on about 100 companies around São Paolo. While it has not all been smooth going, the Government provided crucial institutional support to allow the ethanol industry to develop during its inception stage, 30 years ago, through providing incentives; setting technical standards; supporting new ethanol production technologies; and ensuring appropriate market conditions. Brazil's experience offers replicable lessons. Key among these has been its ability to:

- Carefully zone and map the whole of Brazil, ring-fencing areas of high conservation such as the Amazon and zoning each area for specific feedstock suitability. It also went further, suggesting the best agronomical approach in each area and supporting farmers with GIS and optimal agro-climatic data.
- Improve the productivity of sugarcane by continuously developing genetically improved varieties of all sugarcane, soya, cotton, maize, jatropha and other crops. Improve the mechanisation of planting, harvesting and transport loading of sugarcane.
- Improve technologies of sucrose fermentation, cellulosic hydrolyses and gasification of sugarcane biomass (straw, bagasse, molasses and vinasse) and use wastes for cogeneration and industrial uses.
- Increase local and international awareness using events such as conferences, summits and promotion advertisement about the importance and potential of bioethanol and biodiesel.
- Improve government-private sectors (PPP) partnerships with continuous encouragement and support for bioethanol innovations in Brazil and the "friendly" tropical countries that are willing to cooperate with Brazil in improving the productivity and supply of bioethanol around the world.

Brazil followed up its technological successes with graduated blending and tax incentives and finally a requirement for flexi-fuel cars and biofuels distribution through Petrobas allowing drivers to choose their blends at the petrol pump (Moreiera 2006). In a nutshell, Brazil's biofuels success has been largely attributed to synergies with the sugar industry, electricity and heat production, institutional support and suitable geographical and political aspects. The difficulty of maintaining European ethanol standards when importing Brazilian ethanol to the EU markets makes Africa a prime location in Brazil's quest to supply the European market. Brazil's national jatropha growing association, APPBM, is very active and well supported and is now ready to set up the wide spread planting of three varieties along railway lines, under power lines and one trial, potentially mechanized, 5,000 hectare plantation.

Recent Brazilian activity in Africa involves 22 countries, for instance:

- 2 accords with Mozambique for a US$6billion investment in biofuels exploration. Odebrecht's US$220million ethanol joint venture in Angola.
- In June 2009, the first ethanol manufacturing plant in Sudan was opened, equipped with Brazilian machinery, with a daily production capacity of 200,000 litres of sugarcane ethanol.
- In October 2007, Brazil signed two agreements with the Republic of Congo to provide training, technology and financing to produce biofuels from sugarcane and palm oil.
- In January 2010, a deal was signed between universities in Uganda and Brazil to collaborate on research and innovations to boost the development of biofuels in Uganda.
- The Africa-Brazil Marketplace small grants programme, created by Embrapa and FARA is a proactive way of transferring South-South agricultural and bioenergy technology.

However, it is important to examine the process (the how), and lessons of the Brazilian experience before mapping this experience to Sub-Saharan Africa (SSA), especially when it is realized that SSA is extremely water scarce as compared to Brazil. Further still issues on technology transfer on a South to South basis (e.g. Brazil to Congo) or north to south basis need to be approached with care, since the technology may at the least be outdated and inefficient or at the worst wholly inappropriate for the African country in question either due to technological support and cultural practices among others.

4.1.2 China

While China's current fuel ethanol production is very low, its ethanol industry roots also dates back to the 1970s and 1980s, as a result of grain overproduction. While China is often cited as the world's third largest ethanol producer, it is mostly for potable ethanol production. China has become a net ethanol exporter, from corn and cassava, when the use of food crops for ethanol was banned because of rising food prices and concerns over scarcity (APEC 2010). Feedstock remains China's biggest challenge. Li Rongjie, a deputy of the National People's Congress (NPC), China's top legislature, recently stated that the country has the potential to produce 1.2 billion tons of dry cellulosic biomass per year, with an energy content of 400 million tons of crude oil. Li suggested the government offer subsidies and policy incentives for enterprises engaged in such business to speed up the industrialisation of cellulosic ethanol production. SunOpta Inc. has been awarded a contract to supply a major ethanol producer in China with the Company's proprietary fibre preparation and pre-treatment equipment, including a demonstration plant, scheduled for completion by late 2010, using local corn stover as feedstock. South west China has much jatropha growing but it is in an environmentally sensitive area so there are currently no plans for further development.

China is now Brazil's largest trading partner, having invested in its emerging oil industry and in December 2009, PetroChina signed a deal with Petrobas Brazil to build ethanol plants in Brazil for exporting ethanol to China. At the same time China dropped its import tax on ethanol from 30% to 5%, to provide Brazil a market rather than meeting its internal demands.

There is much talk of China's investments in Africa. China plans on settling more than 1 million indigenous Chinese overseas each year, and with its phenomenal investment in training, government supported industries can offer infrastructure development in

exchange for access to minerals and other resources. This is often more attractive to many African governments than World Bank loans with strict conditions. Some biofuels projects that involve importing Chinese labour have met with opposition. Demonstrating the difficulty of verifying figures, one report suggested that ZTE's '3 million hectares of oil palm plantation in the DR of Congo' was probably nearer to 300,000 hectares, with the mistake arising from the use of Google translator which adds a '0' to Chinese numbers. This misinformation was then spread around the world through unchecked newspaper articles and blogs (Brauitigam D 2010).

4.1.3 India

Figure 6: Pedal-driven biodiesel reactor (Photo: CTxGreEn)

India's BioFuels Policy was finally announced on 23rd December 2009, and gives guidelines but does not propose figures or financial commitments. Some important issues are:

- An indicative target of 20% by 2017 for the blending of biofuels – both bioethanol and bio-diesel have been proposed.
- Tree plantations bearing non-edible oilseeds will be taken up on Government/ Community wasteland, degraded or fallow land in forest and non-forest areas. Contract farming on private wasteland could also be initiated through the Minimum Support Price mechanism proposed in the Policy. Biofuels plantations on agricultural lands will be discouraged.
- A major instrument of the policy is a Minimum Support Price (MSP) for oilseeds which should be announced and implemented with a provision for its periodic revision to ensure a fair price to farmers. The Minimum Purchase Price (MPP) for bio-diesel by the Oil Marketing Companies (OMCs) will be linked to the prevailing retail diesel price.
- Employment provided by plantations of trees and shrub bearing non-edible oilseeds will be eligible under the National Rural Employment Guarantee Program (NREGP).
- Financial incentives, including subsidies and grants, may be considered upon merit for new and second generation feedstock's, advanced technologies and conversion processes, and production units based on new and second generation feed stocks.
- Bio-ethanol already enjoys concessional excise duty of 16% and biodiesel is exempted from excise duty. No other central taxes and duties are proposed to be levied on bio-diesel and bio-ethanol.
- Import of Free Fatty Acid (FFA) oils will not be permitted for production of biofuels.

India is the 2nd largest sugarcane producer after Brazil and also one of the largest sugar consumers. Ethanol is made from molasses and despite India's production capacity to meet a national 5% fuel blending target, progress has been slow due to low productivity, unreliable monsoons, limited advanced technology, and restrictive state controlled policies such as excise duty on alcohol. India is also carrying out intensive research on sweet sorghum and sugar beet for ethanol. Ethanol production was initiated by the Ministry of Petroleum, and natural gas and biodiesel by the planning commission in 2003 with the Ministry of Rural Development responsible for identifying the best feedstock. Within this new policy all activities have been harmonised under a central Ministry of New and Renewable Energy, which is empowered to coordinate with other Ministries.

Figure 7: Biodiesel Production from Jatropha (Photo: Raffaella Bellanca)

India has focused mainly on jatropha for biodiesel feedstock. With more than 1 million jatropha trees planted across 16 states (well short of initial targets), and another million expected to be planted soon, the major problem has been with its lower than expected yields, and higher than expected costs of cultivation.

There is still a huge shortage of supply against demand in India, with a lot of seed being used for planting, and oil companies offering lower prices than production costs. One commentator noted that with the common use of vegetable oil lamps for lighting in homes and temples, many people have turned to buying cheaper 'bio-kerosene' (unrefined biodiesel) depriving the larger biodiesel industry of its oil supply. He also noted that the manual collection of non-edible oil seeds is a huge logistical challenge for large biodiesel plants. A total of 15,000 people are needed for 3 months, once or twice a year, to gather 100 tons of seeds per day, producing 8 million gallons per year. India's biodiesel processing capacity is estimated at 600,000 tons per year. The government is now likely to fix a price of Rupees 34 a litre for the purchase of biodiesel by oil marketing companies.

4.1.4 Malaysia

Malaysia passed its National Biofuels Policy in March 2006, which falls under the Ministry of Plantation Industries and Commodities. Malaysia is the world's largest palm oil producer having started its programme in 1982. It established the national B5 standard in the short term with initial voluntary uptake as well as setting itself up as a major exporter. Incentives were awarded under the Pioneer Status or Investment Tax Allowance if they were considered strategic, high technology or included commercialisation of R&D findings for the public sector and resource-based industries. While both Malaysia and Indonesia have very suitable climates for palm oil production, Malaysia has long since industrialised its forests into rubber and palm plantations with little indigenous forest left. Malaysia's goal was for the share of renewable energy to reach 10% of the total by 2010. In 2010, Malaysia mandated that by 2011 all vehicles must utilize a B5 biodiesel/diesel fuel blend containing five percent processed palm oil (AFP, 2010).

4.1.5 European Union (EU)

Within the EU, the biofuels sector has undergone tremendous growth recently. This growth has been aided by three key directives:

1. Promoting production of biofuel markets in the EU through setting a voluntary 'reference target' of 5.75% biofuel consumption by 2010; this also obliges the member states to set national indicative targets for their share of biofuels.
2. Allowing for the application of tax incentives for biofuels. Since taxation is within the sphere of each member state, each member has autonomy on the level of taxation for fossil fuels and biofuels.
3. Setting environmental specification and limitation on ethanol blending (European Biofuels Technology Platform 2010). Recently, the EU caused a stir by suggesting voluntary schemes with sustainable criteria will become mandatory and will become the basis on which imports are accepted and blending targets set (European Commission energy 2010). Though 12 southern African nations joined to sign a letter of protest, the suggested scheme has the potential to encourage African governments to create the most efficient and sustainable industry from the start, in order to protect African export, carbon and investment markets (Weisleder L. 2009).

On July 19th 2011, the European Commission approved the first seven sustainability certification schemes under the Renewable Energy Directive (RED) for biofuels in the EU. Leading economists say changes in land use caused by biofuels mean that the EU's policy may cause more emissions than previously projected. Oxfam and other international NGOs are challenging the EU 2020 quotas until further studies are done. The EU is likely to make an announcement concerning Indirect Changes in Land Use (ILUC) in late 2011.

4.2 African Countries

Most African countries have passed or are passing renewable energy policies and regulatory frameworks as well as providing requisite legal frameworks in order to ensure the wider adoption of renewable energy technologies and methods of sustainable energy production. Biofuels are part of this drive and below are some brief descriptions of activities in thirteen African countries, picked because they have either been active for a long time, such as Malawi, are set to become major players, such as Nigeria, or are just interesting case studies that illustrate the different challenges that African nations face.

4.2.1 NEPAD

The New Partnership for African Development (NEPAD) was adopted by Heads of African States and governments in 2001 in Lusaka, Zambia. In February 2010 it was integrated into the structures and processes of the African Union (AU). This included the establishment of the NEPAD Planning and Coordinating agency (NPCA) as a technical body of the AU to replace the NEPAD secretariat. The sustainable energy production target of AU/NEPAD is to secure access to adequate energy supply to at least 30% of the African population in 20 years (Elmissiry 2010). The NPCA has set a target for itself to establish and obtain essential information and data that are required for the development of the bio-energy industry in Africa and will embark on sub programmes to assess the current continental capacity: review, develop and harmonise policies regarding bioenergy usage, land tenure, market development, trade and small holder participation as well as the impact on land, water and environmental variables. NEPAD's overall approach is that it is positive about the potential for bioenergy and biofuels on the continent and seeks donor funding and investors into its programmes.

4.2.2 Angola

Recently the Brazilian industrial giant Odebrecht has partnered with Angolan state-owned oil firm Sonangol and private company Damer in a joint venture, Biocom, investing $220 million in a 30,000 ha sugarcane farm in Malange province. By 2013, a processing plant will produce 260,000 tonnes of sugar and 30 million litres of ethanol per year. Biocom/Odebrecht has become Angola's largest private employer. Based on 'food for fuel' concerns, the Angolan government passed a law in March 2010, regulating the involvement of international companies in its domestic biofuels industry. Foreign companies investing in Angolan biofuels or biofuel crops will have to sell some of the resulting biofuels to the Angola's state oil company Sonangol, under the new law, as well as make water, services and medical care available to local people. It also states that only "marginal" lands would be allocated for biofuels production, reserving the most fertile lands for food production.

4.2.3 Ethiopia

While the initiative for biofuels started in the private sector in Ethiopia, the centralised government soon embraced the industry (Anderson and Belay 2008). Molasses ethanol and jatropha biodiesel have been given priority, and regulations on investments have been significantly relaxed especially for the agricultural sector. A minimum capital investment is no longer required, and foreign agricultural activities are exempt from paying custom duties and taxes on imports of capital goods, according to the export orientation of the foreign investor. They are exempt from income tax for a certain time period and foreign investments are exempt from the payment of sales and excise taxes for export commodities.

Figure 8: Stove user talking about the CleanCook stove (Photo: GAIA Association)

There are four government owned sugar factories in Ethiopia, including Finchaa, Metahara, Wonji and Tendaho. All the factories will eventually produce ethanol with the national annual production expected to rise to 128 million litres by 2012. Ethiopia has been a pioneer in ethanol stoves for rural communities, although this program has recently been affected by a low ethanol supply which has been diverted to meet national blending targets. The Ministry of Mines and Energy developed a biofuels development and utilisation strategy in 2007, with 23.3 million hectares being identified for leasing to foreign companies for food and biofuels, mostly in the region of Oromia, as well as in the western regions of Gambella and Benishangule, and the regions of Tigray and Amhara.

The scale, speed and process of this land offering and uptake has created controversy, especially where virgin forest has been cleared and villages and farmland occupied. Some claim that over 80% of all land allocated for biofuels production has been located in fertile arable lands, forests and woodlands, citing no EIA process or assessment of current uses and inhabitants. With 3 million people on food aid, the Ethiopian government denies such biofuels projects are causing hunger and says that

the land deals are attracting hundreds of millions of dollars of foreign investments and creating tens of thousands of jobs. A spokesman said “Ethiopia has 74m hectares of fertile land, of which only 15% is currently in use – mainly by subsistence farmers. Of the remaining land, only a small percentage – 3 to 4% – is offered to foreign investors, who are never given land that belongs to Ethiopian farmers”.

According to data from the Ethiopian Investment Agency, over 60 companies wishing to invest in the sector were issued licenses, but presently only 10 companies are believed to be operational. These include Indian, German, British, Israeli, American and Saudi companies. While horticulture, floriculture, food and meat still predominate FDI’s focus, biofuels investments have expanded enormously since 2006 (Weissleider 2009).

Other strategies in biodiesel production include promoting fuel blending for transport; importing flex fuel vehicles; developing and implementing guidelines to replace kerosene for cooking; promoting the local manufacture of ethanol cook stoves and create a market for export. Additional regulatory measures include co-ordination between government institutions, creating stakeholder forums and public awareness campaigns; market development through the provision of financial incentives for the private sector; the support of technology transfer and research; and developing linkages with international initiatives on technology (Ministry of Mines 2007).

4.2.4 Ghana

In 2005, the government of Ghana set up a Biofuels Committee (BFC) with the objective of developing a National Biofuel Policy (NBP). After a “study”, the BFC recommended, among others, that the National Biofuels Policy should accelerate the development of the biofuels industry in Ghana with special emphasis on the production of biodiesel from jatropha. To date this draft policy has not been finalised while concerns grow about Norwegian, Brazilian, Dutch, Swedish, German and British firms all competing for farmland to grow energy crops in different parts of the country. Seven private companies from these countries are currently farming about 55,000 hectares of land for biofuels with up to 20 currently seeking land deals (Nanna G 2010).

Figure 9: Woman cooking on clean ethanol stove, Kenya (credit: PISCES)

Local civil society and NGO’s are vocal in asking for clear policy frameworks and guidelines that include mapping and zoning the country to exclude biofuels from highly productive areas to avoid competition with prime productive agricultural land and other productive resources, reduce environmental destruction of biodiversity and ecosystems (the Ghanaian environmental protection agency eventually put a stop to Bio-fuel Africa’s clear-cutting, after 6,422 acres of forest had already been cut down), and prevent the extensive application of agro-chemicals for biofuels. Many say that they are not against biofuels production or investment per se, but that productive lands being used by such are a genuine threat to food security.

At the same time, according to COMPETE (COMPETE 2008), the government stimulates the development of the biofuels industry and supports a series of small-scale initiatives. A clear case is the creation of a US$1.6 million fund for the development of Jatropha Curcas plantations across the country. In addition, Community Based Rural Development Projects (CBRDP) is managing a US$5 million overseen by the Natural Resources Management subdivision. This fund addresses the rehabilitation of degraded ecosystems, thereby providing opportunities for jatropha projects due to their positive impact on soil erosion. Other legislation and regulation relevant to bio-energy include environmental policies, energy policies and agricultural policies.

4.2.5 Kenya

Kenya is a mostly arid to semi-arid country with only 17% of its land receiving more than 750mm of rain a year. The choice of widespread commercial cropping feedstock’s is limited to specific feedstock’s in specific areas, along with a higher likelihood of competition with food crops, pastoralism, and wildlife dependent ecotourism, the second largest industry. Kenya’s forest areas have reportedly been reduced to 1.7% of land cover and a growing rural population is very highly dependent on increasingly scarce woody biomass. With limited climatic potential, there is a stronger government focus on geothermal and wind, long-standing hydro schemes, with some focus on biomass and solar resources. Ironically this has led to a perceived lower urgency to enact a specific biofuels policy, while large-scale FDI projects are slated for development in what some regard as socially and environmentally sensitive areas and others as areas ripe for development under the 2030 vision.

An ethanol plant was first set up in 1977 in Kisumu, but ceased operation in 1979. With new investment, ethanol blending was introduced in 1983, but collapsed again in 1993 due to diminishing investment, proper pricing and a policy framework. The government is starting to pilot an E10 blend in Kisumu and Nakuru in 2010, but with up to 60% reported shortfall in ethanol supply versus potential demand, it still needs to address some of the deep financial and efficiency issues that have dogged the predominantly government owned sugar industry. Mumias Sugar Company is set to expand sugar cane production by 40,000 in the Tana River Delta, leading to a long-standing controversy on the best use of this very unique highly diverse wetland region. Imminent changes in the sugar industry are likely and sweet sorghum and cassava are also being explored as Bioethanol crops. Chinese investors are reportedly discussing supporting 40,000 hectares of Cassava on Galana Agricultural Development Corporation land with Kenyan Energy Alliance Ltd linked for export of starch and ethanol to China.

In biodiesels, NGO’s have started to promote jatropha with small holders, and some ground research is being conducted by NARI’s, PPP’s and small-scale donor funded projects. Some of Kenya’s first biodiesel was produced from *Croton Megalocarpus,* an indigenous oil bearing tree that thrives at higher altitudes in central Kenya. One US based company is first promoting supportive institutional reforms as preparation for a large scale croton biofuels investment. Two or three large-scale, irrigated, Jatropha, sunflower, castor and crambe export projects have been given EIA clearance in the Tana and Malindi districts.

The Italian owned Kenyan Jatropha Energy Company has been applying to start with a smaller pilot project as protest formed over cutting down thousands of hectares of sensitive indigenous forests in Malindi district (Gitau, 2010). Bedford Biofuels has

been applying for 64,000 hectares of jatropha plantations across seven Tana district ranches (NEMA, 2010) and has since been cleared to start with 10,000. In cooperation with Agro-biotech China, CIAT of the Consultative Group on International Agricultural Research, the University of Nairobi, the Agricultural Development Corporation, and with Chinese investment, the Jatropha Energy Alliance aims to bulk up cassava stems in the University of Nairobi Farm in Kibwezi for planting on 40,000 hectares of the Agricultural Development Corporation's Galana Ranch, for starch and ethanol export intended for China (Muchiri, 2010). Some of these large projects aim to be irrigated or supported by the Tana River System under the guidance of the growing Tana and Athi River Development Corporation (TARDA), with beneficial proximity to the proposed new Lamu port for export. There is increasing commercial and scientific concern about the impact on the overall hydrology and local rainfall patterns as a result of large scale dams and irrigation schemes as well as the reality of the changing coastal weather patterns, both which are already making the livelihoods of the indigneous agro-pastoralist communities even harsher.

While the Kenyan government has recognised that these coastal regions in particular, are in need of clarity of land tenure and development, the success of these new crops in semi-arid and highly sensitive areas is still uncertain (Republic of Kenya 2009). The large Kenyan coastal projects, have the potential to either benefit or displace large numbers of people, enhance or diminish the pastoralist based beef and dairy industries, and do have a high likelihood of irreversibly compromising existing unique ecosystems, probably driving some vulnerable endemic species into extinction as a consequence of rapid industrial scale development.

The semi-arid/arid nature of Kenya's agro-climatic conditions limits the areas available for rain-fed or irrigated agri-business expansion, leading to some controversial decisions. With quite a few unique ecosystems threatened (Conservation International, 2010), and a successful wildlife-based tourism industry that has the potential to expand, Kenya is perhaps an example of the urgent need for some governments to adopt science-based natural resource management plans in order to realise the benefits of biofuels (Muok et al, 2010). Using a highly integrative and participative methodology, and with careful mapping and zoning , this approach can preserve Kenya's unique indigenous flora and fauna alongside maintaining current land uses, such as for beef cattle in dry seasons, that also provides extensive and high earnings.

Kenya and other water scarce African countries can also innovatively explore new technologies for developing biodiesels from municipal and agricultural waste, which may have great potential for generating much less competitive and controversial feedstocks.

Nested in the Ministry of Energy, the regulatory framework is based on the 2004 Sessional Paper on Energy and the Energy Act of 2006, which set up a renewable energy department. A multiple stakeholder National Biofuels Committee was convened in 2007 and has since produced a biodiesel strategy in 2008, (Mouk et al 2008) revised in 2010 (which included the establishment of the Kenyan Biodiesel Association, KBDA), a Bioethanol strategy in 2009, and a draft National Biofuels Policy in 2010, including a report mapping and zoning of the country for different feedstock suitability. These have not yet been formally taken forward, developed or adopted by the Kenyan government at the time of writing. A different group, with a majority representation of the sugar industry, designed the recently gazetted E10 blending regulations.

4.2.6 Malawi

The history of a biofuels policy in Malawi dates back to the 1970's following the crude oil crisis of that era, with the main leading domain being the private sector (Wambua, 2010). Due to both the lack of a developed infrastructure and a landlocked status, the country suffers from high transportation costs, which only increases the impact that imported petroleum has on the economy.

Since 1982 the country's fuel-blending programme has taken advantage of the economically favourable conditions for ethanol production from sugar industry molasses, and annual production is currently over 10 million litres. Government policy has been to blend ethanol with petrol in a 2:8 ratio but a recent switch to unleaded petrol has dropped this to 1:8. The former blending requirement for 2:8 was optional, however recent regulations reducing the requirement make blending mandatory (Malawi Energy Regulatory Authority 2009). In light of this requirement, there is urgent need for a policy environment that allows biofuels producing companies to redouble efforts in production, to ensure that they are up to the task of sustainably producing enough fuel to meet this blending requirement. It is interesting that Malawi's policy has survived while Kenya's early forays collapsed, largely due to Oligopolistic influences of the petroleum marketers and cartel like activities in controlling the blended ethanol-petroleum market.

Malawi's biofuels 'policy' has since been extended to include jatropha and other biofuels crops with representatives in the policy making team being drawn from the energy, forestry and agricultural sectors. Specifically, stakeholders have formed the Biofuels Association of Malawi (BAM) and the Biofuels Advisory Council (BAC). BAM is a non-profit organisation whose founding members are active in the jatropha industry, and it aims to promote the establishment of a viable biofuels industry in Malawi. Following BAM's first stakeholder meeting held in Malawi in November 2008, it was found necessary to create an advisory council for the biofuels sector. BAC is the advisory council that was formed following this decision, and council members are drawn from government and the private sector. The Council's objective is to develop a policy and legal framework for biofuels production in Malawi. However, a major challenge is the harmonisation of the various existing agricultural and energy policies and strategies to provide a framework for the development of the biofuels industry (UNCTAD 2009).

Each of these stakeholders has a unique contribution towards the development of a sustainable biofuels industry, and measures need to be taken to ensure bioenergy production is conducive to reducing poverty. The Government of Malawi is overseeing biofuels production to ensure that there is no conflict of interest with food security, not least by investing heavily in Agriculture. In addition to enacting legislation that provides for biofuels production licensing requirements, production standards and blending requirements (MERA 2010) incentives like subsidies and tax exemptions are tools the government is targeting to promote biofuels production.

4.2.7 Mali

The government of Mali has set up the National Biofuel Development Agency (ANADEB) to coordinate its biofuels policy. The agency will centralise the government policies and set technical and quality standards for biofuels products. It will also provide a consultation framework for the public and private stakeholders, as well as to ensure regular contacts between national and international partners in the biofuels sector.

The Government adopted the National Energy Policy and the Renewable Energy Development Strategy in 2006, and the National Biofuel Development Strategy in 2009. The strategy is expected to increase national energy production through the development of biofuels. Mali has been home to early development small-scale jatropha research and pilot studies, engaging and teaching small-holder farmers. With Dutch input, Mali Biocaburant has piloted models of farmer inclusion along the lines of Prokon and Diligent in Tanzania. The rural-based organisation ULSPP (Local jatropha Producers Union) has been the leading organisation for the production of Jatropha in the region since 2007. The union consists of 12 producer cooperatives, representing a total of 2,500 members, including 500 women, and the jatropha production area covers over 3,600 hectares (SNV 2010).

4.2.8 Mozambique

In March 2007, The Forum of Energy Ministers of Africa (FEMA) adopted the Maputo Declaration emphasising the imperative and urgent need to accelerate the diversification of Africa's energy matrix. Mozambique's government then carried out a biofuels evaluation in 2007, focused on technical, socio-economical and environmental feasibility, including crop selection; preliminary legislation; and mapping and zoning of 11 million hectares of land potentially suitable for biofuels production with a focus on sugarcane and sorghum, jatropha and coconut palm. They then conducted seminars with civil society, passing the resulting Biofuels policy and Strategy into law in May 2009. The policy upholds principles of inclusiveness, transparency, environmental and social protection, instrumentalism, fiscal sustainability and innovation. Specifically, the strategy is an instrument that focuses on the promotion of ethanol (sugarcane and sweet sorghum) and biodiesel (jatropha and coconut) for the production of liquid fuels to be used mainly in transport, as well as for other energy purposes.

According to this document, biofuels development in Mozambique will be focus on:

- Biofuels as an essential activity for the private sector developed along public-private partnerships.
- Encouragement of international cooperation through the strengthening of existing links between institutions.
- Strengthening of cooperation with development partners, taking into consideration the growing diversity.
- Between south-south and north-south links.
- Strengthening the implementation of mechanisms and instruments of the Kyoto Protocol to encourage the rapid development of production and use of biofuels, contributing to an effective reduction of emission levels of greenhouse gases.

The Action Plan of this strategy identifies the following actions for biofuels development in Mozambique.

Demand for biofuels:

✓ Establish appropriate mechanisms to secure the development of the country's biofuels industry.
✓ Prepare legislation to alter the TSC taxation modules.
✓ Prepare legislation on co-generation of electricity.
✓ Prepare the criteria for sustainable biofuels production.
✓ Contribute to the establishment of a regional agreement between the SADC countries.

Opportunities for Biofuels:

✓ Establish programs for technical cooperation between partners.
✓ Adopt mechanisms to secure the availability of biofuels based on the provisions within the gradual introduction plan.

Price fixing mechanisms:

✓ Develop an operational manual for the bids of the program for purchase of biofuels (PCB).
✓ Develop a method for price fixation for the PCB reference.
✓ Manage the social/environmental impacts and develop sustainability criteria.

Institution framework:

✓ Create a national biofuels commission.
✓ Establish a national program for biofuels development (PNDB).
✓ Establish a program for purchase of biofuels (PCB).
✓ Prepare credential criteria for the certification of service providers.
✓ Formation of social capital.
✓ Support and establish entities for certification of service providers.
✓ Develop biofuels quality norms.
✓ Develop specifications for the importation of flex-fuel vehicles.

On 29 March 2011, the Council of Ministers approved the Regulation on Biofuel Mixtures, as well as establishing the Inter-ministerial Biofuel Commission, headed up by the ministries for Energy and Agriculture. These instruments were set up to promote the domestic biofuel market, its supervision and coordination. The Government expects these regulations to establish conditions for the introduction of mixtures of 90 percent gasoline with 10 percent ethanol and 97 percent fossil diesel with 3 percent biodiesel (Macauhub, 2011)

With much potential in the bioethanol field, in late December 2009, the Government revoked ProCana's 30,000 hectare sugarcane/ethanol concession in Massingir District, a company bought by the British-backed Bioenergy Africa in 2008. The company changed to mining and exploration, renaming itself as Sable mining. The project in the driest areas was set to displace 38,000 people already displaced from the Transborder Peace Park. Mozambique's communal land law gives its inhabitants a strong say in the use of their land, but is not being put into full practice and they're not being given their voice. With more detailed mapping and zoning of the realities on the ground, full participation in decision making, appropriate feedstocks, adequate early regulatory frameworks and strong investment from Brazil and others, Mozambique may emerge as one of the strong players in African biofuels- particularly in bioethanol. Some growers have moved towards setting their own sustainability criteria for jatropha (Partners for Innovation, 2010). EcoEnergia, previously Sekab, strongly supported by Brazilian commerical funding, plans 400,000 hectares of sugarcane between Morogoro and Rifiji in Tanzania and inland from Pemba in Mozambique.

4.2.9 Nigeria

Nigeria has no formal biofuels policy, but the federal government has introduced Nigeria's Biofuel Production Programme to establishing a very intentional top down programme driven the by the Nigerian National Petroleum Corporation. Incentives include:

- Pioneer Status: All registered businesses engaged in activities related to biofuels production and/or the production of feedstock for the purpose of biofuels production and co-generation within the country fall within the provisions of the Industrial Development (Income Tax Relief) Act.
- Withholding tax on interest, dividends, etc.
- Waiver on import and customs duties.
- Waiver on Value Added Tax (VAT): Biofuel companies that are involved in the production of biofuels feedstock or the production of biofuels and/or the generation of electricity from biomass shall be exempted from paying VAT on all products and services they consume.
- Long term preferential loans.

Nigeria signed a memorandum of understanding with Brazil in 2005 and aims to replicate its success. It is developing an ethanol industry based on a projected capacity of 400,000 hectares of sugar cane and cassava for ethanol and E10 national fuel blending. Biodiesel production focuses on oil palm production, often reinvigorating previous plantations such as 10,000 hectares just north of Port Harcourt and Jatropha in the northern regions. The government has partnered with REEEP and IITA to start two ethanol pilot project of up to 30,000 hectares. The state of Ekiti recently started construction of its third biofuels refinery. Nigeria has attracted the highest volume of FDI of all Africa countries, and again with its seaboard is set to become a major biofuels player in Africa.

4.2.10 South Africa

South Africa is the largest energy consumer and the second largest energy producer in Africa (Scott 2009). South Africa started producing bioethanol from sugarcane in the 1920's and has recently started focusing more on crops such as sugarcane, sugar beet and cassava. Some are experimenting with castor and recently waste vegetable oil which may need to be imported.

The Industrial Development Corporation (IDC) and Central Energy Fund (CEF), both Government owned, have been exploring how to participate in two or three large scale bioethanol (sugar beet and sugarcane) and wood waste renewable energy projects but are finding, in practice, that getting government approval on time or being included in Renewable Energy Feed In Tarrif (REFIT) schemes difficult (Njobeni,2011).

As early as 1998, the country developed a white paper on energy. This later translated to white paper on renewable energy in 2003. In 2005 the South African Cabinet established a biofuels task team which led to the release of a draft National Biofuels Industry Strategy in December 2006. Exactly one year later the Cabinet passed the final strategy (Republic of South Africa, 2007).

The aim of the strategy was to include 2% biofuels into its total fuel production by 2013. The strategy originally restricted the 2% target to bio-diesel made from soybeans, canola or sunflower oils, or ethanol from sugarcane or sugar beet, with the exclusion of maize and jatropha, based on food security concerns, assuming that this 5 year target would use 1.4% of arable land on the assumption that 14% of arable land was being underused.

The biodiesel fuel tax exemption was raised from 40% to 50% and a 100% fuel tax exemption was proposed for bioethanol on the assumption that it can also be used in markets other than petrol, e.g. ethanol gel that competes with illuminating paraffin (illuminating paraffin currently carries no levies), (Republic of South Africa 2007). The exemptions created a differentially commercial margin on biodiesel that could provide commercial investment incentives. Information and community support was expected to come through the normal agricultural channels. South Africa sees itself as having less land available than some of its neighbouring countries and is seeking to be first in innovation of second and third generation biofuels in Africa.

4.2.11 Tanzania

Figure 10: Palm oil processing (Photo: Thomas Molony)

In spite of the establishment of a Biofuel Task Force in 2006 to promote the development of the sector and related legislation, no policy or legislation is yet in place (Kiwele, 2009). Instead a moratorium has been put on any new biofuels projects in sensitive areas in Tanzania after controversies arose with regard to large-scale biofuels investment projects. The focus has been on palm oil, sugarcane, cassava, cotton seed, sunflower and some extensive jatropha trials. While Croton Megalocarpus has been mooted along with cape chestnut, projects remain mostly unfounded.

In Tanzania bioenergy supplies 90% of the total energy consumed, and the country is highly dependent on wood biomass for rural energy, often leading to extensive deforestation. Tanzania has a climate that supports the growth of energy crops, in addition to arable land and cheap rural labour. The projects that have survived have specific production models. Kakute has been deeply embedded at the community level since 1995, and has integrated jatropha oil production into the whole rural value chain to ensure its sustainability. Along with TATEDO they have initiated the concept of multifunctional platforms for rural energy development and use. Diligent Oils has been working to develop a large network of smallholders growing jatropha across Tanzania providing seeds, knowledge input and production facilities. These projects support rural energy needs and have all received considerable donor input.

On the other end of the scale, large multinational projects for export, have faced controversy, partly because they focused on rich forested areas where they carried out initial logging and deforestation (such as the case of BioShape (seeking reinvestment) and BioMassive (seeking funds) in the coastal Malindi provinces), and partly because of land tenure and acquisition problems (DI oils and others). All land ownership is controlled by the Tanzanian Investment Centre National Land Bank and allocated centrally, sometimes without full local on the ground participation and consultation. A decision was made that 1.1 million hectares of Tanzania would be available for Agricultural investment with investors requesting over 800,000 hectares.

The issues emerging from large-scale biofuels production in Tanzania include:

- Technology development versus land tenure.
- Lack of real agro-climatic knowledge or assessment of truly commercial rain fed feedstock's.
- Local processing versus export of raw materials.
- Lack of robust social and environmental safeguards.
- Inequitable business models.

Lack of policies and regulations have made investment in the biofuels sector difficult in Tanzania as the prospective return on investment remains largely unclear. Legislative frameworks have been previously incomplete, overlapping and/or lacking complete coherence to ensure all stakeholders are involved. Activities towards implementation of biofuels policies are currently mainly driven by the Ministry of Energy and Minerals (MoE), with a multi-stakeholder group now involving other ministries. COMPETE have created layered crop land suitability maps for certain areas of Tanzania and reportedly good progress is being made (Watson, 2010).

While quite a few jatropha projects have been explored, started and not endured, Sunbiofuels have 2,000 hectares of their 8,000 hectare accession planted out in Morogoro in degraded forest lands. EcoEnergia, the result of a management buy-out of Sekab, aim to produce 100m litres of ethanol from 400,000 hectares of sugarcane and sweet sorghum split between first Bagamoyo, then Rifiji in Tanzania and Cabo Delgado, Mozambique. Indian-owned Kilimanjaro Biochem is constructing an ethanol plant close to Kilimanjaro with 200-800 greenfield hectares of sugarcane. Recently the Tanzanian Petroleum Development Corporation announced the intention of importing Brazilian ethanol to cut fuel costs.

4.2.12 Uganda

Uganda's current energy policy is broadly supportive of the aim of increasing biofuels and is geared at reducing dependence on imported petroleum products. As specific regulatory frameworks are still being developed there is not yet any decision on the different scale and impact of meeting local energy requirements and/or production for export (Byakola and Yiga, 2007). During implementation, government support is coming in the form of production subsidies, tax exemptions and modified tax incentives, fuel blending mandates, tariffs, price regulations, and national biofuels targets. International NGOs have set up large scale outgrowers schemes in three areas using jatropha and candlenut as feedstocks. Again there is muted Chinese investment support of larger scale sweet sorghum development. Palm oil has been developed in areas around the lake and one case of controversial sugarcane expansion was illustrated in a previous chapter.

4.2.13 Zambia

Climatically Zambia is one of the more favourable zones for biofuels, especially jatropha, which is not yet commercial in drier or colder climates. Zambia's 1994 National Energy Policy did not include biofuels issues, but it was revised in 2004 to accommodate biofuels. The Zambian Government had set up an inter-ministerial taskforce to work on targets, incentives and capacity building programs for biofuels development (WWF 2008). In order to create a strong private sector leadership, the Biofuels Association of Zambia was registered in 2006 to promoted biofuels investment, which has improved Zambia's energy policy.

Examples of stakeholder participation in mapping out the liquid biofuels roadmap in Zambia are:

- In August 2006 the Government convened a national stockholder's consultative workshop for liquid biofuels development.
- In April 2007 the draft Biofuels Development Framework was formulated jointly by Government and the Biofuels Association of Zambia and a statutory instrument to legalise biofuels was introduced.
- In December 2007 the Government convened a stakeholder workshop to map out a strategy to roll out the National Energy Policy, approved in November 2007 (Sinkala 2008).
- In May 2008, the Energy Regulation Commission set biofuels standards but the government is yet to make biofuels a priority area under the national development plans as well as to issue incentives.

By the end of 2008, some large international biofuels commercial activities were reported in Zambia (WWF 2008) despite the lack of clarity on the export focus or national energy provision. Proponents of a National Biofuels plan claim that fewer hectares are needed to create national self-sufficiency (250,000 Ha for both Bioethanol and biodiesel based on optimistic yields) than are currently lost to deforestation from wood biomass usage every year (estimated at 450,000ha of forest (Sinkala 2008). The evidence that current biofuels production is targeted at the export market is supported by the fact that Zambia does not have its own biofuels refining facilities.

Perhaps in response to the lack of national integration of biofuels, well organised civil society biofuels forums have emerged, comprising Zambian NGO's and interested stakeholders, to 'research, monitor facilitation, dissemination of information and collaboration with the Government, BAZ and the biofuels industry, to create a pro-poor industry that contributes to rural development and equitable economic growth in the rural parts of the country, with a particular emphasis on small scale rural producers.'

4.2.14 Zimbabwe

Ethanol blending with petrol started in Zimbabwe in 1980 and ceased in 1992 when unblended fuel became cheaper due to a severe drought. Last year the Triangle ethanol plant was refurbished and production resumed. Sugarcane production expansion is planned at the Agricultural and Rural Development Authority estates in Chisumbanje.

In Zimbabwe, public-private partnerships and market coordination (for blending, marketing and transportation) have been critical for the initial establishment of a biofuels programme. The structural adjustment and tax incentives in Zimbabwe were encouraging and private investors such as Triangle found international buyers for portable alcohol. The key replicable lessons for other African countries, especially those at the early stage of biofuels development are:

- Public-private partnerships with oil companies, government and biofuel entrepreneurs can be effective in creating economies of scale and the value chain.
- Feedstock availability (including long term climatic and market conditions) and consistency in government policies and support helps sustain the industry.

A National Bio-diesel Feedstock Production Programme was launched in 2005 which sought to promote the planting of *Jatropha Curcas* in all ten provinces of Zimbabwe. In 2007, Zimbabwe opened its first biodiesel processing plant, expected to produce up to 100 million litres a year from wheat, soya and sunflower. To date, there is still no comprehensive and specific national policy and legal framework, or investment in thorough research, on biofuels. The Minister of Energy and Power Development presented a White Paper on "Principles for Biofuels Development and Use" which stated the Government's position and direction in the development of biofuels (Mtisi, 2010). It states that if smallholder farmers group their available land into five hectare parcels (or above) to grow jatropha, the National Oil Company will contract the farmers as outgrowers and purchase their seeds. With only a draft energy policy, which hardly mentions biofuels, the only other mention is in the Short Term Emergency Recovery Programme (STERP) drafted by the Government of National Unity in March 2009. STERP states that biofuels production has the potential to benefit the economy particularly through improved output in agriculture, as it requires inputs in the form of jatropha, cotton seed, sunflowers, among other oil seeds. It states that the inclusive Government will examine the viability of biofuels. A very thorough analysis of the whole policy framework and the extent to which it supports community-based biofuels production has been conducted recently by the Zimbabwean Environmental Law Association (Mtisi, 2010).

In April 2010, the Government reportedly stopped supporting the national oil company's (NOCZIM) jatropha program because of a lack of funds. The weak national economy following ten years of significant economic decline and a lack of liquidity in the country have forced the Government to shed non-essential activities. Poor coordination in the biodiesel sector also influenced the Government's decision to cut funding. Three government ministries, the Ministry of Energy and Power Development, the Ministry of Science and Technology and the Ministry of Agriculture were all involved in biofuels development and as in other countries, can benefit from greater clarity and integration of roles and responsibilities.

5 Conclusions and Recommendations

While geothermal, solar, wind, biomass, and all energy from waste processes can contribute to providing electricity for Africa, most African countries still face the following two main challenges in differing degrees:

Challenge 1: Over reliance on expensive imported fossil fuels, which are prone to dramatic price changes, for fuelling their emergent economic growth.

Challenge 2: Deficiencies of rural modern energy, in particular for cooking, which is leading to rapid deforestation, environmental degradation and threatening already scarce water resources.

Biofuels and their by-products are seen to (or may) fill some of these gaps. Biofuels also indicate a switch from underground fossil fuels as the primary transport energy source to the extensive use of land, water, and often labour resources. In 2008 COMPETE found only two African countries had workable policy frameworks in place (COMPETE 2008i). Successful policy responses in each African nation are needed to ensure the overall picture remains beneficial for everybody and will ensure that the right balance is achieved between a matrix of factors including:

- Inclusivity based on current land use and tenure.
- Carefully planned land use changes.
- Agro-climatic conditions and suitability for each feedstock.
- Adequate development funds to create nationally inclusive industries that include and benefit all sectors of society.
- Preventing further loss of forest and natural resource, both by replacing unsustainable wood fuel use and preventing large-scale agricultural expansion of huge commercial farms that force existing populations into currently forested lands, exacerbating environmental degradation.

What also stands out from the review is that:

- Biofuels (as well as the current agro-industrial) investment in Africa presents an unprecedented opportunity for 'trade not aid' to successfully modernise rural agriculture and energy supplies. This will only happen if it is accompanied by a strong mind-set shift to invest in the rural communities themselves and to find ways of building a commercial value chain that benefits small holders and ensures national energy and food security.
- Biofuels must be seen as one part of the whole renewable energy matrix.
- Creating policies to support a viable biofuels industry is a multi-dimensional exercise. Politicians must act quickly even when faced with uncertainties about some of the science concerning productivity and the impact of large-scale agro-energy industrialisation.
- What is clear is that common sense for the good of all must prevail as strongly as individual and/or corporate self-serving interests. As such, politicians concerned with national income generation or percentages of fossil fuel replacement must also protect human rights, rural access to productive land for food as well as all high value ecosystems such as forests, wetlands, watersheds and irreplaceable unique areas for high-end ecotourism or other economic services.
- Only this multi-sectoral response will serve the long-term wealth and sustainability

of each nation. This approach requires creating and empowering an inter-ministerial public/private body capable of 'systems thinking' and listening with equal weight to all relevant voices. This approach will generate more equitable, open and informed debate and assist in developing a better balance between positive and negative outcomes within the whole matrix. It will also lessen back-tracking and controversy, both of which erode investor confidence, growth and sustainability.

- While some companies and projects are well-managed and have long-term sustainable aspirations, unverified figures of acreages allocated, planted and potential yields have, especially for *Jatropha Curcas*, been greatly exaggerated by biofuels proponents, companies, and newspapers. This has often been for reasons of attracting investor funds or serving political purposes, either to promote unsustainable large-scale programmes, or to call for a complete moratorium on biofuels. Where governments, companies and NGOs have used figures not backed by their own scientific research, there have been frequent disappointments. It is essential to take a precautionary approach and to pilot testing and verify the more sober realities of most first and second generation feedstocks and in particular to distinguish the different types of cost – benefits of using waste products and growing actual feedstock. This is an essential and vital step in realising the sustainable benefits of these alternative sources of energy.
- The purpose of most Foreign Direct Investment (FDI) is investment for export and quick returns in a global economic crisis, not a long-term investment in Africa's energy self-sufficiency. Numerous jatropha plantations (which take up to 6 years to mature) are failing, according to Friends of the Earth, or being resold within the first three years and biofuel investors have been known to quickly transform into mining companies to pursue more profitable goals when land made available is recalled.
- The much-hyped statement that *Jatropha Curcas*, for instance, can be grown at commercial productivity with minimal inputs, on marginal lands is being proven wrong in almost all cases. Most jatropha plantations need full-scale irrigation and/or use of fertilisers, pesticides/ insecticides with the resulting negative environmental impacts. Bio-engineered varieties able to produce viable crops in sub-optimal or arid conditions may take time to develop and should not form the basis of current policy decisions.
- Each African country must be strongly encouraged to look at a matrix of biofuel feedstocks for different purposes and to stay abreast of, maybe even leapfrog to, advanced 3rd and 4th generation biofuels, especially those that use, for instance, plastic, municipal and processing waste.

Across Africa, there are three main models of biofuels production for energy:

System 1: Smallholder production for local use.

System 2: Scaled up small-holder production with access to commercial processing.

System 3: Medium and large-scale commercial production, often dependent on FDI, large acreages of arable land and often destined for export purposes.

The paradox many African countries find themselves in is that Systems 1 and 2 can address the main challenges, while system 3 is unlikely to unless large scale production is as much for domestic use as for export, as in the case of Zimbabwe and a few others. Otherwise, to have any benefit toward mitigating Challenge 2, production has to be managed in a particularly innovative and skilful manner and not left to some 'hoped for' trickle-down effect. While some countries may advocate for the creation of a policy framework that supports all three systems simultaneously, the choice between the three systems, especially at the outset, is completely biased. In the perceived current global food, greenhouse gas and energy crises, the huge amounts of international money for investment in the biofuels sector are focused almost exclusively on System 3.

As pointed out previously, a trillion dollars of aid has not brought agricultural development or modern energy services to most of rural Africa. Much of the aid money, South-South technology transfer or benefits of large-scale investment activities, goes directly to, and/or is usually absorbed by, central governments. Multilateral donors such as the World Bank, and organisations such as REEEP, are funded by governments and tend to engage with top-down approaches, such as supporting national oil companies to drive the biofuels sector (e.g. Nigeria). So while the need is perhaps more desperate at the rural community level, and projects such as the multifunction platforms (demonstrated in Tanzania) can begin to make a difference, the scale of funds available for rural African energy self-sufficiency are extremely small compared with government to government investments or the current resources available to companies through investment funds.

Ghana has taken the step of setting up a separate fund, and experts such as Thomas Sinkala, Chairman of the Biofuels Association of Zambia, claim they only need 240,000 hectares of biodiesel and ethanol feedstocks to make Zambia self-sufficient in energy, compared with 3-400,000 hectares lost to deforestation each year. Yet no one has yet had the foresight or interest to fund Zambia's proposed biofuels fund to create such a programme. There is no quick return on capital investment in creating rural self-sufficiency and preventing Africa's deforestation. Even relatively small-scale donor and renewable energy 'funds', between $250,000-1,500,000, are dependent on raising matched capital, putting them beyond most small holder's reach.

In reality, System 3 is most likely to dominate, driven either centrally by national governments, such as in Zimbabwe and Nigeria, or through the allocation of huge areas of land to foreign companies to grow mono-crops for export, such as is happening as part of government policies most openly in Ethiopia and Mozambique and to greater or lesser degrees across the rest of Africa. The majority of the African rural population does not have secure land tenure, either through nationalised land policies such as in Tanzania, Ethiopia, Mozambique and Zimbabwe, or through historically weak national land laws and implementation, (often originating from colonial times - such as in Kenya and not fully resolved since).

The worst case scenario is that, as Africa's population increases, much of Africa's prime arable land and much of its forests will be virtually handed over to nationalised or international large scale corporations to create large, often mechanised mono-crop (food and biofuels) plantations, with intensive agricultural practices, that:

1. Only employ a small portion of the existing (displaced) rural population as low waged or virtually bonded labourers.
2. Displace rural populations into unmanaged and sometimes unrecognised urban slums (that can also ferment political dissent and unrest) leading to increased poverty and in some cases increasingly dictatorial and militarised regimes.
3. Lead to serious food shortages, famine and inflation, especially during the increasing number of drought years.
4. Increase deforestation, pollution, water shortages and greenhouse gas emissions

(from both deforestation and intensive agriculture) and lead to the collapse of major ecosystems, as well as other industries such as wildlife dependent tourism.
5. Ecosystems collapse, including the crop-based biofuels industry, resulting in foreign investors leaving to invest in emerging non-land based biofuel technologies and other businesses, and African populations, food security, climate and ecosystems being left much worse off.

Sadly, a number of examples of each of these individual scenarios have already taken place to raise serious alarms that such a 'doomsday' scenario is not being adequately protected against. This has led to headlines such as "Africa's land grab", the "new 21st Century colonialism", "biofuels, boom or bust?" to name but a few.

The best case scenario, where large scale investment is used to simultaneously develop rural agriculture, provide national energy security, protect current environments while reducing the use wood biomass, is exciting. It needs some paradigm shifts, very strong policy frameworks and very robust safeguards to ensure it takes place. Many African governments can understand such a win-win vision and some good examples and processes are emerging.

Perhaps the first paradigm shift is the political will and intent to ensure the best scenarios, through designing policies to:

- Using some of the examples listed in chapter three, creating country specific fiscal structures that will promote inclusion of small-holder farmers, small, medium and larger scale industries, manufacturers and private entrepreneurs to participate in and build a commercially viable biofuels industry.
- Engage all national research institutions and encourage PPP's to carry out intense research and development on different agro-climatically appropriate feedstock's and disseminate accurate information through newspapers, radio, farmer field days and any other means.
- Actively engage in enforcing increasing efficiencies into bioethanol and biodiesel production, while keeping up to date on and exploring all other 2nd, 3rd and 4th generation technologies that will also meet national transport fuel demands as well as lower the competition on arable land, water, forests, biodiversity and wildlife.
- Benefit from foreign investments whilst closely managing them. Policy tools that assist in these are:
  - Using modern GIS and mapping techniques to map and zone National natural resources in great detail and carefully zone the agro climatic areas where each potential bioethanol and biodiesel feedstock can be commercially successfully developed, without interfering with other economic activities, food production, gazetted or ungazetted forests, wetlands, peat, and areas of high conservation value, biodiversity or water catchment. The lead ministry must liaise with other ministries to work out exactly how to implement the results of the mapping through strict environmental legislation and implementation on the ground as well as linking innovative incentives with funding agencies to produce win-win scenarios.
  - Mandate a certain percentage of all production to feed into the local market, particularly for meeting the needs of households. Foreign investors can be taxed differently or made to contribute to a national biofuels fund.
  - Enforce and monitor the strictest environmental management, pollution and water resources safeguards.
  - Create mechanisms for full community participation beyond local chiefs and local government in deciding how to integrate a large-scale project into a landscape, putting aside areas for intensive food production and improvement of infrastructure. In higher populated areas insist on percentage outgrower schemes and access to processing facilities. Create and enforce robust mechanisms for appeal and compensation.
  - When allocating large tracts of land, especially for new biodiesel crops in untried areas, allocate the land but release it at not more than 1-2,000 hectares at a time based on initial proof of productivity after four years. Many jatropha plantations are failing or being sold on in the first three years. Reallocate any land allocations that lie idle for more than 3 years. Insist on inclusive plantation designs in SEIA's allowing for intercropping and/or food production areas, agroforestry to meet workers cooking and energy needs and wildlife patches or corridors. Insist that new projects take out a bond to rehabilitate the land in case of failure, allowing the previous occupants to repossess.
  - Create a strong inter-ministerial committee on biofuels best practice, ensuring all aspects of these robust approaches are properly understood, allocated, endorsed, passed into law and implemented.
- Actively support rural national production of biofuels
  - Establish a mandated national biofuels association with open membership and annually elected leadership with the capacity to set certifiable standards that members need to meet in order to ensure access to increasingly controlled markets (EU) as well as responsible investments.
  - Support the setting up of a biofuels fund managed transparently by National Biofuels Associations to create rural biofuels self-sufficiency through networks of Agricultural extensions services, research institutions, small, medium and large scale investors, NGO's and CBO's.
  - As success becomes evident, put strong and well implemented limits on non-renewable charcoal and logging industries and a price on wood biofuels products that encourages a change of fuel use.
  - Exempt all small-scale straight vegetable oil uses from tax, and duty waivers on importing machinery and only bringing in biodiesel licensing on plants generating more that 250,000 litres a year.

The decision tree below (Figure 1) is an example that can be developed to guide policy and project implementation while minimising threats to the bio-physical environment and livelihoods and maximise opportunities for food security, the environment and economy (Vermeulen 2007). This will assist in creating balances and promoting more innovative solutions to meet the competing needs of the various policy goals.

In summary, the role of government is to provide stimulus for private investment and initiatives, as well as promote effective regulation, monitoring and co-ordination of the biofuels sector. The particular multifaceted opportunity that liquid biofuels offers for Africa demands a new type of public, private and governmental engagement and integration, which may be very beneficial for Africa's overall growth and development. Given the complexity of the different policy objectives, and the many unknowns, the industry is still more likely to succeed within a purpose built legislative structure, than within the current inadequate and/or conflicting frameworks. Subsequently, Working with all relevant ministries and aligning policy within a clear dedicated biofuels policy is the best way to achieve sustainable results.

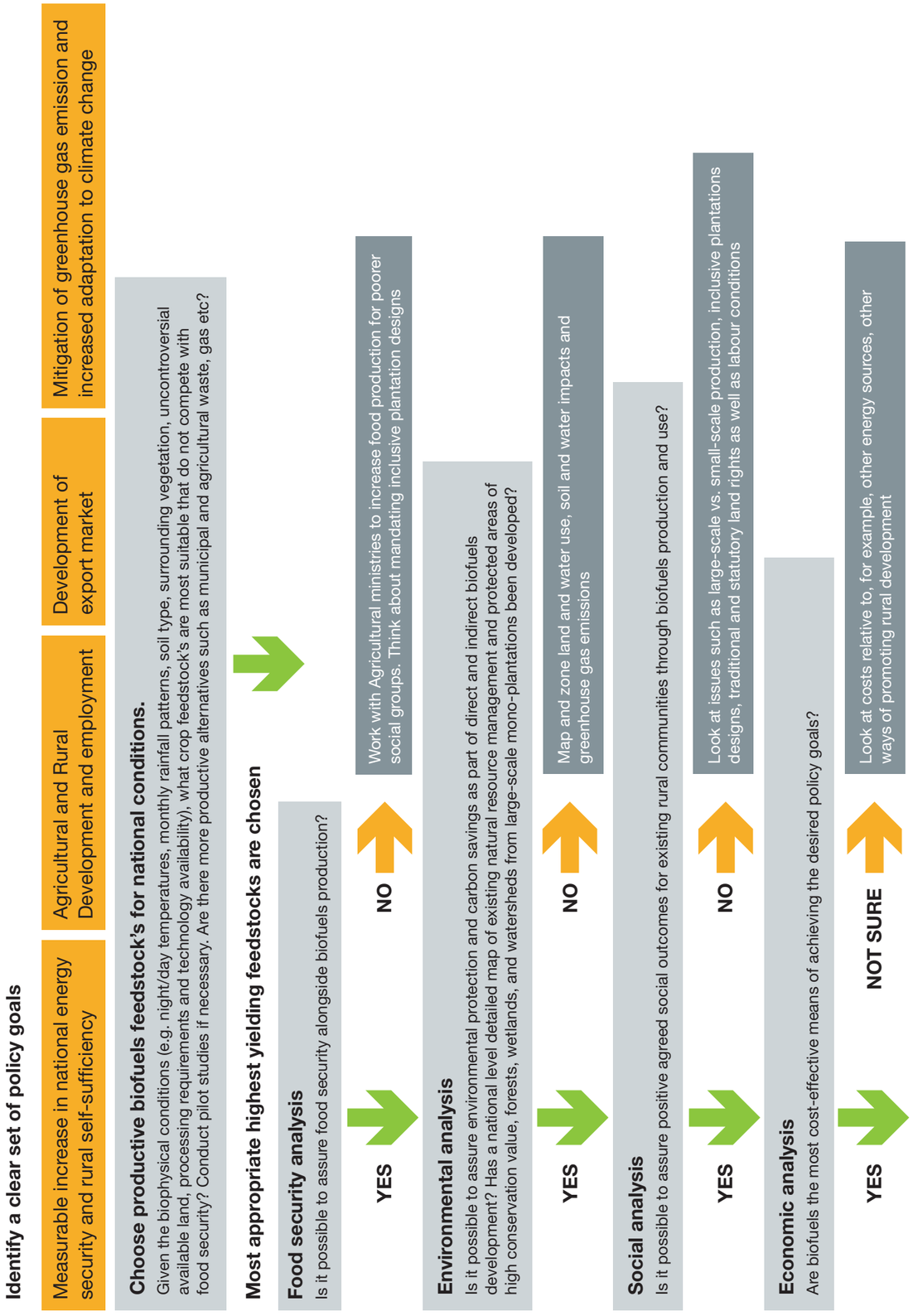

Figure 11: Strategic national choices on biofuels development: A Decision Tree, adapted from Vermeulen et al (2008)

BIBLIOGRAPHY

Anderson T. and Belay M (2009), Rapid Assessment of Biofuels Development Status in Ethiopia and Proceedings of the National Workshop on Environmental Impact Assessment and Biofuels by Hilawe Lakew and Yohannes Shiferaw Melca, Available at www.melca-ethiopia.org/Biofuel%20Dev't.html.pdf

Arndt C, Benfica R, Thurlow J (2010) Gender Implications of Biofuels Expansion: A CGE Analysis for Asia- Pacific Economic Cooperation (APEC) APEC Biofuels. China Biofuels Activities available at http://www.biofuels.apec.org/me_china.html Last accessed on November 27th 2010

Barry G (2010) 'Uganda Government Finally Scraps Mabira Rainforest Giveaway' Ecological Internet overview and commentary available on http://www.dareland.com/freep/issue205.htm Last accessed 5.1.2011

Biofuel Africa (2009) BioFuel Africa Increases Acreage for Local Food Production in Ghana by more than 880% 4th August 2009 available at http://www.biofuel.no/news_viewer.php?news=20090804 Last accessed 05.01.2011

Biofuel Policy Committee Meeting, Mount Lenana hotel Nairobi July 6th 2009

Biofuels Industrial Strategy of the Republic of South Africa: Department of Minerals and Energy December 2007. http://www.energy.gov.za/files/esources/petroleum/petroleum_bio.html#3 Last accessed 05.01.2011

Braun and Pachauri (2006) the promises and challenges of biofuels for the poor in developing countries, IFPRI, Washington DC, U.S.A. Available at http://www.ifpri.org/sites/default/files/publications/ar05e.pdf Last accessed: 05.01.2011

Brautigam D (2010) 'China and the African Land Grab, The DRC oil palm deal' blog and responses March 25th 2010 http://www.chinaafricarealstory.com/2010/03/china-and-african-land-grab-drc-oil.html

Brautigam D (2010) "China and the African "land grab": The DRC Oil Palm Deal China in Africa the real story. Available on http://www.chinaafricarealstory.com/ Last accessed on November 27th 2010.

British Petroleum (2010) BP Statistical Review of World Energy. Full report available on www.bp.com

Byakola, T and Yiga, (2007) climate and development initiatives, biofuel case study. Available at http://np-net.pbworks.com/f/African+Biodiversity+Network+(2007)+Agrofuels+in+Africa,+casestudies+in+Benin,+Tanzania,+Zambia.pdf Last accessed: 05.01.2011

Cheam J (2008) ' Life on Myanmar's Jatropha Biofuels Plantations' Singapore's Straits Times http://blogs.straitstimes.com/2008/12/10/life-on-myanmar-s-biofuels-plantations

Circle of blue (2010) Infographic: water use per mile driven Biofuels vs Fossil fuels September 8 2010 on www.circleofblue.org/ waternews. Last accessed 26th November 2010

Clayton J (May 26 2010) After 1 trillion $ aid, African countries are still worse off." Times online UK http://www.timesonline.co.uk/tol/news/world/africa/article7136758.ece

COMPETE (2008) national policies and strategies on Bioenergy in Africa: Case study, Zambia. Available at http://www.compete-bioafrica.net/policy/countries/COMPETE-032448-NationalBioenergyPolicy-Zambia-0801.pdf Last accessed: 05.01.2011

COMPETE (2008) National Policies and Strategies on Bioenergy in Africa Case Study: Ghana. Available at http://www.scribd.com/doc/22153287/National-Bio-Energy-Policy-Ghana Last accessed: 05.01.2011

COMPETE (2008i) "Sustainable Bioenergy Development in UMMOA Member Countries "Oct.2008 ,the hub for rural development in west and central Africa. Available on http://www.compete-bioafrica.net/publications/publ/UNF_Bioenergy_full_report-10-2008.pdf last accessed November 2010

Conservation International (2010) Biodiversity Hotspots, Coastal Forests of Eastern Africa Available on http://www.biodiversityhotspots.org/xp/Hotspots/coastal_forests/pages/conservation.aspx last accessed November 27th 2010

Cotula L et al (2008) 'Fueling exclusion? The biofuels boom and poor people's access to land'. Iied, FAO, IFAD. http://www.iied.org/pubs/pdfs/12551IIED.pdf

De Keiser, S., and Hongo, H., 2005, Farming for Energy for Better Livelihoods in Southern Africa – FELISA, presented at the PfA-TaTEDO Policy Dialogue Conference on the Role of Renewable Energy for Poverty Alleviation and Sustainable Development in Africa, Dar-es-Salaam. Available at http://www.odi.org.uk/resources/download/78.pdf Last accessed: 05.01.2011

De Keyser S, Hongo H (2005) The Role of Renewable Energy for Poverty Alleviation and Sustainable Development in Africa. Farming for Energy,for better livelihoods in Southern Africa (FELISA) Paper presented at the PfA-TaTEDO Policy Dialogue Conference Dar-es-Salaam, 22 June 2005. Available at http://www.odi.org.uk/resources/download/78.pdf Last accessed: 05.01.2011

Diaz-Chavez R, Mutimba s, Watson H, Rodriguez- Sanchez S, Nguer M (2010) Mapping food and energy in Africa. A report prepared on behalf of FARA. Forum for Agricultural Research in Africa. Ghana. Available at http://blogs.nature.com/news/thegreatbeyond/Mapping%20Food%20and%20bioenergy%20Africa%20June%202010%20Summary.pdf Last accessed: 05.01.2011

ECA/AU, 2009, Economic Report on Africa, 2009. Developing African agriculture through Regional value chains. Available at http://www.uneca.org/era2009/ last accessed 03.03.2011

Elmissiry M M (2010) NEPAD Bioenergy Programme presentation at the Biofuels 2010 5th Annual meeting, Amsterdam 9-11 November 2010. Available at http://www.wraconferences.com/staging/assets/2/4/1013/1015/Biofuels5_FINAL.pdf last accessed 05.01.2011

EU (2010) EU biofuels target borderline sustainable. News report 26th March 2010 Rws 2 - http://www.euractiv.com/en/climate-environment/eu-biofuels-target-borderline-sustainable-report-finds-news-382606

Euractiv (2010) 'Once hidden EU report reveals damage from biodiesel' available on http://www.euractiv.com/en/sustainability/once-hidden-eu-report-reveals-damage-biodiesel-news-469920 Last accessed: 05.01.2011

European Biofuels Technology Platform (2010) EC certification of Biofuels available at http://www.biofuelstp.eu/sustainability.html Last accessed on November 27th 2010

European commission; Energy (2010) Biofuels: Sustainability Criteria: Commission sets up system for certifying sustainable biofuels. Available at http://ec.europa.eu/energy/renewables/biofuels/sustainability_criteria_en.htm Last accessed 05.01.2011

EVS Group plc (2009) 'Sale of Mozambique Jatropha Plantations for US$4m' available on http://www.esvgroup.com/docs/ESV-Sale-of-Mozambique-23112009.pdf Last accessed on November 27th 2010

Fact Foundation (2009) FACT comments on "Jatropha! A socio economic pitfall for Mozambique" by Justiça Ambiental (JA) & União Nacional de Camponeses (UNAC) available on http://www.tanariverdelta.org/tana/9101-DSY/version/default/part/AttachmentData/data/FACT%20comments%20on%20JA-UNAC%20Jatropha%20Study.pdf Last accessed November 2009

Fact Foundation (2009) FACT comments on "Jatropha! A socio-economic pitfall for Mozambique" by Justiça Ambiental (JA) & União Nacional de Camponeses (UNAC) www.fact-foundation.com/media.../Comments_Jatropha_study_Mozambique

FAO (2008) Gender and equity issues in liquid biofuels production, minimizing the risks and maximizing the opportunities. Available at ftp://ftp.fao.org/docrep/fao/010/ai503e/ai503e00.pdf Last accessed: 05.01.2011

FAO (2008), Biofuel: prospects, risks and opportunities; the state of food and agriculture, Rome, Italy. Available at ftp://ftp.fao.org/docrep/fao/011/i0100e/i0100e.pdf Last accessed: 05.01.2011

FAO. 2002. "Gender and access to land". FAO Land Tenure Studies 4. Rome. Available at ftp://ftp.fao.org/docrep/fao/010/ai503e/ai503e00.pdf Last accessed 05.01.2011:

Franco et al (2010) WP1 Agrofuel Crops Co-operative Research on Environmental problems in Europe (CREPE) www.crepeweb.net

Friends of the Earth (2009) Jatropha: Wonder crop? Experience from Swaziland available at http://www.foe.co.uk/resource/reports/jatropha_wonder_crop.pdf Last accessed on November 27th 2010

Friends of the Earth (June 2010) Africa; up for grabs: the scale and impact of land grabbing for agrofuel Report. Available at http://www.crepeweb.net/wp-content/uploads/2010/11/crepe-wp1-final-report.pdf Last accessed 05.01.2011

Friends of the Earth 2010 The Jatropha trap? The realities of farming jatropha in Mozambique' report by Friends of the Earth International and SwissAid is available at: http://www.foei.org/en/resources/publications/pdfs-members/2010/the-jatropha-trap-the-realities-of-farming-jatropha-in-mozambique'

Gathura G. (May 28th 2010) ‘Miracle tree may lack its magic touch it is fabled to have after all’ Daily Nation. Kenya. Available at http://www.nation.co.ke/News/Miracle%20tree%20may%20lack%20the%20magic%20touch/-/1056/927256/-/view/printVersion/-/u43ley/-/index.html Last accessed: 05.01.2011

Geuns L, V and Slingerland, S (2005), Drivers for an international biofuel markets, Discussion paper, CIEP future fuel seminars, Clingendael Institute. Available at http://www.aaee.at/2009-IAEE/uploads/fullpaper_iaee09/P_124_Chaturvedi_Vaibhav%20_29-Aug-2009,%2017:59.pdf Last accessed 05.01.2011

Gitau Paul (2010) ‘Stakeholders okay Jatropha fuel project’ Daily Nation Kenya 1st November 2010

Global finest (2010) available at http://www.globalfinest.com

Government of India. Ministry of new and renewable energy, (December 2009) National Policy on Biofuels. Available at http://www.commodityonline.com/news/India-approves-National-Policy-on-bio-fuels-24194-3-1.html Last accessed: 05.01.2011

Green jobs (2010) Biomass by Green jobs available at http://www.greenjobs.com/Public/info/industry_background.aspx?id=13 . Last Accessed 26TH November, 2010

Grieves–Cook J. (2010) Personal conversation with Jake Greives-Cook head of Porini reserves . Board Chairman of Kenya Tourist Board.

GTZ (2005) Liquid biofuels for transportation in Tanzania: potential and implications for sustainable agriculture and energy in 21st century. Available at: http://www.tnrf.org/node/9105 last accessed: 05.01.2011

GTZ (2009) Jatropha Reality Check; a field assessment of the agronomic viability of Jatropha and other oilseed crops in Kenya. Available at: http://www.worldagroforestry.org/downloads/publications/PDFs/B16599.PDF Last accessed: 05.01.2011

Hazell P B R , Pauchuri R K (2006) ‘Bioenergy and Agriculture’ Promises and challenges International Food Policy Research Institute Focus Brief 14 available at http://www.ifpri.org/sites/default/files/publications/focus14.pdf Last accessed on November 27th 2010

Iiyama M Odongo F. (2009) Survey of Indian Biofuel Policy Development. Presentation at Kenyan Biofuel Policy Committee Meeting, Mount Lenana hotel Nairobi July 6th 2009

J Clayton (2010) Africa seeks clean profitable biofuels 31 may 2010 Times on line available at http://business.timesonline.co.uk/tol/business/industry_sectors/natural_resources/article7140673.ece

January 2008 COMPETE Sixth framework programme FP6-2004-INCO-DEV-3. Available at http://www.compete-bioafrica.net/policy/countries/COMPETE-032448-NationalBioenergyPolicy-BurkinaFaso-0801.pdf Last accessed: 05.01.2011

Jongschaap REE, Corré WJ, (2007) Claims and Facts on Jatropha curcas L.: Global Jatropha curcas Evaluation, Breeding and propagation programme. Report 158 (Plant Research International BV, Wageningen, The Netherlands and Stichting Het Groene Woudt, Laren, The Netherlands). Available at http://www.jatropha.de/news/Claims%20and%20facts%20on%20Jatropha%20curcas%20L%5B5%5D.%20Wageningen%20UR-Plant%20Research%20International-Jongschaap%20et%20al%202007.pdf Last accessed: 05.01.2011

Kar D and Cartwright-Smith D (2010) Illicit financial flows from Africa: hidden resources for development. Global Financial Integrity report. Available at http://www.jsd-africa.com/Jsda/V12No5_Fall2010_A/PDF/21st%20Century%20Africans%20in%20Leadership%20(Adomdza).pdf Last Accessed: 05.01.2011

Kiwele P (2009) Status of the Tanzania Biofuels Policy presentation prepared by P.M. Kiwele. Available at http://www.compete-bioafrica.net/ Last accessed 05.01.2011

Kuiper S (2010) ‘Blowing hot and cold over turbines’ Friday 7 th May 2010 Grocotts mail on line at http://ww.grocotts.co.za/content/blowing-hot-and-cold-over-turbines-07-05-2010. Last accessed on November 27th 2010

Laishley R (Oct. 2009) “Is Africa’s land up for grabs? Foreign acquisitions, some opportunities, but many see threats. African renewal. http://www.un.org/ecosocdev/geninfo/afrec/vol23no3/233-land.html

Laishley R(2010) Is Africa’s land up for grabs: Foreign Acquisitions. Some opportunities but many see threats? African Renewal October 2009 Page 4 Available at http://www.ksla.se/sv/retrieve_file.asp?n=1965&t=ksla Last accessed 05.01.2011

Lapper R (2010) ‘Mozambique typifies aid dilemma’ Times 2 June page 4 available at http://www.ideas4development.org/fileadmin/ressources/medias/pdf/Ermenonville_Forum/EN/LAPPER%20R%20FT%20_2010_%20EN.pdf. Last accessed November 27th 2010

Lapper R. (Feb 2010) ‘ Brazil accelerates Investment in Africa’ Financial Times UK Last accessed on November 27th 2010. Available at http://siteresources.worldbank.org/EXTWDR2011/Resources/6406082-1283882418764/WDR_Background_Paper_Evans.pdf Last accessed: 05.01.2011

Madhi S and Kugman K (cecrepe2006) Acute respiratory infections Chapter 11 in Eds Jamison DT, Feachem RG, Makgoba MW, et al., editors. Disease and Mortality in Sub-Saharan Africa. 2nd edition. Washington (DC): World Bank 2006. Available at http://www.ncbi.nlm.nih.gov/books/NBK2298/ last accessed 06.01.2011

Malawi Energy Regulatory Authority (2009) Press briefing on licensing requirements for liquid fuels and gas supply held at MERA head office 2nd floor, Development House City Centre Lilongwe Thursday May 7th 2009 by C. Kafumba PhD CEO. Available on http://www.meramalawi.mw/Press%20Briefing%20on%20Energy%20licensing%20Requirements%206th%20May%2009.pdf Last accessed November 27th 2010

Malaysia (2006) National Biofuels Policy. Ministry of Plantation Industries and Commodities. Available at http://istic-unesco.org/meetingdoc/Biofuel%20Policy%20and%20Development%20in%20Malaysia.pdf Last accessed 06.01.2011

Mike Lu (2010) ABPPM Presentation World Biofuel Markets March, 15th - 17th, 2010 Amsterdam, Netherlands. Available at http://www.worldbiofuelsmarkets.com/downloads/presentations/17thMarch/Day3_Developing_Nations/Mike_Lu.pdf Last accessed 06.01.2011

Ministry of Mines Ethiopia (2007) Biofuel's Development production and Utilization strategy of Ethiopia. Available at http://phe-ethiopia.org/admin/index.php?attachment=50 Last accessed 06.01.2011

Moreira R, J (2006) Brazil's experience with bioenergy, brief in bioenergy and agriculture: promises and challenges, 2020 focus 14. Available at ftp://ftp.fao.org/docrep/fao/011/i0100e/i0100e09.pdf Last accessed: 06.01.2011

Moyo D (2009) 'Why foreign aid is hurting Africa' Wall street journal, March 21st Available at http://online.wsj.com/article/SB123758895999200083.html Last accessed 06.01.2011

Mozambique. Working paper no 2010/ 111. World Institute for Economic Development Research, United Nations University Available at http://www.wider.unu.edu/publications/working-papers/2010/en_GB/wp2010-111/_files/84313446064848905/default/wp2010-111.pdf Last accessed 06.01.2011

Mtisi S, Makore G (2010) Community participation in biofuels crop production in Zimbabwe: A focus on policy and practical aspects. Published by Zimbabwe Environmental Law Association, accessible through http://www.energydev.net/resource/community-participation-biofue.html

Muchiri R (2010) Cassava 3 F's project, food, fuel and fodder. Kenya Energy Alliance presentation made at the 'Stakeholders workshop on sustainable seed systems for vegetatively Propagated Crops'. Crowne Plaza Hotel 16th November 2010. Available at http://undpke.digitalvision.co.ke/download.php?f=739_ForestReportandVision2030.pdf Last accessed 06.01.2011

Muok B et al (2008) Policies and Regulations Affecting Biofuel Development in Kenya. Policy innovation systems for clean energy security PISCES briefing paper no 1. Available at http://www.cemafrica.net/Events/Workshop_Report_Cape_Town.pdf Last accessed 06.01.2011

Muok, B, Nyabenge, M, Ouma, B. O, Esilaba, A, Nandokha, T, and Owour, B, (2010). Environmental suitability and Agro-environmental zoning of Kenya for biofuel Production. ACTS/UNEP/PISCES.

Musamali G (2010) 'Mabira forest loss to cost $890m' New Vision available on http://www.newvision.co.ug/D/8/12/556450 Last accessed on November 27th 2010

Mwakubo, S, Mutua J, Ikiara M and Aligula, E (2007) Strategies for securing energy supply in Kenya , KIPPRA discussion paper series, DP/74/2007.

Naburete Salvadore H.M (2009) Minster of Energy for Mozambique' Biofuel policy and strategy for Mozambique' Presentation Geneva Switzerland

Nanna G. (Feb 2010) 'Addressing the food versus fuel debate in Ghana' BusinessDay 8th February 2010

National Environment Management Agency (2010) Kenya Environmental Impact Assessment Study Report for proposed establishment of Jatropha plantations in the Garsen division of the Tana River Delta Kenya published in the Daily Nation Kenya 18th November 2010

Ndurya M (2009) Lobby groups calls for legislation over Tana river land Daily Nation. Kenya Sat November 27th 2009 available at http://www.nation.co.ke/Mombasa/-/519978/556052/-/mq2fnt/-/index.html Last Accessed November 207th 2010

Nigerian National Petroleum Corporation Draft National Bio-fuels policy and incentives. Available at http://www.globalbiofuelsltd.com/NNPC%20Approved%20Ethanol%20policy.pdf last accessed 06.01.2011

OECD/IEA (2009) The World Energy Outlook. Available at http://www.iea.org/weo/ Last accessed 06.01.2011

OFID (2010), Energy poverty in Africa, proceedings of a workshop held by OFID in Abuja, Nigeria. June 8 – 10, 2008. The OPEC fund for International Development, OFID pamphlet series 39, Oct, 2010. Available at http://www.ofid.org/publications/PDF/pamphlet/ofid_pam_39_EP.pdf Last accessed 05.01.2010

Oxfam (2009) suffering the science: climate change, people and poverty. Oxfam briefing paper- summary no 130 July 9 2009 available at http://www.un-ngls.org/spip.php?article1607 Last accessed 06.01.2011

Pachauri R, K and Hazell P (2006) Bioenergy and agriculture: promises and challenges, IFPRI, brief2 of 12, 2020 focus 14. available at http://www.biomasszaklaszter.hu/files/focus14.pdf Last accessed 06.01.2011

Partners for innovation (2010) Towards Sustainability Certification of Jatropha Bio-fuels in Mozambique Selection of a sustainability standard for pilot assessments of Jatropha producers in Mozambique by Eva Froger, Ander Paz and Peter Vissers (Partners for Innovation BV) 12 May 2010. Available at http://www.jatropha-alliance.org/fileadmin/documents/Sustainability_assessments-final_report_activity_1.pdf Last accessed06.01.2011

PISCES (2009) visit report, Bioethanol cook stove programme

PRIORITY A.2.3.: Managing Arid and Semi-arid EcosystemsProject Co-ordinator: available at http://www.compete-bioafrica.net/policy/countries/COMPETE-032448-NationalBioenergyPolicy-TheGambia-0801.pdf Last accessed 06.01.2011

Raswant V et al (2008) Biofuel Expansion: Challenges, Risks and Opportunities for Rural Poor People, Paper prepared for the Round Table organized during the Thirty-first session of IFAD's Governing Council, 14 February 2008 available at http://www.ifad.org/events/gc/31/roundtable/biofuels.pdf Last accessed 06.01.2011

Renewable Energy Focus (2010) ' Canadian waste-to-energy facility under construction' 03 September 2010 available on http://www.renewableenergyfocus.com/view/12172/canadian-wastetoenergy-facility-under-construction Last accessed on November 27th 2009

Renton A. (July 2009) 'Suffering the science: Climate change, people and poverty' Oxfam UK http://www.oxfam.org.uk/resources/policy/climate_change/suffering-science-climate-change.html

Republic of Kenya (August 2009) Sessional paper no 3 of 2009 on National land policy. Ministry of Lands

Republic of South Africa (2007) Biofuels Industrial Strategy of the Department of Minerals and Energy December 2007 available on http://www.fanrpan.org/documents/d00472/Biofuels_industry_RSA_Dec2007.pdf Last Accessed Novermber 27th 2010

Ribiero D, Matavel N et al (2009) Jatropha! 'A socio-economic pitfall for Mozambique' Justica Ambietal e Uniao Nacionales de Camponeses (UNAC) Available at http://www.crepeweb.net/wp-content/uploads/2010/11/crepe-wp1-final-report.pdf Last accessed 06.01.2011

Scott Andrew (2009) large-scale biofuel programmes in Africa – who benefits? Paper presented at the VENRO and German NGO Forum on Environment and Development International Symposium: Rethinking Biomass Energy in Sub-Saharan Africa, Bonn, on 25 August 2009. Available at http://www.venro.de/fileadmin/redaktion_afrikas_perspektive/veranstaltungen/Large_scale_biofuels_in_Africa.pdf Last accessed 06.01.2011

Sein Thaung OO (2007) Experience of Biofuel Production in Myanmar Chairman, Myanmar Chemical Engineers Group 1 CO Ltd. 2007 Biofuels and feedstocks conference Philinnes available at

Simbeye F W (2009) Tanzania: governments serious leadership needed in regulating biofuels All Africa.com available on http://allafrica.com/stories/200912310332.html?page=2 Last accessed on November 27th 2010

Sinkala T (Prof) (2008) Approach to Biofuel development in Zambia Presented at the Global renewable energy forum Brazil May 2008. Prof Sinkala is chairman of the Biofuels Association of Zambia. Available at http://www.unido.org/fileadmin/media/documents/pdf/Energy_Environment/brazilforum_Sinkala_080520.pdf Last accessed 06.01.2011

SNV newsletter (2010) Issue 1 Jatropha based biofuels production in the Koulikoro Region, Mali Local feedstock producers connected to oil processing company available at http://www.snvworld.org/en/ourwork/Documents/SNV_Biofuels_Newsletter_-_issue_1_-_May_2010.pdf Last accessed 06.01.2011

Sulle E (March 2009) ' Biofuels,. Land Access and rural livelihoods in Tanzania The Arc Journal Volume 23 http://www.valuingthearc.org/reports_publications/The%20Arc%20Journal%2023.pdf

Sustainable development opinion, International Institute for Environment and Development (IIED) www.iied.org

Taukli-Corpuz V. Oil Palm and Other Commercial Tree Plantations, Monocropping: Impacts on Indigenous Peoples' Land Tenure and Resource Management Systems and Livelihoods presented at the sixth session of the UN Permanent Forum on Indigenous Issues in May 2007.

Thompson Nii Moi (2009) The other side of 'dead aid'. Modern Ghana Monday July 27th 2009 available on http://www.modernghana.com/news/229679/1/the-other-side-of-dead-aid.html. Last accessed on November 27th 2010

Tomomatsu Y and Swallow B, (2007) Jatropha curcas biodiesel production in Kenya: economics and potential value chain development for smallholder farmers ICRAF working paper. Available at http://www.worldagroforestry.org/downloads/publications/PDFS/PO07207.PDF Last accessed 06.01.2011

Tralac (2009) the African trading relationship with Brazil. (1997 – 2008) Trade Law Centre of Southern Africa Available at http://www.tralac.org/cgi-bin/giga.cgi?cmd=cause_dir_news&cat=1044&cause_id=1694 last accessed 06.01.2011

UNCTAD (2009) Multi-Year Expert Meeting on Services, Development and Trade: The Regulatory and Institutional Dimension Geneva, 17-19 March 2009 COUNTRY REPORT: Malawi K. Lungu. Principal Energy Officer Rural Electrification Division Department of Energy Affairs. Available at http://www.unctad.org/Templates/Page.asp?intItemID=4714&lang=1 Last accessed 06.01.2011

UNDP (2010) UN Human Development Report 2010 available on http://hdr.undp.org/en/media/HDR_2010_EN_tables_repring.pdf

UNIDO (2010) 'Abuja conference paves way for coordinated flow of investment into Africa's agribusiness and agro-industries' available at https://www.unido.org/index.php?id=7881&tx_ttnews%5Btt_news%5D=452&cHash=e13e63ebd749eb769705303055a1b135 Last accessed 06.01.2011

Vermeulen S, Dufey A, Vorley B (2008) Biofuels: making tough choices, IIED. Available on http://pubs.iied.org/pdfs/17032IIED.pdf Last accessed on November 27th 2010

Vidal J (2010) 'Rich nations 21st Century Land Grab' Guardian UK http://www.ethiopianreview.com/content/27090

Wambua, C.(2010) The Enabling Environment for Biofuel Production in African Countries: A Case Study of Malawi. Unpublished Msc. Africa and International Development Dissertation, University of Edinburgh

Watson H (2010) Lessons learnt from an attempt to map areas available & suitable for biofuel feedstock production in the drylands of Africa presentation made at ACTS & UNEP International Bioenergy Methodology Workshop 7-9 September,2010 UNEP Nairobi, Kenya

Weissleder L. (2009) 'Foreign Direct Investment in the Agricultural Sector in Ethiopia' Eco fair trade dialogue discussion paper No. 12 / October 2009 / English Version Heinrich Boll Foundation, Misereor available on http://www.ecofair-trade.org/pics/en/FDIs_Ethiopia_15_10_09_c.pdf last accessed 26th November 2010

WIP, Sylvensteinstrasse 2, 81369 Munich, Germany available on http://www.compete-bioafrica.net/policy/countries/COMPETE-032448-NationalBioenergyPolicy-Ghana-0801 last accessed on November 27th 2010

World Wide Fund for Nature (WWF). (2008). Global Market Study on Jatropha. Final Report. London/Berlin http://wwf.panda.org/about_our_earth/all_publications/living_planet_report/demands_on_our_planet/

World Wildlife Fund (WWF) 2010 The Living Planet Report

WWF (2008/9) Biofuel industry in Tanzania. http://files.theecologist.org/resources/E-INFO-WWF-YPO_Biofuel_Industry_Study_Tanzania.pdf

For over 40 years, Practical Action Consulting has provided development consultancy services as the consulting arm of the international NGO, Practical Action, formerly the Intermediate Technology Development Group (ITDG). PAC provides high quality, independent and professional advice to governments, NGOs, aid agencies and the private sector. We work worldwide from regional offices in the UK, Eastern and Southern Africa, South Asia and Latin America. Long standing engagement in technology and developing countries has enabled us to develop a network of local partner organisations and international specialist associates. Practical Action uses technology to challenge poverty by building the capabilities of poor people, improving their access to technical options and knowledge, and working with them to influence social, economic and institutional systems for innovation and the use of technology. Our vision is of a sustainable world free of poverty and injustice in which technology is used for the benefit of all.

For more information visit http://practicalactionconsulting.org and http://practicalaction.org/home

The University of Edinburgh, an internationally renowned centre of academic excellence, works with PISCES through two of its research institutes. The Institute for Energy Systems (IES) has a long involvement with energy and environment related projects in developing countries, including PhD studies of environmental and social impacts of hydro projects. It has active awards in renewable energy research totaling £17M+. IES co-hosts the UK Energy Research Centre, with responsibility for 'Future Sources of Energy' theme; and conducts road-mapping on R&D requirements for future energy technologies. IES studies of climate impacts, liquid fuel synthesis, renewable energy-driven desalination and hybrid renewable energy have relevance and applicability in East Africa and the Indian subcontinent. IES also hosts a Sustainable Energy Systems MSc.The Centre of African Studies (CAS) is an internationally recognised centre of excellence in research on Africa, with expertise in S&T policy, ICT for development, and technology transfer. The Centre for South Asian Studies (CSAS) also researches social impacts of technology, and both centres have a history of working with DFID. Their expertise is complemented by the Science Studies Unit, the Institute for the Study of Science, Technology and Innovation, the Research Centre for the Social Sciences and the Centre for the Study of Environmental Change and Sustainability. These Centres form the largest body of expertise on science and technology studies in the UK. These Centres also host a wide variety of Masters' degrees relevant to PISCES mission.

Policy Innovation Systems for Clean Energy Security (PISCES) is a five-year research project funded by the Department for International Development of the United Kingdom (UK). Project implementation started in July 2007. The purpose of the project is to increase available knowledge and understanding of policy relevant trade-offs between energy, food and water security for livelihoods in relation to bioenergy. PISCES is a Research Programme Consortium (RPC) whose members include African Centre for Technology Studies (ACTS, lead) Kenya; Practical Action Consulting (PAC) UK, Eastern Africa, and Sri Lanka; University of Dar es Salaam (UDSM), Tanzania; M.S. Swaminathan Research Foundation (MSSRF), India; and the University of Edinburgh (UoE), UK.

For more information contact project manager Bernard O. Muok at b.muok@acts.or.ke and visit http://www.pisces.or.ke