International Workshop

'Improved Energy Crop and Agroforestry Systems for Sustainable Development in Africa'

on the occasion of the ICSU 'International Field Workshop on Renewable Energy for Sustainable Development in Africa' (18-21 June 2007)

22 June 2007

Mauritius

WORKSHOP PROCEEDINGS

COMPETE is co-funded by the European Commission in the 6th Framework Programme – Specific Measures in Support of International Cooperation (INCO-CT-2006-032448).

Workshop Objectives

The main objective of this workshop was to evaluate opportunities of improved land use (energy crops, improved agroforestry systems) for the sustainable production of modern bioenergy services in the African context.

Special emphasis has been given to mechanisms ensuring the economic, social and environmental sustainability of future bioenergy production and use, as well as the development of innovative financing tools and practical, targeted and efficient policies.

This workshop was organised in the framework of the Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems – Africa (COMPETE).

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The COMPETE Project

COMPETE Objectives

The Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems – Africa (COMPETE) will establish a **platform for policy dialogue and capacity building** and identify **pathways for the sustainable provision of bioenergy**

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

COMPETE Activities

COMPETE will deliver a matrix of multi-disciplinary and cross-sectoral work-packages

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

COMPETE Partnership

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

COMPETE Website: **www.compete-bioafrica.net**

Workshop Organisation

This international workshop was organised by the University of KwaZulu-Natal, South Africa and WIP Renewable Energies, Germany in the framework of the ***project COMPETE, funded by the European Commission, DG Research***.

This COMPETE workshop took place on the occasion of the ICSU 'International Field Workshop on Renewable Energy for Sustainable Development in Africa' (18-21 June 2007). This international field workshop on the utilizations of renewable energy in Africa was organised by the ICSU (International Council for Science) Regional Office for Africa and the Mauritius Sugar Industry Research Institute (MSIRI)/University of Mauritius, in collaboration with the AU, UNECA, NASAC/AAS/TWAS and UNESCO.

Participants of the ICSU 'International Field Workshop on Renewable Energy for Sustainable Development in Africa' were cordially invited to participate in and contribute to the COMPETE workshop on ‘Improved Energy Crop and Agroforestry Systems for Sustainable Development in Africa’.

Participants of this COMPETE workshop included bioenergy experts (researchers, technologists), policymakers, investors, consumers and other interested stakeholders from Africa, Europe, Latin America and Asia.

Workshop Programme

FRIDAY 22nd JUNE 2007

08:00 – 08:30 Workshop Registration

Opening Session

Session 1:

Improved Land Use – Energy Crops, Agroforestry Systems and the Provision of Energy Services for Sustainable Development in Africa

Chairs: Dr. Romeela Mohee, University of Mauritius and Prof. Giuseppe Ristori, CNR, Italy

Session 2: Sustainability, Climate Change and Supportive Policy Frameworks

Chairs: Prof. Gavin Fraser, University of Fort Hare, South Africa and Mr. Balraj Rajkomar, Food, Agriculture and Natural Resources Policy Analysis Network, Mauritius

Session 3: International Cooperation and Trade

Chairs: Mamadou Dianka, UEMOA-PRBE, and Stephane Senechal, EUBIA

Workshop Closing

COMPETE International Workshop
22 June 2007, Mauritius

Inauguration Address

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Dr Helen Watson, Dr Rainer Janssen, Organisers of Workshop

Your Excellency European Union Representative in Mauritius

Dr Jean Claude Autrey, our host of today

Distinguished participants and colleagues

It is an honour and privilege for me to have been invited to deliver the Inaugural Address at this International Workshop, which I consider to be a crucial one, and I thank the Organisers for this trust.

The overarching theme is Energy, the consumption of which, as we know very well, has been on an alarming and steady ascendancy throughout the world, more so in the D.Cs. And the worrisome fact is that more than 95% derive from non-renewable sources. Such use clearly is unsustainable, because of the effect of the resultant CO_2 emissions on the global climate, and dwindling fossil fuels reserves.

We have moved into a world of energy insecurity.

Our unsustainable exploitation of the world’s resources just to satisfy our lifestyle has, as some have put it, moved us into an ‘ecological overdraft’ situation; in fact it is being claimed that the global economy has started to operate with an ‘ecological deficit’, since 1987.

What are the solutions then?

Decrease in demand – but this can only be part of it – Alternative – and especially renewable - energy sources must also be developed. As the Johannesburg Plan of Implementation puts it: there is a requirement for a transformation – of an unprecedented scale and urgency – to harness the potential both of renewable energy and energy efficiency.

As a component of a renewable energy generation mixture, a bio-energy source such as BIOMASS, definitely has a key role to play; in reducing the pressure on fossil / fuels while significantly decreasing greenhouse gas emissions as the crops and trees are Carbon neutral over their life cycle.

There are 3 types of biomass energy (trees, wastes and crops):

(i) Forestry materials, where the fuel is a by-product of other forestry activities;

(ii) Agricultural & Agro-industrial residues (straw, chicken litter, sugarcane tops, bagasse, etc); and

(iii) Energy crops – which are grown specifically for energy generation purposes.

But we still have to be extremely vigilant as regards strategy and bio-energy crop choices, which have to be sustainable.

You are surely aware of counter-movements that already exist, which are challenging the environmental sustainability of bio-energy and bio-fuels – and these are not solely from the fossil fuels / oil lobby. A ‘Biofuelwatch’ movement is already there in Europe. So we have to heed the concerns raised, on the risks of economic and ecological effects.

(i) The accusation of ‘food conversion to fuel’

Some ecologists are even talking of ‘agro-fuels’ referring to a race for land amongst the ‘4” f’s: food, feed, fibre and fuel; and the risk of local conflicts regarding land usage;

(ii) Risk of loss of biodiversity, especially - as it is being claimed – it is the main reservoirs of biodiversity that are being targeted (i.e. the tropical forests and humid zones).

There are quite some issues to be addressed:

(a) How to tackle the potentially harmful effects of combustion-generated gaseous emissions (i.e. dioxins and heavy metals) and the considerable quantities of ash;

(b) Handling of solid wastes;

(c) And relating to biodiversity:

- Effects of cultivation
- Environmental requirements (soil ph; rainfall; temperature, etc)
- Matching of different crops
- Compatibility / attractiveness to local flora and fauna (harvest time, use of herbicides, etc);
- Environmental impacts: weediness; water usage
- How all these could be modified by production systems (e.g. monocrop versus mixed cropping)?
- What are the socio-economic impacts (i.e. infrastructure for transport; storage; power generation; rural employment; farm diversification)?

Although all energy sources, on deep analysis, are shown to have environmental penalties, these impacts must be balanced against the necessity of developing lower-Carbon sources that are secure and economically viable.

The environmental, social and economic implications thus have to be accurately assessed; separately for the agronomic, technological and infrastructure developments needs to deliver sufficient energy from biomass, e.g. while costs seem comparable, the capital investment required is generally heavier for the latter.

However, it might be safe to say that environmental effects overall have been positive, considering evidence available from Austria and Sweden where biomass use is established.

But the development of a biomass sector does depend on a stable long-term policy, and requires commitment, innovation and vision, which brings me to this Workshop today, which is a welcome step in achieving all this.

The workshop is being organized in the framework of the COMPETE project, mainly funded by the European Union (6th Framework Programme); COMPETE standing for “Competence Platform On Energy Crop and Agro-forestry Systems for Arid & Semi-Arid Eco Systems’ of Africa.

It really is a multidisciplinary, cross-sectoral specialist network, as it should be, of 44 renowned international experts in the fields of Energy Crops and Agro-forestry Systems, with good universal representation as they are from Africa, Europe, Latin America and Asia; constituting a platform for policy dialogue and capacity building in the quest for a sustainable provision of bio-energy.

The specific theme is “Improved Energy Crop & Agro-forestry Systems for Sustainable Development in Africa’ – particularly referring to the arid and semi-arid zones.

The main objective of this meeting is to evaluate the opportunities and challenges of improved land use (in terms of Energy crops and Agro-forestry Systems) for the sustainable production of modern bio-energy services in the African context. And to identify the optimal mix of

- effective mechanisms
- innovative financial tools, and
- appropriate policy framework

for achieving sustainable bio-energy systems in the context of Africa.

And also to explore the opportunities of International Cooperation and Trade’ enhancing the equitable exchange of knowledge between the European Union and Developing Countries, which is one of the core objectives of the COMPETE project.

I do hope that Mauritius find some room for participation in this laudable project, and very appropriately so , as we do also have a programme for bio-energy development as the Hon. Ministers for Agro-Industry and Energy mentioned the other day.

Let me therefore wish all workshop participants very fruitful deliberations on your selected themes and topics, and complete success to the COMPETE project, in the universal interest.

Thank you.

COMPETE International Workshop
22 June 2007, Mauritius

Welcome Address

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COMPETE International Workshop
22 June 2007, Mauritius

The EC Project COMPETE – Activities and Results

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The objective of this Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems- Africa (COMPETE) is to stimulate bioenergy implementation in arid and semi-arid regions in Africa. COMPETE will establish a platform for policy dialogue and capacity building in the major multi- and bi-lateral funding organisations and key stakeholders throughout the bioenergy provision and supply chains.

As global fossil energy resources become constrained, bioenergy is emerging as a major potential resource to supply the energy services currently provided by these fossil fuels. The arid and semi-arid regions of Africa and Latin / South America have, in theory, very large areas of land (and associated water and human resources) ‘available’ for bioenergy production. However, the production of biomass for energy on the scales necessary to supply significant shares of national and global energy provision, will result in very substantial impacts (positive and negative) on the ecosystems and cultures of these target regions. The protection of biodiversity, rural livelihoods and management of scarce water resources are critical considerations in any analysis of the potential for sustainable bioenergy provision in arid and semi-arid regions. Similarly, whilst modern bioenergy could contribute significantly to poverty alleviation in rural areas, the effects of changes to the supplies of natural resources and ownership of those resources must be an integral part of the development options proposed.

Therefore, a comprehensive, multi-disciplinary, assessment of current land use, energy demand and technology innovation focused on Africa, will be carried out through COMPETE. COMPETE will link implementation activities, policy development, trade, funding and South-South-EU cooperation. The improved knowledge of national and regional land use and technology options generated will provide the local and international partners with the basis for a complete assessment of social, environmental and economic impacts. Finally, all the outputs of COMPETE will be integrated into a carefully designed dissemination strategy developed through a dedicated Work Package which will ensure that the outputs are targeted where they will be most useful e.g. selected decision makers and stakeholders.

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

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

COMPETE will deliver a matrix of multi-disciplinary and cross-sectoral work-packages, each led by globally recognised scientists and implementers, to:

- provide an evaluation of current and future potential for the **sustainable provision of bioenergy** in Africa in comparison with existing land use patterns and technologies.
- facilitate **South-South technology and information exchange** capitalising the world-leading RD&D in bioenergy in the key countries Brazil, Mexico, India, China and Thailand
- develop **innovative tools for the provision of financing** for national bioenergy programmes and local bioenergy projects, including: carbon credits, bilateral and multi-lateral funding instruments, and the role of international trade
- develop **practical, targeted and efficient policy mechanisms** for the development of bioenergy systems that enhance local value-added, assist local communities and address gender inequalities

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

The COMPETE project duration will be from January 2007 until December 2009.

For more information on the COMPETE project, please consult the website **www.compete-bioafrica.net**.

The COMPETE project is co-funded by the European Commission in the 6th Framework Programme – Specific Measures in Support of International Cooperation (INCO-CT-2006-032448).

COMPETE - Competence Platform on Energy Crop and Agroforestry Systems - Africa

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ABSTRACT

As global fossil energy resources become constrained, bioenergy is emerging as a major potential resource to supply the energy services currently provided by these fossil fuels. Africa and Latin America have, in theory, very large areas of land resources ‘available’ for bioenergy production. However, the production of biomass for energy on the scales necessary to supply significant shares of national and global energy provision, will result in very substantial impacts (positive and negative) on the ecosystems and cultures of these target regions. The protection of biodiversity, rural livelihoods and management of scarce water resources are critical considerations in any analysis of the potential for sustainable bioenergy provision. The objective of this Competence Platform on Energy Crop and Agroforestry Systems - Africa (COMPETE) is to stimulate bioenergy implementation in Africa. COMPETE will establish a platform for policy dialogue and capacity building in the major multi- and bi-lateral funding organisations and key stakeholders throughout the bioenergy provision and supply chains.

1 INTRODUCTION

At the beginning of the 21st Century, Africa contains some of the poorest and most technologically backward regions in the world, with civil conflicts, diseases, droughts making further exacerbating the lives of the poor. Over the previous decades their quality of life has continued declining, and currently about 52% of the sub-Saharan Africans live on less than US$ 1 per day and about 43% of the urban residents have incomes below US$ 47 per person-month [1].

The poor economic performance and the shortage of work does not allow for a level of income that is sufficient for obtaining modern, clean, energy supplies. Hence, about 80% of the African population is still dependant on charcoal and firewood to fulfill their energy needs [2].

According to the World Energy Council (WEC) [3], the Food and Agriculture Organization (FAO) [4] and the UNDP [5], it is likely, that traditional biomass will be the main energy source for the sub-Saharan population for the foreseeable future, with demand continuing to grow. This trend in development will impose additional pressures on natural resources, particularly on the vulnerable arid and semi-arid ecosystems of Africa. Poor individuals can remain trapped in a cycle of increasingly unsustainable dependence on declining local resources. For the majority, the only known agricultural methods are the traditional ones, which, without sufficient inputs, can cause soil degradation and desertification and have already led to overuse, with a regional decline in available biomass. Concerning energy supply, there is no easy alternative to traditional biomass use unless options emerge to break this cycle.

Modern, locally adapted, wisely implemented and planned, bioenergy systems may provide one such option (see below).Today, at least 16% of the world’s agricultural land, especially cropland and pastures in Africa, already show a significant decline in productivity and about 65% of the cropland and pastures of Africa are degraded [7].Additionally, the traditional agricultural methods are not able to cope with increased pressures climate change already causes.

2 LINKING MODERN BIOENERGY WITH DEVELOPMENT

2.1 A number of studies have estimated the resource base for the supply of biomass for energy highlighting the large areas of ‘unused potential agricultural land’ in Africa (about 750 Mha) and Latin / South America (850 Mha) [7]. Smeets and Faaij [8] predicted for Africa that between 41 and 410 EJ of energy could come from biomass by 2050, with the upper estimate equivalent to current total global primary energy consumption. A further 46 to 310 EJ could be provided from South America once food and other land uses had been accounted for. At the same time as this huge potential for modern bioenergy is being highlighted, the health and environmental consequences of expanded and uncontrolled use of traditional biomass fuels is increasingly being associated with health and drudgery problems that disproportionately affect women and children in the poor areas of developing countries [9]. Finally, the increased cost of the fossil fuel alternatives to traditional biomass use for energy means that those that had switched to cleaner, less demanding alternatives to traditional fuels are now being forced back into using them because these alternatives may no longer be affordable.

2.2 COMPETE Objectives

The objective of this Competence Platform on Energy Crop and Agroforestry Systems - Africa (COMPETE) is to stimulate bioenergy implementation in Africa. COMPETE will establish a platform for policy dialogue and capacity building in the major multi- and bi-lateral funding organisations and key stakeholders throughout the bioenergy provision and supply chains [10]. It is a co-funded project by the European Commission in the 6th Framework Programme and the Specific Measures in Support of International Cooperation.

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

2.3 COMPETE activities and previous experiences.

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

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

COMPETE activities considered also previous projects in Africa such as the coordination action plan for savannas [11]. This network reviewed the works on arid and semi-arid regions which typically contain savanna ecosystems and have complex biophysical and human dynamics associated with them. In order to ensure a full understanding of these dynamics and how they can best be harnessed for bioenergy, COMPETE will also collaborate with the Southern African Savannas Network (SASN) which has extensive experience and knowledge and expertise in these ecosystems. The project concentrates on the opportunities for modern bioenergy to support sustainability of human activities in these ecosystems. Management systems that support biodiversity and are therefore compatible with the Convention on Biodiversity (CBD) will be a critical part of the acceptance of the widespread adoption of biomass production systems for energy, and is an important component of WP3 (Sustainability). The interaction within the COMPETE framework between SASN and the other network partners who have extensive practical experience in all aspects of biomass production, conversion and supply, will facilitate the identification and dissemination of best practice in the use of energy crops and agroforestry systems in testing environment of the arid and semi-arid ecosystems of Africa.

3.0 POTENTIAL IMPACT

3.1 The project will provide an arena for relevant policy making and for project development and funding. It will collaborate with the Africa Development Bank (AFDB). It is expected that a number of demonstration and fully commercial bioenergy projects will have a spawn through the opportunities of review of resources and their sustainable production and support generated through product generation. Detailed and active policy development at the national, regional and international levels is also expected and a number of policy-relevant deliverables will occur and be documented.

The urgent need to develop competitive and practical renewable energy solutions capable of securing substantial shares of national energy supplies in Africa and elsewhere is apparent as a result of five converging but separate agendas. COMPETE will highlight and develop the bioenergy-relevant options presented by these agendas:

- Energy security
- Climate change
- Modern bioenergy technologies
- Biofuels trade

1. Energy security

Increasing expensive oil and gas mean that coal is becoming the only affordable fossil energy supply in selected areas of Africa with good internal reserves or good transport infrastructures. Outside South Africa, it is not possible to use coal for providing transport fuels and its use as a fuel for cooking leads to worse respiratory and general health problems than traditional biomass. The project will quantify the potential for bioenergy to substitute for current and future demand for fossil fuels.

2. Climate change

Fossil fuel use and land use change (some as a result of traditional biomass use) exacerbate climate change and increase the vulnerability of Africa’s poor rural populations crop failure, drought and flooding. Modern bioenergy could provide a local value-added function to land use and increase resilience by providing the local energy services needed to meet the MDGs e.g. emergency irrigation to save crops during droughts or the provision of clean water. COMPETE will evaluate the potential for substituting for fossil fuels and mitigating land use change impacts, thereby reducing GHG emissions.

3. Emerging modern bioenergy technologies

These novel technological pathways could provide cost-effective and sustainable supplies of energy at the local level. In addition, being non-intermittent, bioenergy could provide a good solution for the penetration of other renewable energy technologies. COMPETE will evaluate emerging bioenergy technologies and supply pathways.

4. International trade / sources of biofuels

The EU has aggressive targets for the implementation of renewable energy supplies and GHG reductions but will not be able to achieve these in the near to medium term without importing significant quantities of biofuels. Only Africa and South America have the resources to produce sufficiently large amounts of biomass for energy to impact on EU fossil energy demand.

5. Employment and local investment

The potential for the development of jobs in Africa through the substantive development of bioenergy resources has been highlighted by the World Bank which estimates that up to 9 million jobs could be created by 2050 [12,13].

3.2. African Institutions collaboration

Different institutions and stakeholders already working with issues to develop sustainable long term options for the management of indigenous resources will collaborate tot add value at the local level and simultaneously provide energy security and decrease vulnerability to climate change. This considers the sustainable development objectives as set out by the World Summit on Sustainable Development (WSSD) as follows:

- *Poverty alleviation:* COMPETE will help to establish local sustainable value-added energy provision services from biomass that should allow ground-level development to occur [14]. Evidence from Sao Paulo State in Brazil supports the hypothesis that bioenergy systems simultaneously enhance food production, local wealth creation and the provision of bioenergy supplies [15].
- *Water*: the provision of affordable and reliable energy is one of the basic requirements in the provision of safe water. Small scale modern bioenergy systems are often used to provide water pumping at the village level, both for clean potable water supplies and for irrigation.
- *MDGs*: ensuring that local people have access to secure, clean and affordable supplies of modern energy services is one of the key underpinning actions necessary to meet all of the eight MDGs.
- *Diversify income generation*: being an inherently rural and extensive activity based on using the land, bioenergy systems must be designed so that much of the value-added by the conversion of biomass to modern energy carriers is retained at the local level. Furthermore, the careful coupling of bioenergy supply to enhanced food production and income generating activities will be promoted within the project.
- *Traditional Knowledge*: traditional knowledge and traditional uses of natural resources are one of the main life-supporting and wealth generation activities of the rural poor in the countries of Africa. New systems of land management or alternative uses of natural resources must either provide alternative livelihood options for those currently dependent on traditional uses and/or ensure that existing resources are protected.

4 REPORTING AND FUTURE ACTIVITIES

COMPETE will deliver a matrix of multi-disciplinary and cross-sectoral work-packages, each led by globally recognised scientists and implementers, to:

- provide an evaluation of current and future potential for the sustainable provision of bioenergy in Africa in comparison with existing land use patterns and technologies.
- facilitate South-South technology and information exchange capitalising the world-leading RD&D in bioenergy in the key countries Brazil, Mexico, India, China and Thailand
- develop innovative tools for the provision of financing for national bioenergy programmes and local bioenergy projects, including: carbon credits, bilateral and multi-lateral funding instruments, and the role of international trade
- develop practical, targeted and efficient policy mechanisms for the development of bioenergy systems that enhance local value-added, assist local communities and address gender inequalities

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ICSU Sustainable Energy Activities in Africa

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Introduction to ICSU

ICSU is a nongovernmental membership organisation which was founded in 1931, but its roots go back to 1899. Currently there are 112 National Members and 29 International Scientific Unions. The mission of ICSU is to strengthen international science for the benefit of society. The ICSU Strategic Plan for 2006-2011 is based on 3 themes: international research collaboration, science and policy, and the universality of science.

In the past few years, ICSU Regional Offices for in Africa (Pretoria, South Africa, 1 Sep. 2005), for Asia and the Pacific (Kuala Lumpur, Malaysia, 19 Sep. 2006) and for Latin America and the Caribbean (Rio de Janeiro, Brazil, 18 Apr. 2007) have been established. These offices will ensure that the voice of developing countries influences the international agenda and scientists from the South are fully involved in international research guided by regional priorities.

ICSU (Global) Energy Activities

- International Science Panel on Renewable Energy (ISPRE), held first meeting in January 2007
- IUPAP working group on Energy produced a report on “R&D of Energy Technologies”, October 2004
- ICSU working group on Energy and Sustainable Societies 2002-2004

Priority Areas of ICSU Regional Office for Africa (ICSU ROA)

ICSU ROA focuses its activities on four priority areas, namely: Sustainable Energy; Health and Human Well-being; Natural and Human-induced Hazards and Disasters; and Global Change. Science plans for each priority area have been developed and will soon be published.

The science plan on Sustainable Energy provides an overview of the energy situation in Africa. It identifies the key energy challenges and the modest progress made in the energy sector in sub-Saharan Africa. Some of the national, sub-regional and regional energy projects which were undertaken or are currently ongoing in Africa were highlighted. Within this framework, the plan suggests 3 major projects:

1. Development of energy models and scenarios for sub-Saharan Africa.
2. Increase in access to high quality, reliable and affordable energy in a sustainable manner
3. Strengthening and retention of human institutional capacities.

ICSU ROA Energy projects being implemented

In collaboration with its partners[1], ICSU ROA, organised an international field workshop on “Renewable Energy for Sustainable Development in Africa” in Mauritius from 18 to 21 June 2007 (preceding the COMPETE workshop on 22 June 2007). The overarching aim of this workshop was to initiate the process of drafting fundable project proposals and to continue identifying implementers of funded Energy projects.

Two major project proposals were presented, discussed and endorsed by workshop participants:

1. **Development of Energy Models and Scenarios for Africa** (from the ICSU ROA Sustainable Energy Science plan)

General Objective

To develop energy models and scenarios with related activities for optimizing, effectively managing and planning energy production and use in Africa.

Specific Objectives

- To identify capacity needs for effective development of models and scenarios for the region.
- To harmonise national, sub-regional and regional plans, models and scenarios in the region.
- To develop a harmonised energy database for scenario-building and modelling.
- To strengthen human and institutional capacity in scenario-building and modelling for energy and energy related sectors.
- To develop knowledge networks and other collaborative links among specialists in energy modelling and scenario-building.
- To keep track of developments in scientific and technological advances in the energy sector.

[1] UNESCO, the AU, United Nations Economic Commission for Africa (UNECA), TWAS/African Academies of Science (AAS), Southern African Biofuels Association (SABA), the Mauritius Sugar Industry Research Institute (MSIRI), the University of Mauritius, CTSAV, the Mauritius Research Council (MRC) - with sponsorship from UNESCO, DAAD and KNAW

Activities

- Scoping Meeting
  - Review previous studies on policies and plans of countries in the region
  - Identify and assess the efficacy of system reliability and capacity reserve criteria applicable to countries in the region
  - Review planning and design criteria used in master plans and develop common acceptable criteria

- Data Gathering
  - Collect and organize data needed for simulation mainly from energy and related reports

- Develop Drivers & Markers
  - Undertake scoping to highlight environmental management constraints including legislation, public concerns and other sensitivities

- Modeling Exercise
  - Review and update regional energy forecasts
  - Identify risks and uncertainties
  - Develop base case for integrated planning
  - Undertake detailed financial modeling
  - Train adequate human resources
  - Develop inter-institutional collaboration

NB: It was strongly suggested by workshop participants that far greater attention should be paid to developing scenarios rather than models. The Energy experts will handle this matter during the project write-up.

Deliverables

- Suitable energy and related data bases for constructing energy scenarios and models
- Policy testing tools
- Personnel trained in the development of energy scenarios and models
- Enhanced institutional capacity in energy scenario development and modeling - with international links
- Comprehensive report to guide Africa on energy scenarios and modeling in the region

2. Biofuels for Africa:

a. Electronic library for Renewable Energies (RE) for Africa

The main reasons for undertaking this project are:

- The Biofuels energy sector offers the largest potential for the use of Renewable Energies (RE) in Africa (i.e. liquids, gel, gas) and certain African countries are already engaged in production of electricity from Biofuels.
- The Biofuels energy sector is most sensitive to sustainable development (nature conservation, water management, biodiversity)
- This energy sector creates job opportunities for the various sectors of the country’s population involved therein.
- Documentation of Africa’s existing potential and know how on RE

b. Testing Centers for production of electricity from African Biofuels

The main activities for this project will include the following:

- Testing different technologies and facilities
- Piloting new technologies
- Publishing test reports
- Capacity building in R&D on RE

c. R&D support scheme for energy efficient in the Public Transport sector in Africa

The main objectives for having this project in Africa are:

- affordable public transport
- energy and cost efficiency
- skill and capacity development
- know-how transfer
- broad based job creation for local experts
- sustainable business development

d. Other types of RE (e.g. solar, wind, waves/tides and geothermal energies) will be considered after the successful take-off of the Biofuels projects.

Call for Participation

Those interested in participating in R&D activities falling within the Models and Scenarios and the Biofuels projects should also submit their 1-page CV and indicate which aspect of the project they would like to be involved in to:

Dr Janine Chantson, ICSU Regional Office for Africa
Fax: +27 (0)12 481 4273, Tel: +27 (0)12 481 4185
Email: j.chantson@icsu-africa.org or k.potgieter@icsu-africa.org

For more information, visit www.icsu-africa.org, where the ICSU ROA science plans and ICSU ROA energy projects can be downloaded.

The ICSU Strategic plan 2006-2011 and ICSU energies reports are available on www.icsu.org.

COMPETE International Workshop
22 June 2007, Mauritius

Sugar Cane and Sweet Sorghum Production Expansion Potential in Southern Africa

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Abstract

The Cane Resources Network for Southern Africa (www.CARENSA.net) evaluated how bio-energy from sugarcane can support sustainable development and improve global competitiveness in southern Africa. CARENSA’s work program included five areas of analysis: agriculture, industry, markets, impacts, and integration. The assessment described in this paper was part of the agricultural analysis. Two approaches were used to identify Malawi, Mozambique and Zambia as the countries in the region with the greatest contemporary potential for expansion of sugarcane production. Using Geographic Information Systems (GIS) and the IGBP Miombo data set, which has 1km^2 resolution, a detailed analysis involving filtering out land that was unavailable and/or unsuitable for expanding sugarcane cultivation on, was carried out in these countries. The analysis showed substantial suitable and available land in them, and suggests that ‘land’ is unlikely to be a limiting factor in harnessing sugarcane’s bio-energy potential to create rural livelihoods and alleviate poverty, reduce dependence on imported energy sources, and offer new development pathways in the region.

Introduction

Smeets *et al.* (2004) revealed that compared to all the world’s major regions, sub-Saharan Africa has the greatest bioenergy potential as a result of large areas of suitable cropland, large areas of unused pasture land and the low productivity of land under agriculture. The Cane Resources Network for Southern Africa focused on southern Africa because the economic integration of resources, markets and infrastructure that 14 countries in the region are committed to under the auspices of the Southern African Development Community (SADC), bodes well for initiatives to harness the region’s bio-energy potential (Johnson and Maksika, 2006). CARENSA focused on sugarcane because it is currently the world’s most significant energy crop, and there is a long experience with it in the SADC region (Johnson *et al.* 2007). Phillips (2002) estimated that a 50% increase over the region’s 2000 sugarcane production,would require expansion of 200 000 ha of land and create 100 000 jobs.

Knowing the habitat requirements for sugarcane, Geographic Information Systems (GIS) can be used to interrogate environmental data sets to identify suitable habitats. The larger the number of environmental parameters included, the higher the resolution and quality of the data, the more reliably these habitats can be identified. Using climate, terrain and soil data with a 10 km^2 resolution, the FAO (2004) shows most of southern Africa to be prohibitive and unsuitable for rain fed sugarcane production. Only the northern and eastern parts of Zaire and the lower reaches of the Zambezi in Mozambique are identified as suitable to very suitable (refer Figure 1). This paper describes how two approaches were used to identify the three countries in the region with the greatest contemporary potential for expansion of sugarcane production. These countries were then subjected to a detailed GIS analysis that involved filtering out land that was unavailable and/or unsuitable, and verifying the soil and climate suitability of the land left over. The analysis revealed that area of suitable and available land in Malawi, Mozambique and Zambia exceeds Phillip's (2002) requirement by a factor of 18.6 times.

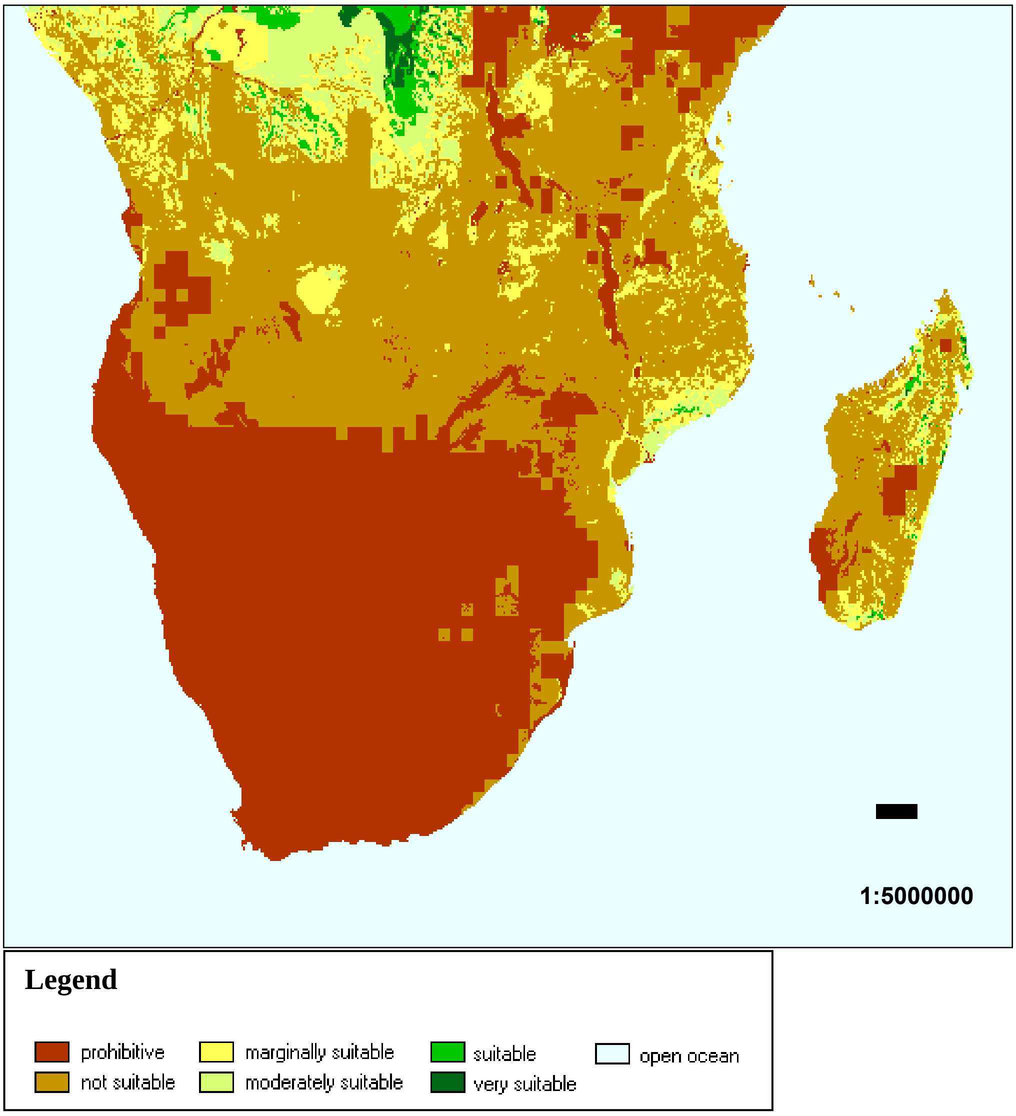

Figure 1: Land suitability for sugar cane production in southern Africa (http://www.fao.org/ag/agl/agll/cropsuit.asp).

Methodology

The potential to increase the area under sugarcane in southern Africa was assessed by Garland and Watson (2003) based on the proportion of arable land currently under the crop, the land reform and climatic change context, and the potential effect of such expansion on food crops, veld products and irrigation. They concluded that (a) the potential for any new plantings in Mauritius is very limited, (b) the potential for medium to large scale and irrigated plantings in South Africa, Swaziland, and Zimbabwe is limited, and (c) elsewhere, the potential for small, medium and large scale, rain fed and irrigated plantings, is good.

Based on Blume's (1985:93) assertion that "countries or regions with high areal intensity per ha under cane and sugar yields per ha under cane are the environments which offer optimum conditions for sugarcane agriculture", Watson and Garland (2005) reassessed this potential by evaluating the crop's comparative performance. Malawi, Zambia and Mozambique emerged as the most suitable and were therefore selected for further interrogation.

The Miombo Network (IGBP/IHDP, 1995) used an annual cycle of 1 km^2 Radiometer data to delineate land surfaces in southern Africa which exhibited a distinctive phenology and common level of primary production. Surfaces with a spectral signature corresponding to sugarcane and sugarcane-like crops are shown in black in Figure 2.

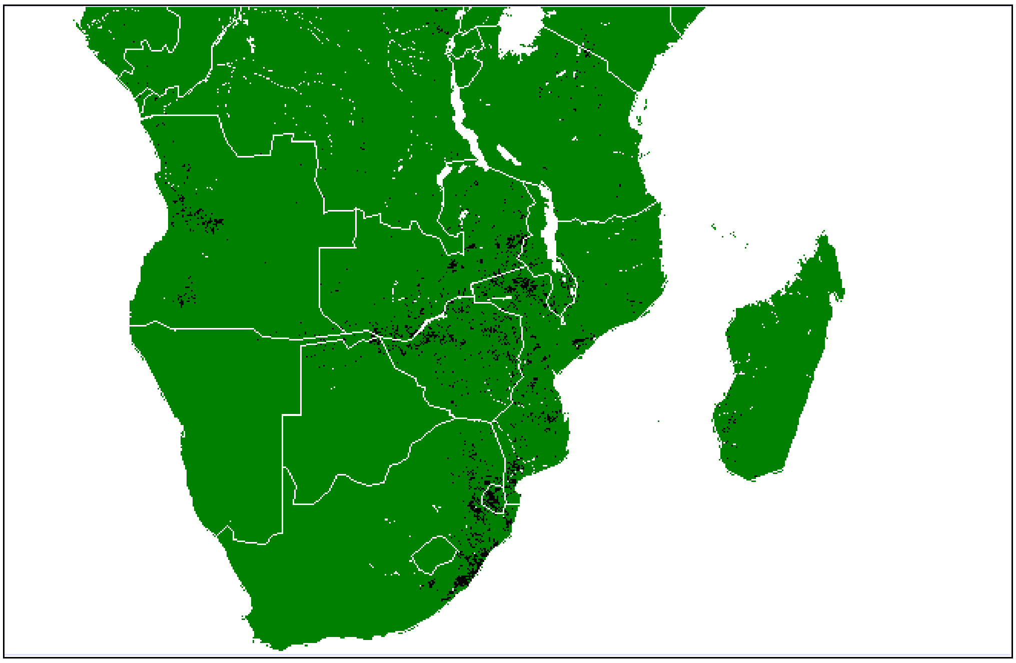

Figure 2: Areas in southern Africa potentially suitable for sugarcane production shaded black. Derived from IGBP/IHDP (1995).

Focusing on South Africa, a GIS was used to overlay these areas on two other maps viz; Schulze *et al.'s* (1997) 2km^2 resolution map showing areas climatically suitable for sugarcane cultivation and Bezuidenhout and Gers's (2002) map which integrates contemporary sugarcane producing areas with 1 km^2 resolution climate and altitude data. There was 88% correlation between the Miombo sugarcane surfaces and the sugarcane surfaces in the other two datasets.

This suggests that surfaces shaded black elsewhere in the region are potentially suitable for the crop. In Malawi, Zambia and Mozambique, if these surfaces fell within protected areas, areas where the slopes were in excess of 16%, or cultivated or wetland areas, they were filtered out using the World Database on Protected Areas (WDPA, 2005), Africa Digital Elevation Model (EROS, 1996), and Global Land Cover 2000 (Global Vegetation Monitoring Unit, 2003), respectively. All areas already under sugarcane were filtered out. The areas smaller than 500ha were then removed. The suitability of the areas left over for sugarcane production was then verified employing Sys *et al.’s* (1993) parametric ITC-Ghent land suitability assessment method and using Leemans and Cramer’s (1991) and New *et al’s* (2002) climatic data, and FAO (2003) soil data. A more detailed account of this methodology is found in Baijnath (2005).

Results and Discussion

The findings of the GIS analysis described above are given in Table 1 below. Relative to the total area of the country, Malawi (7.9%) has the highest proportion of areas potentially suitable for sugarcane production, and Zambia (4.8%) the least. Once all the unsuitable and unavailable surfaces have been filtered out from these areas, Mozambique (3.0%) has the highest proportion of suitable/available areas and Zambia (1.6%) retains it position of being the worst candidate among these three countries for expansion of sugarcane production. However, Malawi is a comparatively small country with Mozambique and Zambia being 8.3 and 7.9 times bigger than it, respectively. In terms of area suitable and available for expanding sugarcane production, Mozambique (2338 ha^3) followed by Zambia (1178 ha^3) present the greatest prospects with Malawi’s (206 ha^3) lagging 11 and 6 orders of magnitude behind, respectively.

Table 1: Areas suitable for sugarcane production remaining after successive filtering out of data, given in 1000 ha and as a percentage of country’s area.

	Malawi		**Mozambique**		**Zambia**	
	1000ha	%	1000ha	%	1000ha	%
Country area	9408		78409		74339	
Potentially suitable for sugarcane	742	7.9	4906	6.3	3546	4.8
Protected areas filtered out	595	6.3	4602	5.9	2433	3.3
Slopes > 16% filtered out	580	6.2	4530	5.8	2427	3.3
Crops & wetlands filtered out	316	3.4	3773	4.8	1726	2.3
Existing sugarcane filtered out	314	3.3	3771	4.8	1726	2.3
Areas < 500 ha filtered out	256	2.7	3470	4.4	1485	2.0
Unsuitable soils & rainfall filtered out	206	2.2	2338	3.0	1178	1.6

The area suitable and available for expanding sugarcane production in these three countries exceeds Phillips’s (2002) threshold for creating a 100 000 jobs in SADC by a factor of 18.6. Clearly, ‘land’ is unlikely to be a limiting factor in harnessing sugarcane’s bio-energy potential to create rural livelihoods and alleviate poverty, reduce dependence on imported energy sources, and offer new development pathways in the region. As Johnson et al. (2007) note the potential of these countries alone is greater than the current production of cane in SADC. Furthermore, they draw attention to the fact that the areas identified in these countries are better suited for cane-growing than much of the land that is under cane in South Africa and Mauritius. The IGBP/IHDP (1995) data suggests that substantial areas of Angola are suitable for sugarcane production. Now that the country is politically stable and cleared of landmines, a similar GIS analysis to that described above is currently being carried out under the Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems – Africa (COMPETE) (www.compete-bioafrica.net).

Once politically stable the bio-energy potential of the Democratic Republic of Congo can also be unleashed.

Conclusion

The land surfaces delineated as having a spectral signature corresponding to sugarcane and sugarcane-like crops in the IGBP/IHDP (1995) radiometer data give a good broad-sweep indication of areas potentially suitable for sugarcane production in southern Africa. Focusing only on the three SADC countries currently offering the greatest amount of suitable and available land for sugarcane production, the region has well in excess of 4 million such hectares. And based on Phillips’s (2002) estimates, is capable of sustaining a 500 fold increase in areas under cultivation and creating two million jobs. ‘Land’ is clearly unlikely to be a limiting factor in harnessing sugarcane’s bio-energy potential to create rural livelihoods and alleviate poverty, reduce dependence on imported energy sources, and offer new development pathways in the region.

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Experiences and Status-quo of Sweet Sorghum Cultivation in Zambia

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1.0 INTRODUCTION

Depending on the policy on blending ratio, potential bio-ethanol markets exist in Southern Africa for blending ethanol with gasoline. This potential is illustrated in Table 1 for E5 (95% gasoline and % ethanol), and E10 (90% gasoline and 10% ethanol).

Table 1: Potential Ethanol Markets based on E5 and E10 (in million litres per year)

Country	**2000**		**2015**	
	E5	**E10**	**E5**	**E10**
Malawi	4.81	9.62	6.54	13.07
Mozambique	3.33	6.66	4.71	9.41
South Africa	511.9	1,023.8	691.45	1,382.9
Swaziland	4.64	9.28	6.21	12.42
Zambia	8.89	17.7	19.0	25.31
Zimbabwe	23.46	46.91	28.89	57.78
TOTAL	**557.03**	**1,113.97**	**756.8**	**1,500.89**

The biggest challenge in Southern Africa is that although potential markets exist, and conventional technologies are available, feedstocks are not available in sufficient quantities. For example, at 10% blending, ethanol demand was estimated at 1.0 billion litres at 2000 levels, against a potential supply of 0.37 billion litres from C-molasses, assuming all sugar cane factories in Southern Africa covert most of their C-molasses into ethanol. This scenario leaves a deficit of 0.74 billion litres. This deficit increases to 1.0 billion litres by the year 2015. Even if existing sugar cane factories are allowed to expand at acceptable levels of 2-3% per annum, the C-molasses will not be sufficient to offset the deficit.

Ethanol from lignocellulosic sources such as wood, grass and bagasse are promising, however, conversion technologies are currently uncompetitive, while feedstocks are abundant. For these reasons, in the short and medium term, it is advisable to seek for alternative sugar based feedstocks. In this case sweet sorghum stands out as a competitive complementary feedstock.

2.0 SWEET SORGHUM CHARACTERISTICS

Sugar cane and sorghum are C4 plants which have high photosynthesis potential and produce high biomass compared to other crop categories (Munyinda, 2007). The genus sorghum includes grain sorghum noted for their high yields and efficiency of manufacture, and sweet sorghum. Sweet sorghum differs from grain sorghum by a few genes, controlling plant height, and the presence of sugar in the stem. Sweet sorghum accumulates sugars in the stem just as sugar cane. The main advantages of sweet sorghum are as follows:

- Shorter growing period (100 to 130 days)
- Low cost
- Relatively drought resistance

3.0 SWEET SORGHUM AGRONOMIC PERFORMANCE FIELD TESTS

In the first phase of the field study, agronomic performance field tests of sweet sorghum varieties were undertaken in three agro ecological regions of Zambia with respect to biomass production, sugar content and accumulation, and optimum time of sweet sorghum harvest.

Eight exotic sweet sorghum varieties were compared to a local sweet sorghum variety (SIMA). The exotic sweet sorghum varieties were TS1, Madhura, Praj-1, GE2, GE3, Wray, Cowley, and Keller. The second phase of the study involved agronomic performance of sweet sorghum under rain fed and irrigation conditions.

4.0 RESULTS AND ANALYSIS

Results of biomass production of sweet sorghum varieties at different growth stages, and accumulation of sugar in different varieties are shown in figures 1 and 2, respectively.

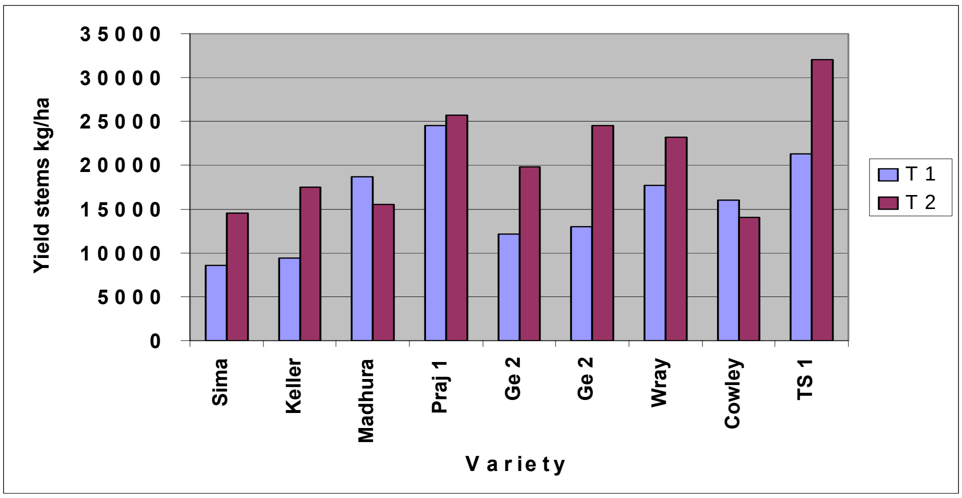

Figure 1: Harvest of sweet sorghum at different growth stages (T1 - Boot stage, T2 - Soft dough stage)

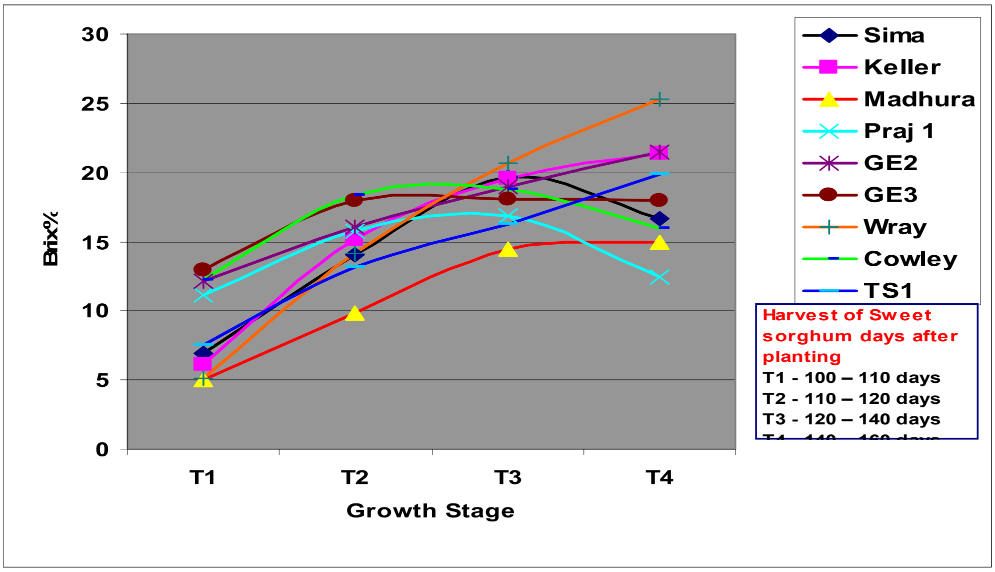

Figure 2: Accumulation of sugar in different varieties of sweet sorghum at UNZA Farm.

Results indicate that there was a tendency for the yields to be highest with TS1. Wray had similar yields with Praj-1, Madhura, GE3; GE3 and Cowley averaging at 21.2 Mt/Ha. Sima had the lowest yield of 13.8 Mt/Ha.

As part of phase 1, further analysis was undertaken to adapt varieties to soil types, and soil and crop management. With regards to soil types, adaptation of sweet sorghum varieties to soils resulted in ethanol production increase by 50%, and performance of yields production depending on variety and soils. For example TS1 performance was on Lixisols, Keller on Acrisols, GE and Praj 1 on Phaeozems, and Cowley and Madhura on Vertisols

Soil and crop management analysis involved investigating the degree of stem yield of sweet sorghum varieties on a particular soil type. The highest stem yield of sweet sorghum verities were obtained on Phaeozems as shown in table 2.

Table 2: Yield increase of Sweet Sorghum varieties on Phaeozems and Lixisols compared to to Ferralsols and Vertisols

Variety	Minimum yield	Soil type	Maximum yield	Soil type	Yield Increase
Madhura	4,816	Ferralsols	32,370	Phaeozems	85.1
GE2	7,056	Ferralsols	43,030	Phaeozems	83.6
Praj-1	6,545	Ferralsols	38,720	Phaeozems	83.1
TS1	5,223	Ferralsols	29,690	Lixisols	82.4
GE3	9,495	Vertisols	34,590	Phaeozems	72.5
Cowley	10,190	Ferralsols	32,370	Phaeozems	68.5
Keller	11,900	Ferralsols	33,430	Phaeozems	64.4
Wray	12,140	Vertisols	28,670	Phaeozems	57.7
Sima	9,293	Ferralsols	20,960	Phaeozems	55.7
GE3	9,744	Vertisols	43,030	Phaeozems	77.4
Wray	22,340	Vertisols	28,670	Phaeozems	22.1

To improve soil and crop management practices on sweet sorghum varieties will require the following:

- Addition of macro and microelements through fertilizer application;
- Application of irrigation during the dry season;
- Timely planting and control of weeds and pests;
- Implementing cultural practices that increase soil organic matter content. Such practices also improve the stability of the highly erodible soils of Acrisols, Alisols and Arenosols;
- Judicious application of lime to neutralize soil solution aluminum and render phosphate and other essential elements more available in order to produce high stem yields. This is particularly relevant for acidic soils.

As part of Phase II, field tests were undertaken to assess performance of rain fed and supplementary irrigation of sweet sorghum production. Much higher millable production of sweet sorghum, and corresponding ethanol production were obtained as shown in Table 3.

Table 3: Sweet Sorghum Production (rain fed and under supplementary irrigation)

	Millable Stalk (Mt/ha)		**Ethanol production (m liters)**	
Variety	**Single crop**	**Double (ratoon) crop**	**Single crop**	**Double (ratoon) crop**
GE3	82.5	165.0	38.2	76.3
Cowley	71.4	142.8	33.0	66.1
Wray	70.2	140.4	32.5	65.0
TS1	51.7	103.4	23.9	47.8
Madhura	41.8	83.6	19.3	38.7
Praj-1	40.7	81.4	18.8	37.7
GE2	40.3	80.6	18.6	37.3
Keller	35.8	71.6	16.6	33.1
Sima	22.2	44.4	10.3	20.5

5.0 CONCLUSIONS AND WAY FORWARD

Results obtained so far are encouraging, but more work is required to further improve the yields. The following future work is recommended:

- Improved crop and soil management on the currently available sweet sorghum varieties.
- Appropriate agronomic packages for sustained agricultural production should be developed.
- The focus should also be on increasing the proportion of area grown to sweet sorghum.
- One of the potential limitations to sweet sorghum production is the control of pests, especially stem borers. Stem borers cause severe damage to the crop if not adequately controlled.
- Low cost control of stem borers should be explored.
- Promising bio-control measures such as the use of nematodes should be evaluated.
- Diseases such as anthracnose, bacterial stripe, blight, gray leaf spot, sorghum rust, sooty stripe and sheath blight could pose severe limitations to the growth of the crop.
- In the longer term, the focus of the programme should be on crop improvement. Local and exotic sweet sorghum germplasm should be selected for yield and the materials also screened for tolerance to pests and diseases.
- To achieve higher stem yields, sweet sorghum should be grown under rain-fed and supplementary irrigation with single or double cropping especially for the better resourced farmers or those in irrigation schemes.
- Research should be conducted in an interdisciplinary framework involving all the important stakeholders.

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Agroforestry as a potential alternative to sugarcane in marginal areas of Mauritius for economic and environmental sustainability and energy

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The Indian Ocean island of Mauritius has been growing sugarcane for almost two centuries now. This sugar industry is one of the best structured in the world. The crop is well suited for the island’s soil, topography as well as the climate. Twenty-five years now, almost 90% of the agricultural area (50% of the total island area) was occupied by sugarcane. This industry was one of the most important pillars of the economy employing the largest labour force and contributing a large percentage to the GDP of the island economy. The industry also had its social contribution in the development of the island.

The price of sugar exported to the European Union was guaranteed under the Lomé Convention and was much higher than the prevailing price of sugar on the world market. The returns form the export of sugar was used to diversify the economy of the island into other sectors such as tourism, services sector as well as ICT, which are now important income generating sectors of the economy. However, with the coming into force of the WTO, the price of sugar exported to EU will fall by 36% in the coming years. Many sugar producers in the island will go out of business, as they may not be able to cover the cost of production. The sugar planters cultivating marginal lands, i.e. lands of low productivity, land on difficult terrain and adverse climatic zones are the most to suffer from this reduction in price. The Government of Mauritius has come up with bold policy measures to address these policy issues. The latest one being the Multi Annual Adaptation Strategy (MAAS) presented to the EU. Among the various measures enunciated in this strategy, the important ones are the derocking scheme to allow mechanization of sugarcane land, as well as clustering or grouping of farmers to enjoy the economies of scale. These measures although important, may not be applicable in all cases. For these farmers, therefore, the change in land use remains an alternative option.

It has been estimated that about 12,341 ha will be uneconomical for sugarcane production (MSIRI, 2007). Any land use change option must be clearly analysed because of the specificities of the island as a Small Island Developing State.

Sugarcane has a multifunctional role which includes reduction of soil erosion, increase din carbon sequestration and biomass in addition to providing fodder for animals, and by-products such as ethanol such as ethanol, bagasse for generation of electricity, molasses, scum etc. as fertilizers.

Present Land Use of Mauritius

Table 1 shows the present land use situation of Mauritius.

Table 1: Land Use Situation of Mauritius

Land Use	Area (ha)
Sugarcane	67,404
Tea	670
Tobacco	300
Food crops	7,000
Forests, scrub area, grasslands and grazing lands	47,066
Reservoirs and ponds	1180
Swamps and rocks	1430
Roads	3465
Built up areas	46625
Newly developped areas	11335
Total Island	**186,475**

Source: Modified from the Digest of Agricultural Statistics, 1996

Sugarcane occupies 67,404 ha which is almost 36.2% of the total area of the island. This acreage was much higher earlier as can be seen from the Fig. 1 below.

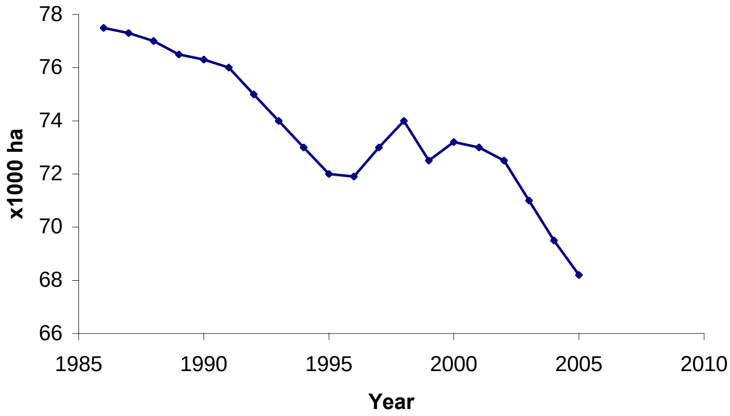

Fig.1:Change in land area under sugarcane in Mauritius

Many of the areas converted from sugarcane land have been transformed into infrastructure, roads, residence, morcellement, etc. Furthermore, most of these conversions have taken place on fertile soils. Recent Government policies such as the Integrated Resort Scheme and land conversion have also contributed to the decrease in sugarcane acreage in the island.

Agroforestry

Agroforestry is one such land use that offers a promising alternative. Just like sugarcane, Agroforestry is multifunctional, environmentally sustainable, and requires minimum cultural operations.

Agroforestry is a collective name of land use systems in which woody perennials (trees, shrubs, etc.) are grown in association with herbaceous plants (e.g. crops, pastures, etc.) and/or livestock in a spatial arrangements, a rotation, or both in which there are both ecological and economic interactions between the tree and the non-tree components of the system (Young, 1991).

Agroforestry systems

There are various forms of agroforestry systems which can be envisaged for Mauritius. These are:

- Silvicultural (trees with crops)
- Silvopastoral (trees with pastures and livestock)
- Entomoagroforestry (trees with insects such as honey bees, silkworm)
- Aqua-agroforestry (trees with aquatic organisms such as fish, crustaceans)

Components of agroforestry systems

The components of an agroforestry system include the following:

- Trees
- Shrubs
- Crops
- Pastures
- Animals (insects, livestock, fish and other aquatic organisms)
- Environmental factors (soil, land form, climate)

Agroforestry as a practical land management option

Agroforestry is widely applicable as a practical land management option. For instance:

- Type of land: the range of practices allows agroforestry to be applied over a wide variety of environmental conditions, e.g. wetlands, dry lands, rocky, slopy lands.
- Extent of land: most agroforestry practices are not land intensive.
- Supply of inputs: agroforestry does not require inputs that are costly or in short supply. It is a relatively inexpensive form of land development.
- Technology: the technology employed is generally known and familiar to farmers.

Benefits of agroforestry

Some of the benefits of agroforestry on the soil include the following:

- On soil: increases soil organic matter through carbon fixation in photosynthesis and transfer via litter and root decay
- Nitrogen fixation by leguminous and non-leguminous trees
- Nutrient uptake: taking up nutrients released by rock weathering in deeper layers and recycling it to the surface
- Atmospheric input by trapping rainfall, dust and nutrients
- Exudation of growth promoting substances
- Prevention of soil erosion and loss of organic matter and nutrients
- Nutrient retrieval
- Reduction in rate of decomposition of matter by shading
- Improvement of soil physical properties, e.g. structure, porosity, WHC, breaking up of indurated layers
- Modification of soil temperature extremes
- Reduction of soil acidity through addition of plant litter
- Reduction of salinity or sodicity
- Production of a range of plant litter of different quality
- Timing of nutrient release
- Beneficial effects on soil flora and fauna
- Transfer of assimilates between root systems

Table 2 shows the improvement of soil properties under *Leucaena leucocephala* as compared to the open filed. pH had a higher value under *L. leucocephala*, and available K, organic matter, and N were higher under *L. leucocpephla*, compared to the open field.

Table 2: Soil characteristics under longterm Leucaena leucocephala (> 20 yrs)

Characteristics	***L. leucocephala***	**Open field**
pH	6.84	5.04
Total N (%)	0.33	0.50
Av. P (%)	0.011	0.012
Av. K. (%)	0.037	0.021
Organic matter (%)	3.23	2.90
NH_4^+N (mg/kg)	1095	1048
NO_3N (mg/kg)	603	400

Source : Lalljee, 1996

Tables 3, 4 and 5 show the effects of long term *L. leucocephala* on soil properties in different parts of the world. In all cases, the effects are positive and beneficial to the soil and consequently to crops grown on such soils.

Table 3 : Physical properties of soil under L. leucocephala and in an open field

Site	**Bulk Density**	**Particle Density**	**Porosity**	**Infiltration Rate**	**Penetrometer Resistance**	**Particle Size**		
Yrs. under *L. leucocephala*	**kg/m^3**	**kg/m^3**	**%**	**cm/min**	**kg/cm^2**	**Sand (%)**	**Silt (%)**	**Clay (%)**
0	916a	2552b	64.1b	0.60d	3.15a	41.8	26.6	31.6
9	818bc	2663a	69.2a	0.88c	2.69b	41.9	25.8	32.3
12	826b	2698a	68.7a	1.50b	2.52c	42.1	26.2	31.7
21	812c	2668a	69.5a	1.66a	2.34d	40.9	26.7	32.4

Source : Lalljee et al., 1999

Table 4 : Soil properties beneath trees in northwest India

Characteristics	***L. leucocephala***	**Open field**	pH
6.84	5.04	Total N (%)	0.33
0.50	Av. P (%)	0.011	0.012
Av. K. (%)	0.037	0.021	Organic matter (%)

Source : Aggarwal, 1980

Table 5 : Soil properties beneath trees in a dry climate in Nigeria

Soil property	***Azadirachta indica***	**Bare fallow**
pH	6.8	5.4
Organic C (%)	0.57	0.12
Total N (%)	0.047	0.013
P (mg/kg)	68	195
TEB (cM/kg)	2.40	0.39
CEC (cM/kg)	2.25	1.70
Base Saturation (%)	98	20

Source : Radwanski and Wicqens, 1981

Table 6 gives the properties of soil under neem (*Azadirachta indica*) and the percentage change in these properties. There is a general improvement in most of the soil parameters studied.

Table 6: Chemical properties of soil under neem and in open field

Parameter	**Under neem**	**Open field**	**% change**
pH	6.54 ± 1.01	6.72 ± 1.23	- 2.8
Organic matter (%)	7.32 ± 1.46	4.38 ± 1.62	+ 40.2
Total nitrogen (%)	0.41 ± 0.09	0.17 ± 0.12	+ 58.5
NH_4^+ (mg/kg)	30.7 ± 4.7	53.4 ± 9.3	- 73.9
NO_3^- (mg/kg)	150.2 ± 8.9	180.3 ± 15.2	- 20.2
Phosphorus (mg/kg0	9.6 ± 1.7	7.3 ± 2.3	+ 24.0
Exchangeable K (mg/kg)	52.0 ± 5.9	48.0 ± 4.9	+ 7.6
Exchangeable Ca (mg/kg)	106.4 ± 12.6	59.1 ± 15.2	+ 44.6
Exchangeable Mg (mg/kg)	79.3 ± 7.8	42.2 ± 8.4	+ 46.8
Available Zn (mg/kg)	27.6 ± 2.9	18.9 ± 3.2	+ 31.5
Available Cu (mg/kg)	15.7 ± 1.7	10.3 ± 2.8	+ 34.4
Available Fe (mg/kg)	499 ± 10.9	325 ± 13.6	+ 34.9
Available Mn (mg/kg)	270 ± 7.8	195 ± 12.9	+ 27.8

Source : Lalljee and Facknath, 2002

Other benefits of agroforestry

In addition to the above positive effects on soil trees and shrubs agroforstry systems offer other environmental advantages.

- Wind effects: act as windbreaks and therefore as antierosive agents
- Capture industrial aerosols and therefore purifies air and reduces air pollution
- Reduce compression and turbulence
- Rehumidify air streams
- Control air temperature by evaporative cooling
- Noise reduction

Adverse effects of trees on soil

Some of the adverse effects of agroforestry on soil are as follows:

- Loss of organic matter and nutrients in tree harvest
- Nutrient competition between trees and crops
- Moisture competition between trees and crops
- Production of substances which inhibit germination or growth (allelochemicals)
- Acidification of soil by some tree species

Economic aspects

- Most of the trees chosen for agroforestry are multipurpose.
- They provide fodder for animals;
- Some can be exploited for medicinal and pesticidal properties, e.g. neem;
- Some serve as habitat for bees for production of honey, wax, propolis, royal jelly, etc. for silkworms.
- They are very efficient in biomass production, which can be transformed into energy.
- They fertilise the soil and therefore reduce the cost of fertiliser application.
- Biomass can be used as poultry litter, mushroom production.
- Some can be used as ornamentals, e.g. Christmas trees.

Table 7 : Yield of above ground biomass of some MPT (kg dry matter/ha/yr)

Trees	**Biomass**
Leucaena leucocephala	4,000-8,000
Acacia mangian	18,000
Albizia falcutana	11,300
Prosopis juliflora	30,000

Source : Young, 1991

Table 8 : Nitrogen fixed by trees and shrubs

Species	**N fixed (kg N/ha/yr)**
Acacia albida	20
A. mearnsii	200
Casuarina equsetifolia	60 – 110
Gliricidia sepium	13
Leucaena leucocephala	100 – 500
Prosopis glandulosa	40 – 80
P. tamarugo	200

Source : Nair, 1984; Dommergues, 1987

Characteristics of trees to be considered suitable for agroforestry

- High biomass production
- High N fixation
- Well developed rooting system
- High nutrient content in biomass, including roots
- Fast or moderate decay of litter
- Absence of toxic substances in foliage or root exudates
- Cyclone resistant

Potential Agribusiness from Agroforestry

- Fuel Briquettes for Green Energy: Small planters could be grouped into cooperatives or associations to produce fuel briquettes which can be co-fired in bagasse as well as coal powered stations. There are various ways of producing these briquettes, e.g. production of charcoal and conversion to charcoal briquettes or production of waxed briquettes, or non-waxed briquettes.
- Pesticidal preparations: setting up of SMEs to extract pesticidal extracts from trees/shrubs/plants and prepare into commercial formulations
- Medicinal preparations: same as above.
- Apiculture: SMEs or individuals for production of honey, propolis, royal jelly, wax.
- Food production: fruits, vegetables, poultry litter, mushroom substrates, etc.
- Ornamentals: decorative plants, Christmas trees for local tourist and domestic, as well as for the export market
- Construction industry: scaffolding, poles, etc.

The way forward

To harness all these ideas into strategic and action plans the creation of a Biomass Energy Group is proposed. This Forum for Renewable Energy Development in Mauritius (FREDM) biomass energy group will *interalia* consider and bring forward proposals that will:

⇒ Create momentum in the development of a biomass industry that will

  a) Maximise the contribution that Agroforestry, including secondary sawmill products, energy crops, and other arable based agricultural materials can make towards the achievement of a renewable technology mix;

  b) Identify the correct tree/crop species for the different climatic zones and soil types; and

  c) Contribute to sustainable rural development.

International Implications

- The conversion of marginal lands under sugarcane to agroforestry will help improve the environment by increased in C sequestration, reduction in C emission, increase in Oxygen in the atmosphere.
- This will be in line with the Clean Development Mechanism of the Kyoto Protocol.
- Such land use conversions are eligible for carbon credits by the World Bank and the Carbon Finance Fund. Hence these funds can be used to create the enabling environment for SMEs in the sector of Agroforestry.

Conclusion

- Agroforestry is a potentially promising alternative land use system for sugarcane.
- It has economic advantages as well as environmental sustainability.
- It has a multifunctional role.
- It is a sector which will create opportunities for SMEs.
- There needs to be put in place an enabling environment for the same. The Faculty of Agriculture, University of Mauritius can lead such a programme in terms of consultancy, research, outreach, capacity building.

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Development of Jatropha Biofuel in Southern Africa

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1. Introduction

Jatropha curcas is an energy crop used for the production of first generation biodiesel. It is a biofuel crop increasingly grown in southern Africa and other regions of the developing world. Biofuels are fuels produced mainly from biomass for the purpose of transport or heating (Dufey, 2006). The two main types of biofuels are bio-ethanol and bio-diesel, which account for 90% of the global consumption of biofuels (Brown, 2006). The interest in the production of biofuels in southern Africa has been mainly driven by concerns about the increasing energy prices, possible depletion of fossil energy sources and concerns about the environment (especially climate change) and rural development (Dufey, 2006; Goldemberg, 2007). Fossil fuels account for 80% of the total energy supply (Goldemberg, 2007) and reduction of their consumption is therefore expected to have climate benefits. Biofuels can be used for blending with petroleum fuels and hence reduce environmental problems. The use of biofuels also increases savings in foreign exchange through import substitution, and can lead to the creation of new jobs and attraction of money under what is known as the Clean Development Mechanism of the Kyoto Protocol (Dufey, 2006).

Recognizing the importance of renewable energy in sustainable development, this paper reviews the development of *Jatropha curcas* in southern Africa and also makes suggestions for policy to guide biofuel development. The specific objectives of the paper are to: 1) review the characteristics of *Jatropha curcas* in order to contribute to research and policy, 2) assess the extent to which *Jatropha curcas* is being grown in southern Africa and the challenges experienced, 3) review economic policies adopted to promote its development. The review is by no means exhaustive, but rather aims to highlight some of the critical issues.

The study area for this paper is southern Africa with particular reference to Botswana, Malawi, South Africa, Namibia, Zimbabwe, and Zambia. These countries are at varying levels of economic development with South Africa being the most developed and Malawi being the least developed in terms of per capita income and human development indicators. Although southern Africa is endowed with energy resources, the distribution of these resources is uneven and dominated by fossil energy sources (Wakeford, 2006).

Overall, southern Africa is net energy exporter, though many individual countries are net energy importers (Wakeford, 2006). Angola, South Africa and DRC are the only producers of crude oil in southern Africa, and in 2004 they produced 79%, 19% and 2% of the total petroleum production in the SADC region, respectively (Wakeford, 2006). Information for this study was obtained from various literature sources on biofuel development in southern Africa. In addition, a series of interviews with policy-makers, researchers, and managers of companies for bio-diesel production were undertaken.

2. Policies and Targets

A number of countries in both the developed and the developing world are involved in research and development projects for biofuels. Targets for their production and consumption are being initiated. For instance, the European Union Directive of 2003 recommends that member states should achieve a minimum proportion of biofuels target of 5.75% of the consumption of petrol and diesel placed in the market by 2010 (EC, 2003).

Some of the southern African countries have already drafted policies for biofuels development, while others have started reviewing their energy policies. In South Africa, a strategy for biofuels development had already been drafted by the end of 2006. Biofuels are among the energy sources being promoted to enable the country to meet its renewable energy supply target of 10 000 GWh by 2013 (Wienesse and Purchase, 2006). It is expected that biofuels will account for 4.5% of the total consumption of liquid fuels by 2013 in South Africa. To achieve this target, incentives have been introduced to increase the production of biofuels (Republic of South Africa, 2006).

In other southern African countries, there is a growing interest in energy crops for bio-diesel production and the road maps for bioenergy production are being constructed. In Zambia, for instance, a Task Force Committee on Renewable Energy has been formed. It is composed of members from various government ministries and representatives from the British company of D1 Oils Zambia (Stephenson, 2006). Because biofuels are likely to promote employment creation and reduce greenhouse gases, their development is an appropriate strategy for reaching the United Nations Millennium Development Goals in southern Africa, especially those of eradication of extreme poverty (goal No.1) and ensuring environmental sustainability (goal no 3) (Dufey, 2006).

3. Energy crops

A recent study in the SADC region identified the following energy crops for biofuel production: Oil palm, sweet sorghum, sugarcane, sunflower, soybean, *jatropha curcas* and cassava (Table 1; Takavarasha et al., 2005).

The study ranked the crops according to their potential for the production of biofuels, employment creation, level of production costs, yield, impacts on food security, foreign exchange savings and energy balance. Interestingly, no mention was made about the crucial issue of greenhouse gases associated with the production and use of feedstocks of these energy crops for biofuels.

Table 1: Energy crops recommended by the SADC study on biofuels

Energy Crop	Rank	Reasons
Sugarcane	1	• already grown in the region for ethanol production • generates a lot of employment • produced from a by-product of sugar, hence there a double benefit • foreign exchange benefit
Soy beans	2	• same reasons as sugarcane • expanded use for biodiesel can be achieved in one season • scores high for biodiesel production
Oil Palm	3	• Scores high for biodiesel
Sunflower	4	• Ranked fourth because not widely grown in the region
Sweet Sorghum	5	• Ranks low because not yet commercially grown
Jatropha	6	• Not yet commercially grown
Cassava		• Not a major crop in the region

Source: Takavarasha, *et. al* (2005)

Energy crops such as sugarcane, soybean and oil palm were ranked first, second, and third, respectively. Sugarcane was ranked high because it is already being grown and used in the production of bio-ethanol in the region and also because of benefits in terms of employment generation and foreign exchange savings. Soybean and oil palm scored high because of their potential for bio-diesel production. The former is also widely grown in the region by farmers of different socio-economic groups. The crops of sunflower, sweet sorghum, *Jatropha curcas* and cassava were given lower rankings because they are not widely grown in the region. There is evidence that some of these have a great potential to be grown as energy crops. A number of studies have revealed that there is great potential for the growing *Jatropha curcas* in semi-arid regions (Francis *et al*., 2005; Wood, 2005). The plant has been identified by the Namibian Agronomic Board as a suitable energy crop in northern Kavango region of Namibia, an area characterised sandy soils and minimum rainfall of 500 mm/annum (Colin Christian and Associates, 2006).

4. Characteristics of Jatropha Curcas

Jatropha Curcas is a tree belonging to the euphobia family and is native to the coastal areas of South America and Mexico, though it is widely grown in many parts of Africa, Asia and Central America (Benge, 2006; Francis et al., 2005). The plant can be easily grown from seeds and cuttings, and reaches maturity after a period of two to three years (Figure 1; Wood, 2005). The yield of seeds harvested is estimated at 0.5 to 12 tonnes /ha/year, depending on the type of soils, available nutrients and level of rainfall (Francis et al, 2005).

One of the most important features of this plant is that it can be grown on marginal land where most crops cannot be grown. Estimates made by D1 Oils suggest that a 5 000 ha of *Jatropha* plantation with 10 million trees, established in “waste or marginalised land” can produce 35 000 tonnes of seeds (Wood, 2005). The life time of this perennial crop is estimated to be over 30 years (Caniels *et al*., 2007; Francis *et al*, 2005). The plant is drought and pest resistant and it is not eaten by animals, hence it is widely used as hedge for protection of cropland from animals (Francis et al., 2005). The leaves and nuts of the plant are toxic as they contain phorbol esters and curcin and are used as medicine for skin diseases and rheumatic pain. However, there is a non-toxic variety in Mexico and Central America which is sometimes eaten by people after being roasted (Benge, 2006).

Jatropha curcas is classified as noxious weed in Australia and as weed in Brazil, India, Jamaica and Salvador (Benge, 2006), but D1 Oils Africa suggests that the plant is not a weed and there is no evidence that it is self-propagating (Wood, 2005). Opinion is also varied on whether the plant is invasive or not, but most studies reveal that the potential for invasiveness is low and that humans are the main agents of dispersal (Christian, 2007). *Jatropha curcas* has the second highest oil content among all known energy crops. According to Benge (2006), the seed and kernel of the plant contain 35% to 40% and 55% to 60% of oil, respectively, which can be used for the production of bio-diesel. According to D1 Oils, 14 000 tonnes of crude oil or 15 million litres of bio-diesel can be produced per annum from a 5 000 ha of *Jatropha* plantation (Wood, 2005). The oil produced from the *Jatropha* seeds and the by-product from bio-diesel production in the form of glycerine can be used for the manufacture of soap (Figure 1). According to Benge (2006), other potential uses of the *Jatropha* oil include lighting and cooking as it has properties similar to those of kerosene, though it cannot be used in conventional kerosene stoves.

Jatropha has the potential to have very high “well to wheels” energy balances. This is mainly because it is a perennial crop that produces oil seeds for over 30 years after being planted. Life cycle assessments of the reduction of greenhouse gases of *Jatropha*-based bio-diesel have not been undertaken. It is, however, assumed that the reductions in greenhouse gases may be higher than those of soybean–based bio-diesel because *Jatropha* production is low input and requires no tillage (Francis et al., 2005). The growing of *Jatropha* is also associated with improved livelihoods due to employment creation associated with the establishment of nurseries and also because of the restoration of degraded lands known to have a zero opportunity cost (Dufey, 2006; Francis et al., 2005). It is contended its production may not have any conflict with food production because its production results in restoration of degraded lands (Dufey, 2006).

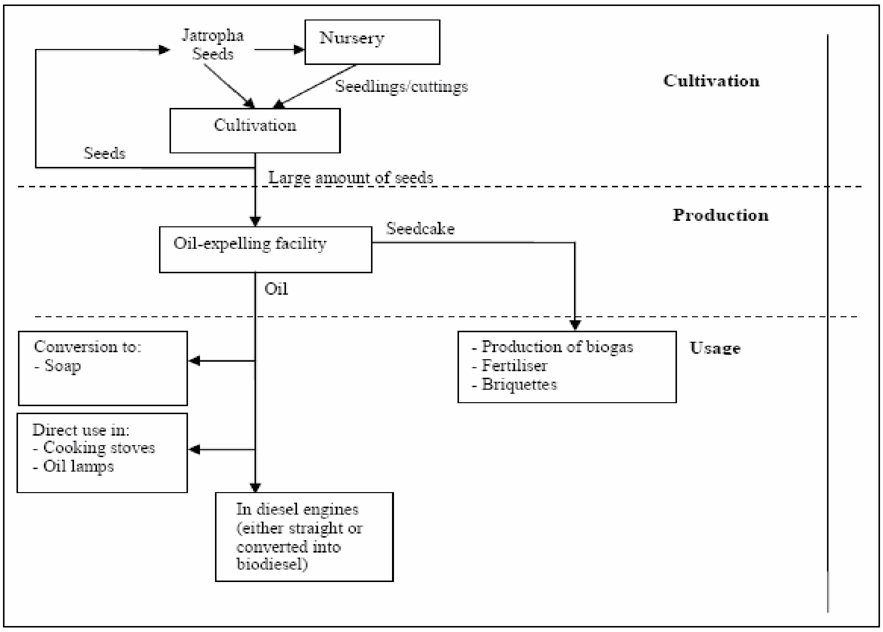

Figure 1: Jatropha-biodiesel supply chain (Source: Caniels et al (2007))

5. Jatropha plantations

Most countries in southern Africa such as Botswana, Madagascar, Namibia, South Africa, Tanzania, Zambia and Zimbabwe (Figure 2) have either initiated or are initiating the planting *of Jatropha curcas* for the production of feedstocks for bio-diesel. *Jatropha* plantations in Africa are partly promoted by European companies such as D1 Oils; and they are seen as a way of meeting the demand of feedstocks for biodiesel production. The available land in the EU countries is not sufficient to meet the extra demand for rapeseed needed to meet the targets for the EU Biofuels Directive. D1 Oils Africa contends that it makes moral and economic sense to grow fuel crops in degraded areas of Africa to meet local demand and for sale to Europe (Wood, 2005). In this section, biofuel initiatives undertaken in the selected countries of Botswana, Namibia, South Africa, Zambia and Malawi are briefly discussed.

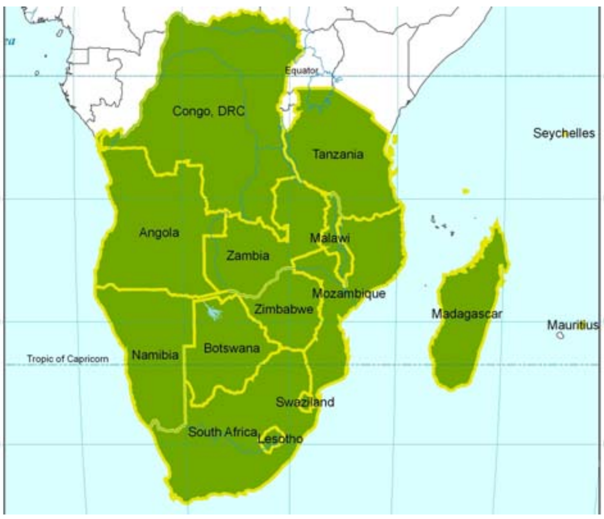

Figure 2: Map of southern Africa

In ***Botswana***, a feasibility study is on-going to assess the potential for the production of energy crops and compare the potential of the following energy crops: *Jatropha curcas*, palm oil, sunflower, soybeans, sugarcane, maize, and sweet sorghum. The study will assume that the price of oil is USA $78 per barrel and that there will be no subsidy for biofuel production. The draft policy for biofuel development in Botswana is expected to be one of the outputs of this study (Government of Botswana, 2006).

In ***Namibia***, there is a proposal by a local company to involve local communities in the growing of *Jatropha curcas* in Kavango (Namibia), along the Okavango River from Katwitwi (near Nkurenkuru) via Rundu to Divundu. In order for the project to be viable, there is need to establish 70 000 to 130 000 ha of *Jatropha* plantation for the production of bio-diesel (Colin Christian and Associates, 2006). Income will be derived from three sources of sale of bio-diesel, marketing of seed cake products (fertilizer, animal feed) and carbon credits (Colin Christian and Associates, 2006). About 200 million *Jatropha* seedlings will be established in five nurseries which will be situated along the Okavango River in Kavango, Namibia. The project has the potential to generate a total revenue of N$ 189 million, equivalent to 0.5% of the Namibian GDP (Colin Christian and Associates, 2006). Farmers who decide to plough *Jatropha* will not be allowed to do so on land cleared after 1990 as they may not qualify for carbon credits under the Kyoto Protocol (Colin Christian and Associates, 2006). This is likely to be a major constraint as most people will not have access to such land. Attempts will be made to identify such land using satellite images. The proposal states that some of the fields were no longer being ploughed. However, the switching of land-use from arable farming to *Jatropha* plantations will result in a reduction in national food production, though farmers will receive income from the project. The project may have a greater impact on the welfare of the rural households if the income received by farmers from the project will exceed the value of the crops they used to obtain from the farms. The project aims at establishing two factories in Rundu and Windhoek in 2008 for oil and diesel production, respectively.

In ***South Africa***, a fuel levy of 30% was introduced from 2003 and later increased to 40% in 2005 to promote the production of bio-diesel. In addition, other incentives, for the production of bio-diesel, have been introduced (tax depreciation write-off of 50:40:20 per cent over a three year period equivalent to a support of $ 2/bbl). According to the document on biofuels strategy, there is only 14% of arable land available for use in South Africa (Republic of South Africa, 2006). The document further states that there is 3 million ha of the land which is underutilized in the former homelands and 1 million ha of such land could be used for biofuel production. According to Sugrue and Douthwaite (2007), it is wrong to assume that such land is underutilized as substantial benefits can be derived from it. They cited the Wits Rural facility study which revealed that direct use values derived by rural households from the surrounding land in Mametja in Limpopo Province of South Africa was approximately R 3 959.00 per household. There is a great interest in growing *Jatropha curcas* in Kwa Zulu Natal and North West Province. In the latter, a 400 million tree nursery was being considered for *Jatropha* plantation in 2004. A feasibility study undertaken by Mitsui and Co Ltd (2005) on the possibility of producing bio-diesel oil from *Jatropha curcas* revealed that the project was not viable with an internal rate of return (IRR) of 4.4%, much lower than the opportunity cost of capital (the best alternative use of funds) of 11.5%. However, the project was viable when it was assumed that carbon credits would be earned by the project. Currently, commercial production of *Jatropha* is still banned in South Africa as the potential for the invasiveness of the plant is not clearly known.

In ***Zambia***, 174 000 ha of land is committed to D1 Oils Africa for *Jatropha* plantations. In 2005, D1 Oils Zambia was to start planting 15 000 ha of *Jatropha curcas* in cooperation with the Government of Zambia and Kachumu Community Development Network, an organisation funded by the Government of Zambia to promote rural development in the northern part of the country. The farming projects are based on contract farming whereby D1 Oils provides technical advice, seeds and also guarantees to purchase the crop (Stephenson, 2006).

In ***Zimbabwe***, 30 000 ha of *Jatropha* were to be planted in 2005/2006 (Jepsen, 2006). The Government recommends that *Jatroph*a should be planted on marginal land and non-marginal land should only be used for food production (Benge, 2006).

Finally, in ***Malawi***, D1 Oils has contracted Malawi Biodiesel Association to initiate the planting of *Jatropha curcas*. Land rights amounting to 13 000 ha have been secured for the planting of *Jatropha* through contract farming like in Zambia (Mkoka, 2005).

6. Conclusion

There is an increasing interest in the development of *Jatropha* biofuels in southern Africa. One of the crucial factors influencing the implementation of these projects is their economic viability (Amigun et al., 2006). Our case studies reveal that projects for production of *Jatropha* biodiesel in southern Africa are only financially viable if they earn carbon credits. Since carbon credits are only available till 2012, the long term sustainability of these projects cannot be assured.

Another crucial issue is the need to formulate socio-economic and environmental standards to guide the development of *Jatropha* biofuels in southern Africa. One of the crucial issues is how to reduce conflicts over land-use. It is necessary to use degraded land for the growing of *Jatropha curcas* and leave fertile land for food production. This will partly address concerns about the unsustainability of food-based biofuels due to conflicts in land-use and environmental problems. The use of food-based feedstocks and their land is associated with an increase in food prices and food shortages. However, the growing of *Jatropha* may lead to improved livelihoods due to employment creation associated with the establishment of nurseries and also because of the restoration of degraded lands.

It is also necessary to determine incentives for biofuels production on the extent to which they impact on environmental sustainability. Therefore the view of Sugrue and Douthwaite (2007) that tax breaks and excise duty reductions in South Africa should not apply to food-based bio-ethanol production is supported here since this practice does not promote sustainability. In the opinion of these authors, the energy and climate change benefits gained from using these crops for biofuels is negligible. To accomplish the task of linking incentives to the sustainability of biofuels, it will be necessary to have an idea about life cycle impacts of these fuels on greenhouse gases and energy balances. In such an analysis, all the factors associated with energy production are taken into consideration

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Biodiesel – Key Trends and Innovative Developments

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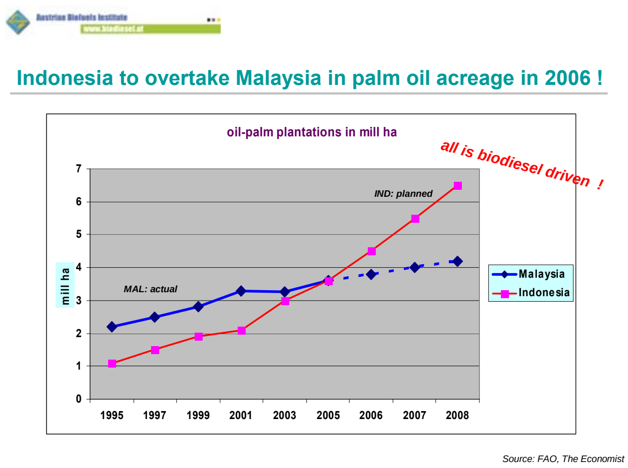
Introduction:

Having started the development of biodiesel in small lab scale pilot plants in 1987 at the Federal Institute for Agricultural Engineering in Wieselburg / Austria and the establishing of the first industrial scale biodiesel production plant in 1992 at Aschach / Austria it took quite some time until biodiesel became accepted as a technically reliable fuel for the modern diesel engine. One key element in market acceptance was the development of a European biodiesel fuel standard EN 14214 as a basis for quality assurance, which lead to acceptance of biodiesel as a reliable fuel by the diesel engine and fuel injection equipment industry.

Present development:

Supported by adequate legislation within the European Union biodiesel was able to gain broader acceptance and market share. Triggered by the promising production and usage development in the European Union as well as by rising crude oil prices other countries realised the business opportunities and started to develop a national biodiesel industry as well. This development has however reached today an unexpected strong accelerating momentum all over the world, specifically in e.g. Southeast Asia (Malaysia, Indonesia, Singapore, China), in North and South America (Brazil, Argentina, USA,) and Southeast Europe (Romania, Serbia), where challenging expansion plans can be observed: e.g. by 2010 Malaysia wants to capture 10 % of the global biodiesel market, China intends to reach a 10 % market share by 2010, Indonesia is expanding its oil palm plantation from 3 mill in 2003 to nearly 7 mill ha by 2008:



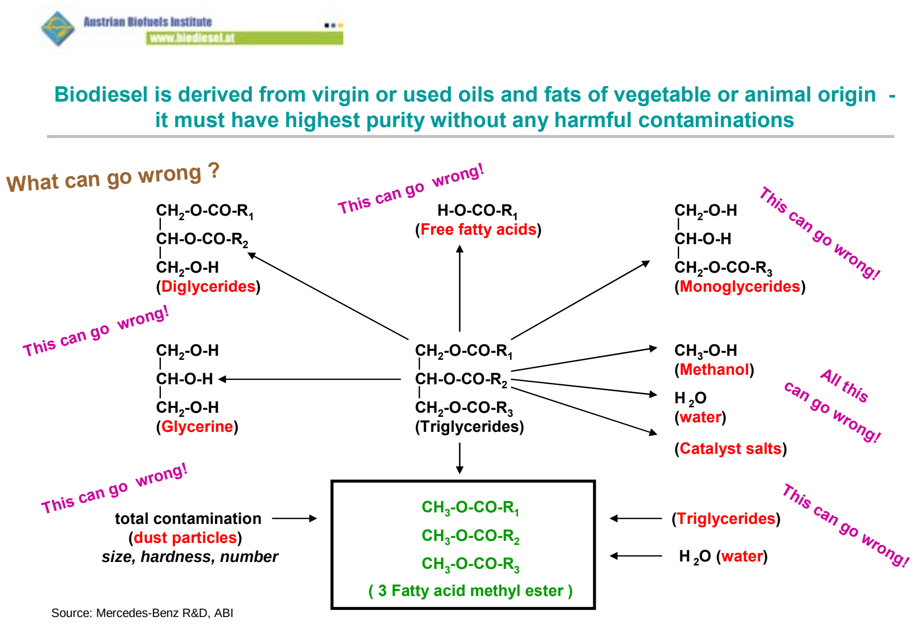
For a solid and sustainable development of biodiesel a few key criteria have to be fulfilled, which are:

1. Producing high quality biodiesel according to well defined standard specifications.
2. Assure supply of suitable and low cost feedstock from a variety of oilseed plants and sources contributing to high quality biodiesel.
3. Select and use a highly efficient and flexible biodiesel production process technology.
4. Select a site for biodiesel production with strong synergistic factors.
5. Identify profitable markets with secured take-off conditions.
6. Use all biodiesel information, which is readily available today.

Investing into a biodiesel production plant and running such an industry according to above mentioned criteria will lead to a solid and sustainable profit and a secured competitive position.

1. Quality assurance:

One has to be aware that during the process of converting a vegetable oil into biodiesel many unwanted reactions and chemical substances can develop as shown below:



As the modern, highly fuel efficient diesel engine has to provide highest performance, while working at challenging low emission levels for e.g. particulate matter (PM), hydrocarbons (HC) and NOx (Nitrous oxide) as demanded by health supporting legislation, the quality for a diesel fuel – regardless whether of fossil or bio origin – must have highest quality, which is defined in Europe by the biodiesel fuel standard EN 14214 in 30 different criteria and limits. It goes without saying that a quality assurance laboratory must be well equipped and the staff well trained.

2. Feedstock suitability, supply and multifeedstock-flexibility:

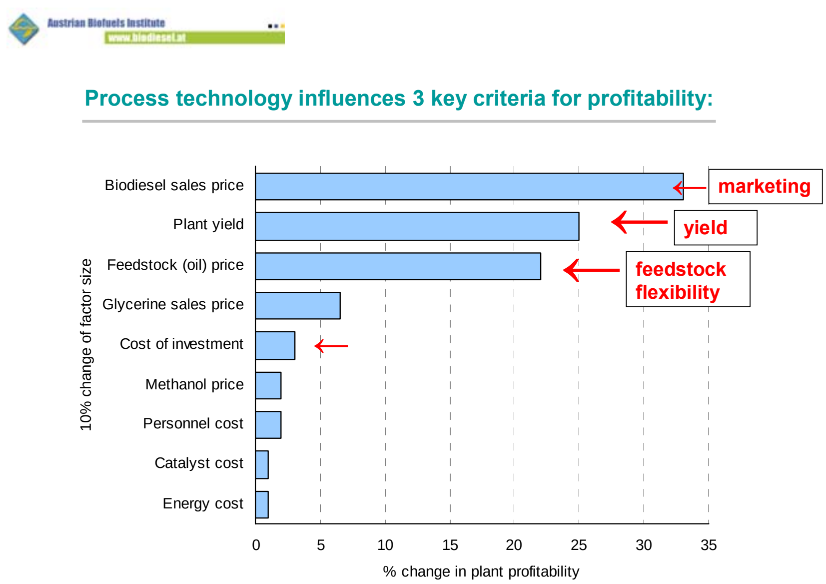
Presently rapeseed oil is the leading feedstock in volume with a high market share within the European Union, while palm oil is the feedstock of choice in Malaysia and Indonesia and soy oil in the traditionally soy growing countries like Brazil and the USA. In a few countries also low cost waste oils from restaurants or animal fats from slaughterhouses are used to a limited extent. It has to be observed however that at the end of the pipe high quality biodiesel according to the EN 14214 standard has to be produced regardless of the kind of feedstock used.

There are also many non-food oilseed crops available like the physic nut (*Jatropha curcas*), which produces a highly suitable oil and which is looking very promising as a crop for planting in semi-arid climatic zones with marginal soils but will need time for further breeding and improvements concerning yield. Coconut oil (e.g. *Cocos nucifera* in African countries, *Acrocomia totai* in Paraguay) can become as well an interesting supply source as biodiesel produced from such oil exhibits smooth combustion behaviour, very high oxidation stability because of the high level of saturation but with slightly lower energy content than the standard food oils.

From a commercial standpoint one should prefer those process technologies and plant designs, which are able to process a number of different oils and fats in a flexible way, thus being able to take advantage of the cheapest but suitable oil on the market at a specific point of time.

3. Select and use a highly efficient and flexible biodiesel production process technology.

As the basic chemical process working at normal pressure and ambient temperature appears to be quite simple, which can be easily reproduced in any chemical laboratory, one can observe the emergence of quite a number of “inventors” of a seemingly new biodiesel process. Usually those “technologies” have weaknesses in reaching the required quality and in reaching required high yield levels, which should not go below 99% of all available triglycerides and free fatty acids in an oil being turned into FAME (Fatty-Acid-Methyl-Ester) or biodiesel.



Above graph shows the sensitivity of a number of factors, which have an influence on profitability. While marketing biodiesel is most important (a 10% biodiesel sales price discount results in a 33% drop in profitability), yield as factor of process efficiency is second in importance as a 10% drop in yield results in a 25% drop in profitability, which mostly disregarded by so called hobby inventors.

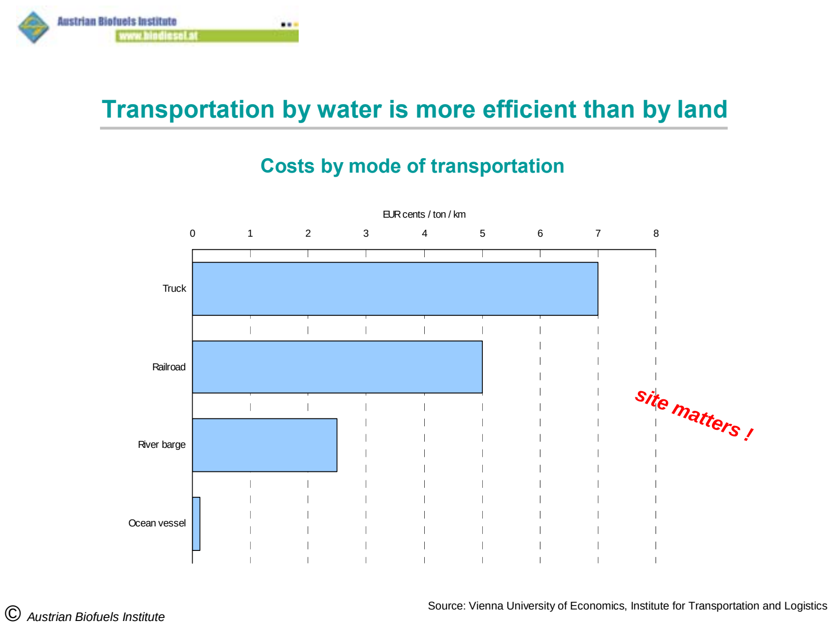
Flexibility in choosing, storing and processing a large variety of different oils and fats and thus being always able to purchase from the cheapest source is third in importance.

The following process technology suppliers as well as engineering companies can be recommended as they all meet the above mentioned criteria:

- AT-Agrartechnik (Germany),
- Axens (France),
- BDI (Austria),
- Christof Group (Austria),
- Desmet Ballestra (Netherlands/Italy),
- Energea (Austria),
- Lurgi (Germany),
- Connemann process as represented by Westfalia (Germany).

4. Site selection.

One additional key factor for profitability in the Biodiesel business is logistics, i.e. transport cost of supplied feedstock from vegetable oil or oilseed suppliers and of Biodiesel to consumer markets. Those products are usually traded worldwide in very large volumes at rather low feedstock price levels. It is therefore not a surprise that deep sea harbour sites have a clear cost advantage both for purchasing oilseeds or vegetable oils in ocean vessel type volumes on the world markets and for selling Biodiesel in large volumes for blending to oil refineries within those harbours (e.g. Rotterdam) transported there ideally by pipeline.



5. Identify profitable markets with secured take-off conditions.

Market conditions may be influenced by national legislation in most of the countries involved, e.g. the Directive on Biofuels of the European Commission requires minimum market shares to be reached by a certain point of time, which is:

- 2 % obligatory market share of biofuels (biodiesel and/or bioethanol) by the year 2005, and
- 5,75 % obligatory market share of biofuels by the year 2010,
- and with a so far not committing vision of 10% market share by the year 2020.

As not all biodiesel is going to be produced within the European Union one can expect that quite a sizeable import business is going to be developed, which can be seen as a business opportunity of countries strong in feedstock production and supply e.g. Malaysia.

6. Use all biodiesel information, which is readily available today.

In contrary to the very beginning of biodiesel there is plenty of well founded information available today, which in most cases can be obtained free of charge. It is therefore recommended to use all those information as much as possible before reinventing the wheel again. Recommended websites:

- European Biodiesel Board - http://www.ebb-eu.org
- Union zur Förderung von Öl- und Proteinpflanzen - http://www.ufop.de/english_news.php
- National Biodiesel Board / USA - http://www.nbb.org

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Sustainable Charcoal and Wood Energy Production

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EXECUTIVE SUMMARY

The aim of this survey and report is to provide information for policy makers in order to help them make informed decisions about the charcoal industry. The ‘*National Charcoal Survey of Kenya*’ was a major undertaking by private, government agency and civil society, which set out to find out more about the charcoal industry. The survey was particularly concerned to address social economy and livelihood issues, as well as providing an up-to-date information baseline to stimulate dialogue around charcoal policy and any associated legal, regulatory and institutional changes.

The charcoal industry involves a commodity that is illegally produced throughout Kenya, and yet is a major contributor to the informal socio-economy. Charcoal production is affecting Kenya’s environment either through the felling of trees from protected forests, or as a by-product of land clearance for settlement, pasture or agriculture. This is causing biodiversity loss, soil erosion, the depletion of water catchment areas, and is resulting in increased greenhouse gas emissions.

Charcoal ban still ineffective

Until now, a blanket ban on charcoal production has not worked. Charcoal production still takes place in spite of the ban, and this current ‘illegal’ status has driven production underground, contributing towards corruption, makeshift and inefficient production methods, marginalisation of producers and little or no resources being put into replanting and agro forestry.

Sustainable production of charcoal is currently stifled due to unsupportive policies and a contradictory legislative environment. Cleaner alternatives to charcoal (Liquid Petroleum Gas-LPG or briquettes) are not only in short supply, but are also unlikely to fulfil the energy demands of low-income households. Given Kenya’s significant dependence on charcoal, the industry’s lack of regulation is of concern, especially where unchecked harvesting could lead to a deficit of affordable charcoal in the future. Furthermore, the charcoal industry is a significant source of income and an important livelihood activity for many poor people throughout Kenya, and thus needs to be addressed at policy level.

This survey and the resulting report sets to find out what is really happening in the industry today in order to inform serious policy recommendations.

Main findings

The main findings from this survey are as follows:

- There are 200,000 producers operating in Kenya, and around half a million people (producers, transporters and vendors) involved directly in the charcoal trade (around half of these on a full time basis) who support around 2.5 million dependents.
- The amount of charcoal produced each year in Kenya is 1.6 million tones. This is equivalent (by weight) to a third of Kenya's sugar cane production.
- The annual income from charcoal is around Kshs. 32 billion, almost equivalent to the income generated from Kenya's tea industry. This represents lost revenue of Kshs 5.1 billion that could be invested into making the industry sustainable.
- Average gross incomes generated from charcoal are Kshs. 4,496 per month for producers, Kshs. 11,298 for transporters and Kshs. 7,503 for vendors. Charcoal is produced from trees obtained from a producer's own farm (44%), private land (38%), Government or County Council Land (13%) and communal land (5%). On average, more trees were removed from government forests in those districts neighbouring protected forests such as Nakuru, Kakamega, Nyeri and Trans Nzoia. Charcoal producers taking trees from Government forests ('Sneak and Snip' producers[2]) tend to create charcoal in the most environmentally destructive way. Producers using branches from trees on their own land ('Sow and Reap' producers) tend to create charcoal in the most environmentally sensitive way. Producers making charcoal as a by-product of land clearance for settlement, pasture or agriculture ('Salvage' producers) are also environmentally destructive on a large scale.
- More than half of the producers interviewed are finding that their preferred tree (Acacia for making charcoal is becoming scarce.
- Over 90% of charcoal producers are using inefficient, traditional earth kilns with recovery rates of as low as 10%
- The average cost of a mature, whole tree to a charcoal producer is Kshs. 583, as little as the price of a telephone scratch card (this is frequently obtained for 'free' in return for labour).
- 20% of producers and vendors cited corruption as the main problem that they face in the trade.
- 27% of all charcoal workers have found that their business has been directly affected by HIV/AIDS.

[2] See chapter 4 on types of charcoal producers

Summary of findings

Economics

Key Economic Survey Findings

- Number of charcoal producers 200,000
- Number of people involved in the charcoal trade 0.5 million
- Number of people supported by the charcoal trade 2.5 million
- Total number of people supported or involved in charcoal 3 million
- Amount of charcoal produced annually 1.6 million tones
- Annual total income from charcoal KShs 32 billion
- Annual lost revenue for investment in sustainability KShs 5.1 billion
- Average gross monthly income from charcoal
  - For producers KShs 4,496
  - For transporters KShs 11,298
  - For vendors KShs 7,503

Environment

Key Environmental Survey Findings

- Charcoal is produced from trees obtained from a number of land tenure systems namely:
  - Own farm 44%
  - Private land 38%
  - Government or County Council Land 13%
  - Communal land 5%
- On average, more trees were removed from government forests in those districts neighbouring protected forests such as Nakuru, Kakamega, Nyeri and Trans Nzoia. These trees are acquired illegally.
- Charcoal producers taking trees from Government forests tend to make charcoal in the most environmentally destructive way.
- Charcoal producers using branches from trees on their own land tend to create charcoal in the most environmentally sensitive way.
- Percentage of producers who found their preferred tree scarce 54%
- Percentage of producers using inefficient, traditional earth kilns 99%
- Average cost of a mature, whole tree to a charcoal producer KShs 583

Social

Key Social Survey Findings

Education: Most people in the charcoal industry have attained some level of formal education. Over half (56%) have attended primary school, 31% have attained secondary school while 10% have no formal education.

Dependants: The charcoal industry helps support 2.5 million people dependent on charcoal traders.

A charcoal trader's average spend on

- Clothes per year KShs 2,700
- Medicines per year KShs 1,800
- Education per year KShs 8,500
- Food per month KShs 2,400

HIV/AIDS: As in the rest of Kenya HIV/AIDS has directly affected 27% of charcoal traders.

Main Recommendations

The main recommendations stemming from this survey are:

- Channelling of potential taxation and revenue collection from legalised charcoal production into the creation of a more sustainable industry.
- Packaging and marketing of sustainable charcoal to differentiate it from illegal charcoal production.
- Allocation of land for sustainable charcoal production.
- Introduction of 'Buffer zones' where sustainable charcoal production can be practiced in areas bordering protected ecozones to check human wildlife conflicts
- Better regulations and guidance on land-use, especially where changes in land-use are taking place
- Addressing the unchecked harvesting of trees without replacement
- Addressing inefficiencies in charcoal production
- Complete banning of 'Sneak and Snip' production from Government and County Council forests
- Support for 'Sow and Reap' producers[3],
- Support for fuel substitution and production away from charcoal and towards cleaner forms of affordable energy.
- Organisation of charcoal workers into associations or cooperatives.
- Training of charcoal workers to widen their skills

[3] **Sow and Reap** charcoal production is carried out on individual farms whereby producers plant trees and selectively cut or prune them to make charcoal.

- Outline standards and guidelines for the production of sustainable charcoal, as well as simple licensing procedures.
- Set up a tough Wood Fuel overseeing and auditing body to organise the shift towards sustainable production and enforcement of regulations.
- Set up a Sustainable Wood Fuel Fund or Levy.
- Recognise charcoal associations
- Encourage pilot projects to demonstrate that sustainable charcoal production can be practised.

Conclusions

The next steps that need to be taken towards the creation of a sustainable and pro-poor charcoal industry include:

- Recognition by the Government that the charcoal industry is going to change through making a start at creating the right policy environment for it to become sustainable and properly regulated.
- Put in place pilot projects or zones of sustainable charcoal production to test what really works on the ground and to inform future legislation and functional management models that have representation at the national and district level.
- Work in detail on those standards and guidelines that would be needed for sustainable charcoal production, tree nurseries and planting.
- Work on participatory forms of regulation that can be practically enforced by communities, including the mechanisms through which a levy towards a Sustainability Fund might work at the community level.

Change is possible

Tackling the charcoal trade and bringing it into the formal regulated economy seems an impossible task. Yet, this is exactly what has been achieved successfully in Sudan *(Forest Department 2004).* The Kenyan Government has shown it is able to tackle difficult issues such as free primary education and *matatu*[4] reforms, surely charcoal could be tackled too.

Regulation for sustainability

Some fear that regulating and legalising the charcoal industry is tantamount to providing producers with a free-for-all ticket to burn any tree for charcoal. However, with the commitment and proper enforcement the industry could be made more sustainable by properly cracking down on producers taking trees from protected forests, on the one hand, and training and encouraging sustainable production and replanting on the other.

The charcoal trade, its people, its environmental impact, and its contribution to the Kenyan economy have been ignored for too long. Now is the time to use the ‘*National Charcoal Survey of Kenya’* to review the situation and then make informed changes, towards a sustainable form of charcoal production, rather than the messy, disorganised and environmentally degrading form of production that exists in Kenya today.

[4] Transport sector reforms

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The Potential of Sweet Sorghum as Source of Fermentable Sugars

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Abstract

This study was undertaken to assess the potential of sweet sorghum as a source of fermentable carbohydrates that can serve as primary substrates in ethanol production. Against this background, a comparative analysis of non-structural carbohydrate amounts in mature stems of sugarcane and in mature stems of several local accessions of sweet sorghum was carried out. Sucrose was the predominant sugar in the mature stems of both sweet sorghum and sugarcane. However, the overall carbohydrate profiles of sweet sorghum were markedly different from those of sugarcane. In sweet sorghum, sucrose was the major non-structural carbohydrate in the younger internodes (uppermost parts of the stem) whereas the amounts of sucrose were relatively uniform in the sugarcane stem. Hexose sugars in the stems of sweet sorghum were more than those in the sugarcane stem by up to five orders of magnitude and they were predominantly concentrated in older internodes. Unlike sugarcane, sweet sorghum also accumulates starch in the stem as well as in the seeds. This demonstrates the renewable energy resource potential of sweet sorghum. Even though non-structural carbohydrates accumulate in both sugarcane and sweet sorghum stems, carbohydrate metabolism is different between these crops. Nonetheless, data for sweet sorghum clearly demonstrates the potential of this crop as a source of fermentable substrates for industrial use such as ethanol production. However, further studies on control of carbon partitioning in sweet sorghum are warranted. These could provide a better understanding of the implications of such partitioning on fermentable substrate yield in this crop.

Keywords: Hexose sugars, non-structural carbohydrates, sucrose, fermentable substrates, renewable energy

INTRODUCTION

The current world-wide interest in sustainable production of energy using renewable resources is providing an opportunity for agro-industrial development in many parts of the world. Production of biofuels (bioethanol and biodiesel) features prominently in this scenario and of these, bioethanol is more attractive since the demand for it is projected to increase more rapidly (Amaducci et al, 2004). Bioethanol accounts for a significant part (90%) of the total biofuel production in the world. Production of this commodity requires fermentable substrates (Woods, 2001). Agricultural crops such as maize, sugarcane and or its byproducts are the traditional sources of fermentable substrates for ethanol production.

However, production of sugarcane and maize require high input of water (Reddy et al, 2005). Sweet sorghum has high water use efficiency (Unlu and Steduto, 2000) and it also accumulates sweet juice in the stem at maturity. In view of the above, alternative sources of substrates for bioethanol production are sought, especially in semi arid regions where rainfall is low and erratic. Sweet sorghum (*Sorghum bicolor* (L.) Moech), is a crop that is tolerant to a wide range of climatic conditions (Reddy et al, 2005) and it is often grown with success in the hot and drought-prone areas that receive low rainfall (Figure 1). This is because sweet sorghum has high water use efficiency.

In spite of these facts, sweet sorghum remains a minor agricultural crop even in semi arid regions like Botswana. It is often grown in mixed cropping with other crops even under conditions where no other crop can do better. This underscores the need for research into the agro-industrial potential of this crop. The increasing in the demand for biofuels in the largest markets of the world presents a strong incentive for identification and development of biofuel feedstock crops even in developing countries. Sweet sorghum is particularly attractive because it is a low input crop that can benefit the small farmer.

Figure 1: Sweet sorghum in a field

This study was therefore undertaken to determine levels of fermentable carbohydrates in some of the accessions of sweet sorghum present in Botswana. Information derived could have a significant impact on the agro-industrial development of this crop and the concomitant improvement of the socio-economic situation of the farming communities of Botswana.

MATERIALS AND METHODS

Plants

All experiments were conducted with samples from 5 months old sweet sorghum plants that had been grown under rain-fed conditions for (with approximately 350 mm of rainfall during the season). The sugarcane samples were from a sugarcane crop that had been grown under normal sugarcane agronomy practices for 14 months.

Chemicals

Analytical reagent grade chemicals were purchased from Sigma Chemical Company, South Africa. Enzymes were from Roche Products, South Africa. Water was de-ionised unless otherwise stated.

Methods - Sampling and assay of non-structural carbohydrates

Samples from the top, middle, and bottom internodes of stems from mature 5 months old plants of each sweet sorghum accession were used. The plants used were randomly chosen from the field. Mature (15 months old) sugarcane stems were included as a positive control. Cross-sectional tissue samples (0.6 g to 1.5 g) without rind were obtained from the central region of each internode. The boiling 80% (v/v) aqueous ethanol method was used to kill tissue and extract soluble sugars. Amounts of non-structural carbohydrates in the samples were determined as described by Fondy et al. (1989).

RESULTS AND DISCUSSION

This study was undertaken to evaluate the potential of sweet sorghum as a source of fermentable substrates for industrial usage. To this end, a comparative analysis of the amounts of non-structural carbohydrates in the stems of some local accessions of sweet sorghum was carried out. For comparison, an analysis of the same products was also carried out in mature sugarcane stems. Sucrose amounts were first to be determined. The results (Figure 2) show a clear segregation of the accessions of sweet sorghum in terms of sucrose accumulation.

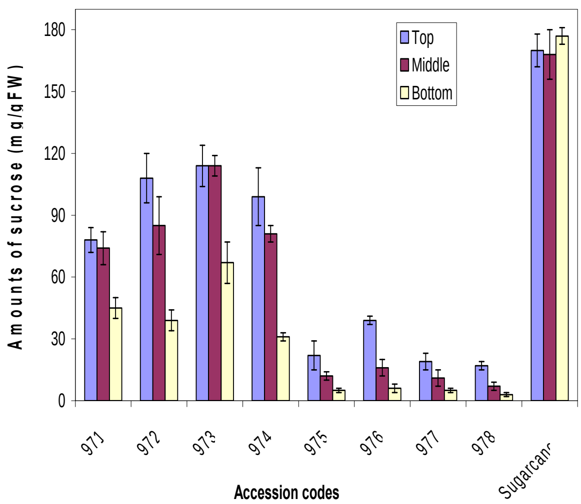

Figure 2 : Comparative amounts of sucrose in different accessions of sweet sorghum and in sugarcane (n = 3)

The best sucrose accumulators in sweet sorghum contained 11% (w/w) sucrose in the top internodes. This compares favourably with 17% (w/w) sucrose in the top internodes of sugarcane. However, the distribution of sucrose in sweet sorghum differed markedly from that of sugarcane (Figure 2).

The difference in the distribution of sucrose in mature stems of sweet sorghum and sugarcane may be indicative of differences in carbohydrate metabolism between these species. To test this hypothesis, the relative amounts of fructose and glucose were also assayed in the same samples used for assaying sucrose. These hexose sugars are readily fermentable and their quantification is pertinent to the aim of this study. The results (Figures 3 and 4) show that sweet sorghum contains appreciable amounts of fructose and glucose in their stems at maturity.

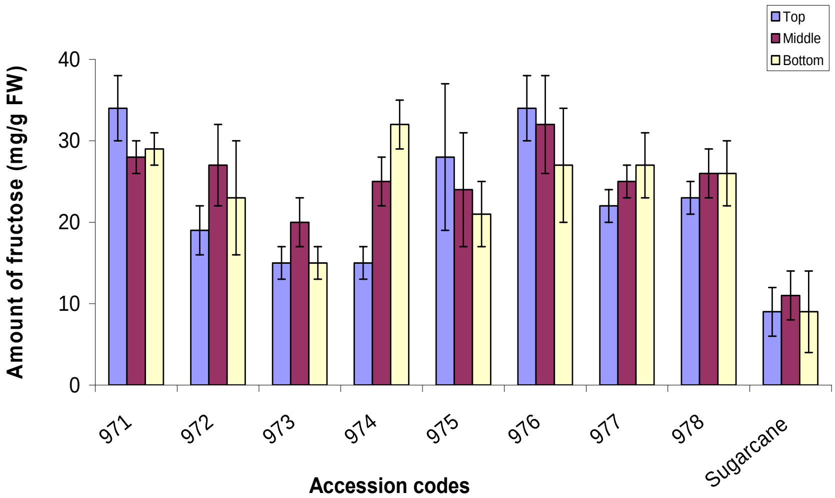

Figure 3: Comparative amounts of fructose in different accessions of sweet sorghum and in sugarcane (n=3)

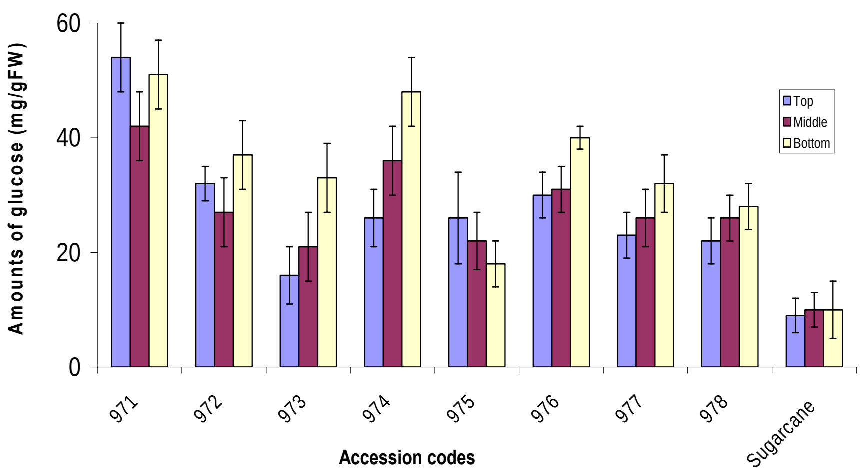

Figure 4: Comparative amounts of glucose in different accessions of sweet sorghum and in sugarcane (n = 3)

In contrast, sugarcane has lower amounts of these sugars in the stem at maturity. In sweet sorghum, higher amounts of fructose and glucose were predominantly found in older (bottom) internodes of whereas sugarcane stems had relatively uniform amounts of these sugars throughout the stems. In addition, sweet sorghum had higher amounts of glucose than those of fructose in all samples. This observation, together with the distribution patterns of these sugars in sweet sorghum, suggests that there may be some hydrolysis of sucrose and an α-glucan in older internodes of sweet sorghum.

Since starch is a widespread α-glucan in the plant kingdom, starch was assayed in the same tissue samples used for soluble sugar extraction and assay.

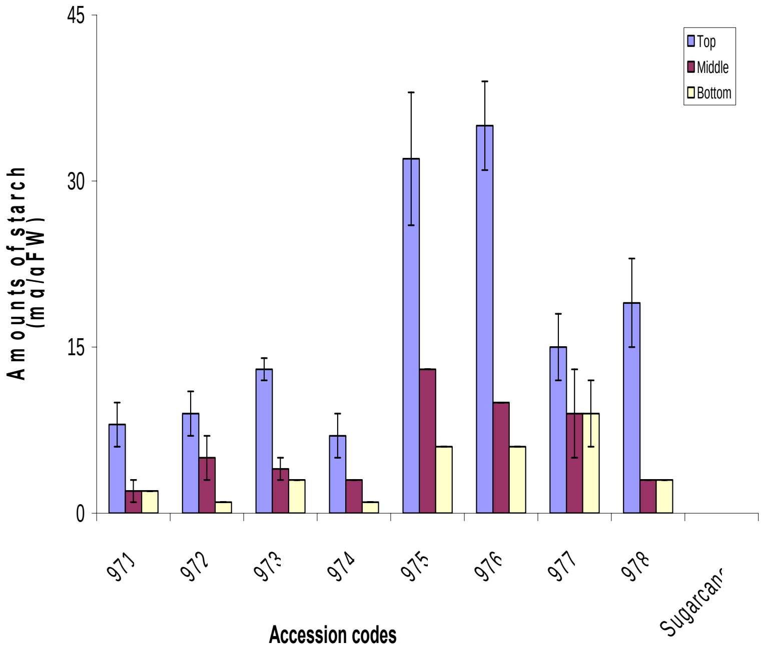

Figure 5: Comparative amounts of starch in the stems of different accessions of sweet sorghum (n=3)

The results in figure 5 prove that sweet sorghum accumulates starch in the stem and they also lend support to the hypothesis that both starch and sucrose get hydrolysed in older internodes of sweet sorghum. Regardless of the latter, the results presented here clearly demonstrate that sweet sorghum is a good source of fermentable substrates that can be successfully grown in semi-arid climates. This is more so because of the low water demand and the short growth period (4-5 months to reach mature) of sweet sorghum. Two crops of sweet sorghum can be produced in a12 months period and the yields would be comparatively higher than those of sugarcane over the same period. Production of sweet sorghum as a bioethanol feedstock would not pose a threat to food security especially in developing countries where this is a major concern

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Sustainability Assurance Standards and Certification Schemes – Considerations on Biomass Trading

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Abstract:

The rising demand on biofuels mainly in Europe and the United States has increased concerns about their sustainability of production. Several initiatives, based mainly in Europe, are developing standard schemes as a means of ensuring the sustainability of environmental and social criteria for both producers and users. This paper presents an overview of these schemes and how they intend to promote sustainability and training to prevent negative social, economic and environmental impacts. Illustrative examples are provided, such as the recent “tortilla crisis” in Mexico in January 2007.

1. Introduction

Since the mid-1990s there has been a growing interest worldwide in alternative transport fuels, with ethanol and biodiesel emerging as perhaps the most promising options. This interest has been driven by different concerns, ranging from energy security, rural development through to climate change and the Kyoto Protocol agreements. This has also widened the feedstock market, drawing attention to alternative energy uses and different elements of the biofuels supply chain (including resources used, the technologies employed and constraints on the world market). However, the feedstock remains the principal cost determinant and the primary limitation to the supply of biofuels (Worldwatch Institute, 2006).

The main renewable transport fuels expected to be available in the EU market to 2010 are biodiesel (from oil crops and wastes, rapeseed, sunflower, soybean, palm oil, jatropha, waste vegetable oil, waste animal fats) and ethanol (from starch and sugar crops of wheat grain, sugar beet, sugar cane, sorghum, maize). Although biofuels have been in use in the EU since the EU Directive on Biofuels (Directive 2003/30/EC) came into force, there has been a growing concern over the availability of resources and the increasing demand for energy crops to produce them.

The EU Commission for Agriculture (DGAgri, 2007) indicated that it will require 18 Mha of agricultural land to meet the demand using first generation biofuels to supply the Biofuels Directive's target of 5.75% of the transport sector's energy by 2010. Thus, internal land constraints mean that in order to achieve the Directive's target, it will be necessary to have a mixture of imported and locally derived biofuels as well as more research in biofuels produced form lingo cellulosic products, or the so called 'second generation'. The imported increment is expected to come mainly from sugar cane, soy bean/oil, palm oil, rape seed/oil, and wood products.

2. Current sustainability schemes

The increasing market demand for biofuels, has raised the need for a certification system for biofuels. According to the World Wildlife Foundation, a certification system in Europe in eco-certification of biofuels is needed, not only for those produced within the region, but also for those imported (WWF, 2006).

Initiatives are currently being undertaken in the UK through the Renewable Transport Fuel Obligation (RTFO), whilst in the Netherlands (ETFS, 2006) and in Germany (Fritsche, et al., 2006) working is being undertaken to develop a certification system to ensure sustainable production and use of biofuels. Other applicable environmental standards have already been reviewed by the ECCM (ECCM, 2006), Junginger (2006) and Lewandowski & Faaij (2006). Other important initiatives to develop assurance schemes are the Roundtable on Sustainable Palm Oil (RSPO, 2005), Roundtable on responsible Soya (RTRS, 2007) and, more recently, the Global Roundtable on Sustainable Biofuels (EPFL, 2007). Figure 1 shows the main biofuel regions by energy crops and available certification and standard systems.

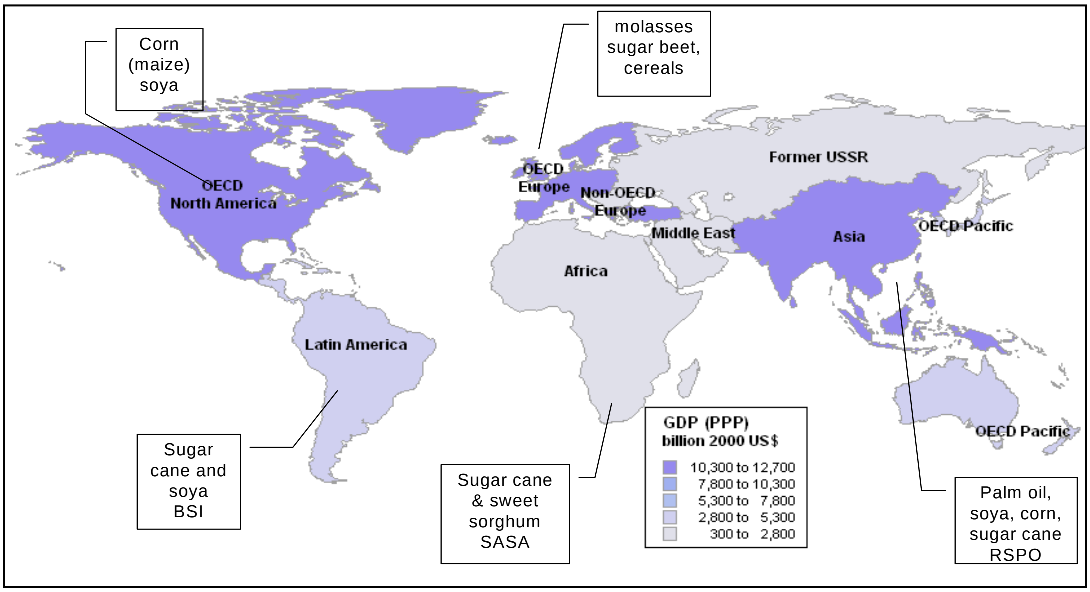

Fig 1: Biofuel regions by energy crops and available assurance schemes (Modified from IEA, 2003).[BSI Basel Criteria; SASA South African Sugar Association; RSPO Round Table on Sustainable Palm Oil].

The main three systems developed in Europe (UK, The Netherlands and Germany) emphasise environmental and social criteria. Currently, the Low Carbon Vehicle Partnership (LowCVP) is developing a scheme based on a meta-standard that allows the use of available schemes to certify biofuel production (Ecofys, 2007). The criteria employed are:

1. Carbon storage [stocks]
2. Biodiversity
3. Soil quality
4. Water quality and quantity
5. Air pollution
6. Compliance with Applicable law (social issues)
7. Contracts and subcontracters
8. Freedom of association and right to collective bargain
9. Working hours
10. Child labour
11. Health and safety
12. Wages/compensation
13. Discrimination
14. Forced labour
15. Land right issues

Additionally, a green house gas (GHG) reporting system will be implemented in order to award Renewable Transport Fuel Certificates (RTFCs) to supplied to the UK market, based on the calculation of the carbon intensity of biofuels which, among other factors, includes land use change (E4Tech, 2007).

3. Trading biomass for biofuels

The main issue surrounding sustainability assurance schemes is that environmental and social criteria are employed for the production of biofuels but without consideration of trading. The World Trade Organisation (WTO) does not currently have a specific position on biofuels. However, a recent report by the International Policy Council in collaboration with the Renewable Energy and International Law (2006), explored how WTO rules could potentially be applied to biofuels. The authors speculate how the WTO might view biofuels standards using three different scenarios:

i) addressing the environmental impact of biofuels in importing country
ii) looking to the net effects of a particular fuel on carbon emissions throughout its entire life-cycle
iii) going beyond carbon emissions to promote sustainable agriculture in the country producing the feedstock for the biofuel.

These three scenarios, and the possible WTO interpretations of each highlight the need to draft and enforce standards that are equally applied to domestic and imported goods. Ideally, regulations for imported feedstocks or biofuels should be as rigorous as those for production in the EU, although strict enforcement on imported biofuels may not be politically feasible. Nonetheless, agreeable protocols are required, given the scrutiny that will be given to the environmental sustainability of imported biofuels.

A report from WIP (2007) to the EU DGAgri on certification aspects related to the promotion of the use of biofuels in the European Union (under review) considers that mandatory measures run a higher potential risk of infringing trade laws because this would might appear an arbitrary or unjustifiable discrimination. There are various approaches to address this issue which will allow for the creation of a certification scheme which abides by WTO regulations (Table 1) (WIP, 2007).

Table 1. General issues considering challenge or compliance with international trade rules (WIP, 2007).

No consideration →		← Clear consideration
CHALLENGE	1. Specify that there will be no discrimination between imported and domestic biomass/biofuel 2. The methodology should be science-based, manageable and transparent 3. Flexibility, system and criteria have to evolve continuously, taking into account the specific situation of trade partner 4. International consultation, mutual, multilateral, stakeholders should be sought 5. Integrate the negotiations into Clean Development Mechanisms (CDM)	COMPLIANCE

Other issues regarding the applicability of the different assurance schemes need also to be taken into account, such as the supply chain, the participation of different stakeholders, the different technologies according to geographic situation, local regulations and markets, as well as social and environmental local conditions.

4. Impacts of biofuels

The growing use of biofuels in Europe and the USA has been giving rise to concerns about environmental and social issues, such as, actual carbon savings, fuel versus food, deforestation and lost of biodiversity among others.

One of the most recent examples of such concerns is the supposed effect of the USA bioethanol production on the tortilla prices in Mexico. Since the price increase in early 2007, this has been publicised as providing a clear example of the negative effects biofuels on the substitution of crops from food to supply a fuel market. Yet, although this is one of the major concerns in sustainability assessment (as seen in the previous section), a better understanding of the situation in Mexico requires an examination of a fuller picture.

Currently, the United States is the major producer and exporter of maize, producing 295 millions of tons of maize/year. From these, approximately 35 million tons are dedicated to the production of ethanol. The country has at present 74 ethanol plants and 15 are under construction (UNAM, 2007).

Mexico is considered to be the genetic origin of maize with over 50 subspecies and varieties. The current cost of maize is $3,500 MX/ton 2007 ($ 2916 USD) while in 2006 the cost of production was of $1,700 - $2,000 MX/ton ($1400 - $1600 USD/ton). Mexico consumes 39 million tons of maize per year, mainly the white variety which is for human consumption, and approximately 21.3 million tons of maize are produced per year. The yellow variety is used mainly for feedstock (fig 2). Therefore, the deficit of 17.7 millions tons is imported from USA (Paredes, 2007).

Fig. 2.: Maize white and yellow varieties.

In January 10 2007 the price of the tortilla reached $20 MX/kilo ($1.67 USD) in different regions in the country, affecting nearly 19 million of poor in urban areas and nearly 70 million consumers in the country including the middle class. The previous price of tortilla was around $6.00 MX/kilo ($0.50 USD) (La Jornada, 2007).

The main reason was attributed to the use of maize to produce ethanol in the USA and the reduction of exports to Mexico. Nevertheless, the situation was not simply one of a lack of imports but combination of factors, among them: the monopoly and speculation with white maize in Mexico; the increment in the production inputs, including transport and grain storage, diesel, petrol and electricity prices; and the increment in the global market prices of maize (Hernandez, 2007).

Additionally, some historical factors have also to be considered. These go back to the 1970's, when the policy on agriculture changed globally due to the Green Revolution. The first "war of tortillas" started during two previous government terms in the 1990s, where a national monopoly for corn flour was "allowed" and whose value is 9 thousand millions USD, corresponding to approximately 70 - 80 % of the national tortilla market. The subsidies to tortilla that held the price for many years and were suddenly removed, the subsidies to the national agriculture compared to the subsidies received in Canada and the USA, resulted from the NAFTA agreement which left national farmers (*campesinos*) without protection.

As further important issue related to environmental effects, transnational companies put pressure producers and government to use genetically modified maize (seeds) for better production, even though in Mexico there are over 50 subspecies and varieties, as previously mentioned. Finally, a new government took office in Mexico in December 1st 2006, after the elect President Gustavo Calderon started his presidential term under political pressure as a the result of the elections in 2006.

The cost of tortilla was mutually agreed and set by Mr Calderon and the tortilla manufacturers, associations and producers in $8.50 MX/kg ($0.70 USD) to remain in force until August 2007, being scheduled for review after that date.

5. Conclusions

Environmental, social and economic issues must be considered in the production and use of ethanol and biofuels in general. A standard assurance or certification system must be implanted to avoid future problems regarding the sustainability of production and use. A scheme is currently under design at different levels in the EU considering local issues and participation in the process. (stakeholders).

Biofuels production may be seen as an additional form to help reduce poverty in developing countries instead of a trade barrier. The main problems with certification or standard assurance lay within implementation, additional costs, audit and compliance.

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The necessity of Legal Frameworks and Government Guidelines for the Production of Energy Crops in Africa

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1. Introduction

Ladies and gentlemen, it is an honor and a sincere pleasure that I have been given the opportunity to share with you some thoughts about positive aspects but also problems involved in the production of energy crop and how to possibly deal with them.

The term Energy Crop has become quite popular in recent years in particular due to its link to climatic changes. Although we may not be solely responsible for these changes it is by now widely acknowledged that we contribute considerably towards it particularly due to the intensive use of fossil fuel. Energy crops have inter alia the potential of providing environmentally friendly energy and to reduce harmful emissions. And with the increasing awareness of our growing environmental and climatic problems environmentally friendly energy has moved closer to the center of attention.

But energy crops also have other properties that can directly help to improve living conditions and stimulate economic developments, which is of particular importance for developing countries.

However, the production of energy crops can also have negative side effects or may even lead to detrimental developments impeding the results aimed at. It may even cause bigger problems, compared to the positive contributions achieved. The deforestation of the rain forests for the sake of producing the raw materials for environmentally friendly fuel or fuel additives and the positive effect of using such a environmentally friendly fuel does not even come near to the devastating effects of the destruction of rain forests.

The cause of such counterproductive activities is initially the necessity to generate some income. But as soon as markets develop, greed for profit starts to dictate actions. And as we know, profit is a magical word, by which other aspects of importance are often discarded.

Another problem is the time factor. To counteract the negative effects on environment and climate requires well considered planning. The less time is available for decisions the more pressure builds up and the more hastily they are taken. Consequently they often lack a thorough and comprehensive basis.

We know that it has become a matter of urgency to respond to the ongoing environmental damages and climatic changes caused by our energy management. But the energy management as well as climatic changes are part of a complex system which did not emerge suddenly but came as the result of a development over many decades. An appropriate reaction would be a counter movement allowing lasting alternatives to develop without causing new hazards to systems that have proven their load bearing capacity.

The increasing awareness of environmental and climatic problems tends to lead to an overreaction in an attempt to solve them. But we should be aware of our limited ability to tune into the complex ecological balance, despite our scientific and technological progress. With regard to nature we cause in many instances problems ourselves and aggravate these problems by trying in a disproportionate way to correct them thereafter. Certainly, some decisions ought to be taken swiftly to stop the ongoing production and emission of harmful substances. But the saying also goes that each wound needs time to heal.

The internationally well known and recognized meteorologist and climatologist Prof. Graßl explained that climatic changes become noticeable to us approx. 20 years after the causing events have taken place. In other words we are experiencing at present the results of our energy management in 1987. Considering the development of energy consumption during the last 20 years, in particular during the last 5 years, we can imagine what lies ahead of us. There is no doubt that we will have to act promptly.

But the wounds we have inflicted to the environment and climate exist in the form of melting glaciers, that are the freshwater reservoirs for many villages, the melting polar ice causing a rise of sea levels and a global warming. A different ecological balance will develop. It is our responsibility to slow down or perhaps to even stop further negative and harmful contributions toward such developments without producing new ones.

Positive effects and possible wrong turns in the context of producing energy crops and how appropriate guide lines and regulatory frame works could have a stabilizing effect shall occupy us for the next thirty minutes.

2. The various effects with regard to the production of energy crop

Bearing in mind that we are approaching this issue in the context of African and developing countries one can basically determine a two-fold aim:

- Energy crops as a source for the improvement of living conditions including economic developments.
- Energy crops as a source of relief on the environment and on climatic changes

Both aims will have to support each other if a lasting result ought to be expected. It would not satisfy if e.g. energy crop is produced without showing a positive effect on the living conditions of the people and/or their economic situation.

Let us start our brief analysis with the positive aspect, how energy crop can directly improve the living conditions (2.1). Thereafter we will look at possible wrong turns (2.2). In a third section (2.3) we shall deal with the general economic effect. In section four (2.4) we will look at biotopes.

2.1 The positive effect of energy crop on living conditions:

An improvement of the living conditions could be noticeable particularly with people belonging to the lower income groups, i.e. for those living in rural areas, and subsistence farmers. The latter work together in many cases in a group or community and operate on small pieces of land. In some cases they can afford a co-op tractor, in other cases they operate using traditional methods. So far their main objective is to produce food crops either for their own consumption or for sale. Their energy requirements are moderate and mainly concern fuel for cooking, which is mostly fire wood.

These farmers should be encouraged to grow energy crop since it can help to directly improve their living conditions.

- Clean burning fuel for stoves and heating such as pelleted residues after oil extraction can be generated from energy crops. This is particularly significant for reducing health hazards with respect to respiratory diseases. The fog like pall of smoke caused by open fire places operated with wood are a common sight above populated areas in most African countries in the mornings and in the evenings. As a result, millions of people, mainly children and women, suffer from respiratory diseases annually.

- Oil extracted from energy crop, particularly from Canola, can be used as fuel/additive for agricultural machinery, depending on the equipment partly without any further refining processes. The advantage being that the producer of the energy crop becomes less dependent on the fluctuation of the international oil prices.

- After the extraction of oil, the remains can be used as fertilizer, reducing the costs for purchasing fertilizer or improving harvesting results without having to purchase fertilizer. In this regard one would also have to look into the aspect of crop rotation.

- Energy crop remains are also valuable fodder or additives to fodder improving the quality and nutritional value of meat.

- Depending on the type of energy crop the extracted oil can be used for the preparation of food.

- And last but not least any surplus production can be sold to generate some cash income.

- One can see that energy crop has considerable potential to improve living conditions directly and at the same time to provide environmentally friendly energy/fuel. The growing of energy crop by subsistence farmers ought to be therefore supported with appropriate programs.

2.2. Possible wrong turns

However, there is also the possibility of wrong turns in developments, in particular the excessive use of land for the production of energy crops thereby neglecting the production of food crops. This could be triggered off by an increasing demand for energy crop or, to be more precise: for fuel or fuel additives generated from it.

It is certain that fuel from biological sources will not replace the conventional fuel within the foreseeable future since there will be no sufficient land available.

Canola: 3t/ha = 1.500 l fuel/ha
Fuel for transport, aviation. ships etc.

	Barrel x 1.000		l. p.a. x 1.000.000	ha p.a. x 1000	Total area ha x 1000
	day	p.a.			
North America	18.100	6.606.500	1.050.433	700.288	2.157.000
Europe (EU)	11.148	4.069.020	646.974	431.316	1.050.000 432.500
Africa	1.738	634.370	100.806	67.204	3.030.000
China	3.345	1.220.925	194.139	129.426	959.800
World	50.138	18.300.370	2.909.700	1.939.800	

As we can se, it would require the total area of the EU if one would attempt to cover the fuel demand of the EU from energy crop.

Nevertheless, any reduction on CO_2 emissions will be a welcome contribution with regard to slow down climatic changes. Accordingly there are existing international stipulations that a certain percentage of fuel from biological sources has to be added to fuel from fossil sources. And there are preparations and negotiations under way to increase the ratio as well as to invite countries having not yet adopted these stipulations to join. It is by now already almost certain that the EU will have to look at imports of bio-fuels since the areas available will not suffice to cover the needs to meet the stipulated quota from own production. There are already initiatives to produce 200.000t of bio-oil annually in an African country to be exported to the EU. Evidently there is a fast developing market. A market with export chances for countries with large areas of land suitable for agriculture – as we find it in Africa.

Looking at the situation of subsistence farmers in Africa, it has to be assumed that they have neither the knowledge about international markets nor access to it, to sell energy crops.

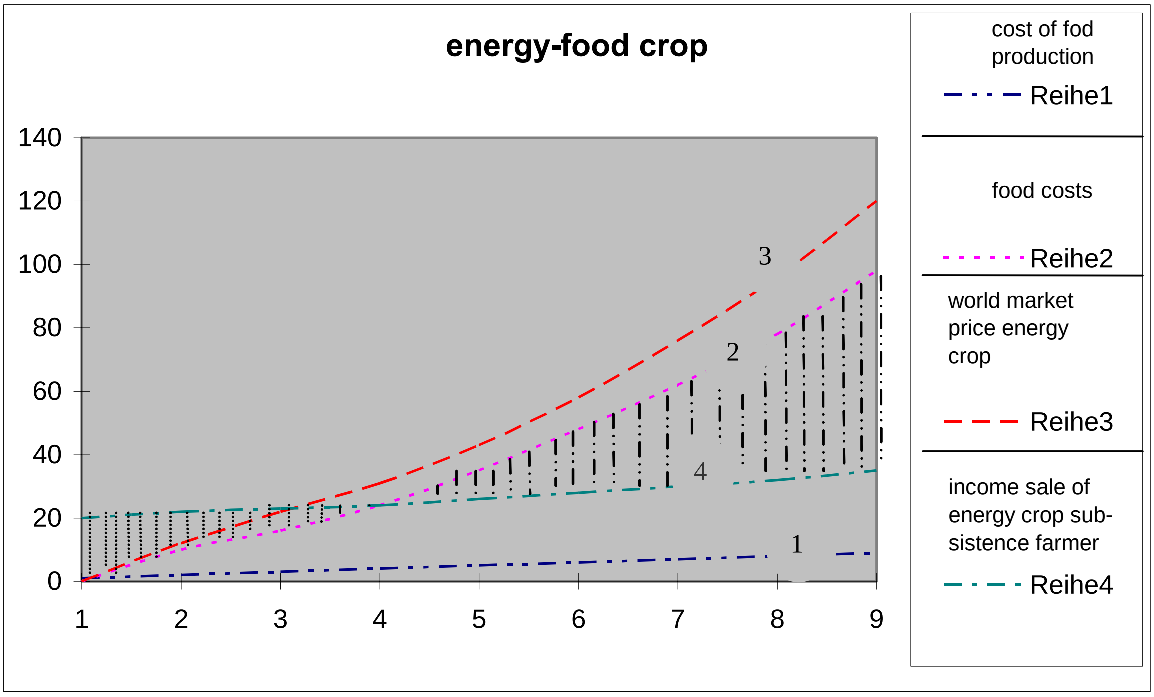
But in developing countries are also people, who have the necessary knowledge and who understand the potential of and growing demand for fuel from energy crop. It can well be expected that they may convince or persuade subsistence farmers or communities to rather grow energy crop instead of food crop in order to obtain a higher cash income. They may argue that the income generated from the sale of energy crop would be considerably higher than the cost of purchasing food, which would otherwise be produced by the farmer.

Agents or bulk buyers would offer their assistance. But it has to be expected that they would try to make a maximum profit themselves. It can thereby not be excluded that this will happen at the expense of the - inexperienced - subsistence farmer. As a result the subsistence farmer would receive only a comparative small part of the sales proceeds.

Even if this would initially exceed the cost of food the possibility of increases in food prices are to be considered, because food basics such as grain, maize, cane etc. are increasingly used for the production of Ethanol. As a result of an increasing demand for these products their price will increase and consequently also the food price.

At present Mexico is experiencing such a development. Many people, particularly from the lower income groups, have problems in buying the maize which they need to prepare their basic national food: Tortillas. The reason being that the USA, the main supplier of maize to Mexico, is now using up to 30% of its maize production for generating Ethanol.

Should the income from the sale of energy crop stay the same or increase only marginally, it may well happen that the subsistence farmer eventually has to pay more for his food than he receives for his energy crop.



The above diagram illustrates how people could become increasingly poorer despite high and rising prices for energy crop. (The data used are purely fictitious.) For the first approx. four years the higher prices for energy crop would give a reasonable profit margin which would allow for the purchase of food rather than to produce food crop themselves. But after four years would be a breakeven point. And thereafter the food prices would continuously exceed the income generated from sale of energy crop. People would become poorer and would find it more and more difficult to finance the costs of their basic food stuffs.

In addition there is a high risk of a solely export orientated production in particular for developing countries which has to be pointed out. The production for export means dependency on the international market. The exporter has only little influence and he will be vulnerable in view of recessions and volatile prices.

Extreme movements can even lead to the collapse of a national economy as was the case with Ivory Coast. It concentrated on the production of cocoa and became one of the largest cocoa producers in the world. Due to high cocoa prices in the 1970ths the country recorded very high revenues and became a glowing example of successful development work. Some years later the world cocoa price collapsed and the Ivory Coast collapsed economically – and socially - as well.

If subsistence farmers would produce energy crop solely for export to the world market, they would be facing a high risk since it has already been predicted that due to limited reserves of crude oil, engines will be revolutionized within the next 35 to 40 years. There are numerous indications from car manufacturers such as Daimler Chrysler, Volkswagen, Toyota, Honda and others but also from other producers of engines for e.g. aero planes that completely new propelling devices will be developed using fuels very much different from today’s.

For long-term developments subsistence farmers in developing countries would be well advised to find a balanced combination for the use of energy crop for local use and export on the one side, and food crop on the other side.

2.3. The general economic effect

The rapidly growing international demand for bio-fuels will call national and international investors on to the plan. And Sub-Sahara Africa will be a prime target for large scale energy crop production due to ample land being available.

Besides the growing export market also the national energy demand will grow, expanding the market for energy crop further. The improvement of living standards in African countries, a growing challenge for the world not only for ethical reasons but also in its own economic and political interest, will inevitably entail a growing demand for energy/fuel. In view of the growing fuel price for fossil fuel any national production of fuel reduces the dependency on international price movements.

Another market of vital importance is the national industry. Over eighty products can be produced industrially from energy crops. The main industrial fields are the chemical industry, building industry, the food-, pharmaceutical- and cosmetic industry and the agricultural industry. Since the industry is the backbone of a modern economy, energy crop can serve as a generator for the important industrial developments. It must therefore be in the interest of any responsible government to support or to even establish the preconditions for such an industrial development. Governmental influence can gradually be decreased as the industry begins to regulate itself.

There is no doubt that ample market opportunities make a large scale production of energy crop an interesting business proposition.

For investors and large scale producers the natural choice of land will be the one with the most promising properties with regard to an “as low as possible input with an as large as possible harvesting result and the lowest possible risk”: easily accessible, good topographic structure, good soil quality and either situated in a good rainfall area or access to water for irrigation. Needless to say that these are also the same land qualities required for optimal food crop realization.

Once again, there is rivalry between food crop and energy crop. Again we have the question of proportionate use of land and under what conditions balanced use can be expected. We can also ask the question as follows: can balanced use be expected if it is left to customary market mechanisms or will some regulatory framework be required?

The main market force is profit. Large scale producers may be international or national investors whose target is the highest possible return. The criteria for this have been set out above. It is predictable that energy crop will be more profitable for the foreseeable future than food crop, and investors will look for the most attractive land. Therefore it has to be expected that large scale production of energy crops might dominate the food crop production and occupy the most attractive land which will consequently be lost for food crop production.

A further consequence is, the cost of producing food crop on inferior land will increase and/or the food supply of the population will suffer. To avoid such negative developments it will be necessary to be able to exercise the necessary guidance and control based on efficient regulatory frameworks.

2.4 The possible effect on biotopes.

The aforesaid applies in a similar way also to biotopes. Should such land be suitable for energy crop it will be cleared to make space for energy crops. This is not just a possibility but has already occurred in e.g. the Philippines and Indonesia and other countries for years. Every year thousands of hectares of rain forest are cleared. The damages caused to the environment being further contributions toward climatic changes is far worse than the relatively small positive effect of producing environmentally friendly fuel or fuel additives.

Once cleared the jungle, will never be re-established and the damage caused will be final. It also has to be noted that in many cases the clearing of biotopes and in particular forests eventually results in soil erosion. To reestablish damaged areas is costly and often even not possible. As a result the land is lost, also for the production of food crop.

2.5. Interim conclusion

As an interim conclusion we can record the following:

- Guide lines and regulatory frameworks are necessary to ascertain
    - A balanced use of land for food crop and energy crop and
    - The protection of existing biotopes

- Supportive programs for the production of energy crop are helpful and should be introduced for
  - subsistence farming
  - large scale farming
- Supportive programs for industrial processing of energy crop are advisable and helpful

3. The structuring of regulatory frame works and supportive programs

3.1 Regulatory frameworks

Regulatory frameworks will raise the question of governmental dirigisme, certainly a point to be looked at. It will require fine tuning in order to find the line between dirigisme and basic conditions to be created and/or to be supported for economic development. This shall be dealt with in the following under "national issue" (3.1.1). Another dimension will be its international context (3.1.2).

3.1.1. Regulatory frameworks as a national issue

History has given sufficient evidence that free market systems, refined with social elements, are superior to government controlled and directed economies. Free market systems are characterized by competition which mobilizes creativity and performance. Superior creativity and performance ultimately determine winner and loser.

However, this system will only provide satisfying results if the parameters of competition are balanced. It is a futile exercise to let highly qualified professionals compete against amateurs. This would simply be no competition. Such an exercise would lead to frustration on both sides. The amateur has no real chance and the professional would easily dominate the amateur. As a result the professional would not perform to the best of his abilities because he is not challenged enough. The amateur would not perform adequately because he does not see a chance of winning.

It is therefore essential to find the appropriate frame for all participants to encourage and challenge them to perform to the best of their abilities. This principle is well known in sports and other fields of our life, a principle that becomes nevertheless difficult when entities with substantial differences encounter and are compelled to compete. And this is exactly the situation within developing countries but also in view of their position in the global context.

In many cases we find small groups with a good standard of formal education and a large group with a low standard. To avoid misunderstandings: formal education is meant with regard to modern technological and economic systems. The small group is able to influence developmental targets, can fill key positions and stimulate activities. Sustainability, however, requires the participation of the major part of the population so that the development is based on a solid foundation. It is therefore necessary to find the appropriate frame to accommodate both parties and to motivate them to perform to the best of their abilities.

It will have to be avoided that the “professionals” crush or suffocate the attempts of the “amateurs” due to their superiority. But to create a situation in which the “amateurs” will have an easy way and be rewarded with benefits they did not exert themselves for, is also to be avoided.

The key items in a national regulatory framework have already been identified: (a) balanced use of land and (b) protection of biotopes.

a) The balanced use of land.

It will not suffice to just determine a percentage figure. Rather it will have to be assessed how much arable/suitable land for food crop/energy crop is available, its location with regard to communities and centers of population and its potential for subsistence or large scale farming (topographic structure and accessibility etc). It would be beyond the scope of this presentation to elaborate in detail on the various criteria which could be relevant for a decision as to the balanced use of land.

Qualified institutions in each country such as agricultural high schools, government departments (agriculture, water affairs, environment, mineral and energy, co-operation and development, community development etc), semi governmental institutions and national NGO´s will have to be involved to collect and assemble the relevant information and data. It is clear that, because aspects linked to specific cultures, characteristics and peculiarities of each country (e.g. nutritional and residential habits, communal life) are relevant for the decision concerning a balanced use of land, the preparation of the frame work can only be done individually by each country.

The international community can offer its expertise and knowledge and can, upon request, put it at the service of the African countries. By the way, this is the purpose of Compete.

The governments of the individual countries will have to develop and adopt long term plans and strategies instead of opting for quick but short lived profit. And it is their prerogative to mobilize the national forces as well as to call in international partners in accordance with their visions.

b) The protection of environment and biotopes

The aforesaid applies mutis mutandis also to biotopes. It certainly will require courage and stamina not to forfeit biotopes for quick money. But once being aware of the growing natural catastrophes and the losses of lives and costly damages caused by it, it might make it easier to decide in favor of a slower but sustainable development without sacrificing biotopes.

3.1.2 Regulatory frame works as an international issue.

The issue at stake is a sensitive one.

The argument by developing countries, why they should operate on – more expensive – bio-fuels because of environmental and climatic problems that have been caused mainly by the wealthy industrialized nations, is quite understandable. To a large extent they have obtained their wealth because of using inexpensive fossil fuel and the developing countries should now pay the bill.

Certainly, it will have to be taken into account that climatic changes will, in the first instance, hit those countries between the 30th latitude north and south of the Equator, where most of the developing countries are situated. Any contribution, to slow down or even to stop climatic changes, would be in the specific interest of the developing countries.

It also will have to be considered that the reserves of crude oil are limited, which will result in a continuous price increase. This could well have dangerous repercussions on the economic upswing of developing countries. To produce bio-fuels themselves would reduce their dependency and could help to stabilize their developments.

And finally one also will have to accept that, in accordance with what has been said earlier on about the potential of energy crop to improve the living conditions and to stimulate industrial and agricultural developments, the production of energy crops is in the interest of the developing nations.

Nevertheless, one can not deny that the argument of the developing countries has some merits and that the wealthy nations should feel morally obliged to now contribute financially and with their technological know-how toward the production of environmentally friendly energy. By the way, this will be also in their own interest since any escalation of environmental damages or climatic changes, irrespective who causes it, has global effects and concerns therefore everybody.

Looking at the interests of both sides – the industrialized countries and the developing countries – it appears that only a joint handling of the problems will justify the optimism to find lasting solutions. Each of the participants will be a partner, a partner with equal rights and duties but different contributions due to their different positions and abilities. Each partner will have to work out his position by himself and afterwards all contributions will have to be coordinated jointly by all partners.

For such a process the industrial nations will have to work out their contributions, which will particularly concern know-how and finances. Here it should be pointed out that any financial contribution should not be seen as a grant or alms but rather as a contribution by partners in a joint venture.

Understanding it in this way, developing countries would move out of a position of recipients of charitable acts. But as equal partners they must feel challenged, to not only offer cooperation and to make land available but to work out proposals and plans themselves as a basis for discussions and negotiations. This is also imperative from the point of view that only the individual countries will know their prevailing conditions (see above “the balanced use of land”). In this context one should also look into the possibility of common strategies and goals by African countries.

It will be of vital importance that the African countries, being the scene of events, can show that they can exercise the necessary control in view of a pre-planned production of energy crop and that neither the food production nor biotopes are jeopardized. And the most convincing evidence for such a control will be the respective regulatory frame works, and solid stand in such a process by working out basics that could be important not only in view of their own interest but in view of the result aimed at with the intended agreements.

3.2 Supportive programs.

A guiding influence can also be exercised by supportive programs. The developments which should be supported, have already been identified as improvement of the living conditions and the development of the national economy through the industrial processing of energy crops.

With regard to an improvement of living conditions it will have to be decided, which expectations exist and which type of energy crop could in which way further the process toward the aim. Should certain means be unknown or strange with regard to cultural traditions, informative actions might have to be planned.

Based on specific data collected with respect to communities, subsistence farmer, large scale producers as well as data concerning specifics of land it will be possible, to establish programs, which are supportive if normal mechanisms fail or do not perform satisfactorily.

The same applies for the industrial process. Also there it ought to be assessed, which products from energy crop are accepted by the people, for which an interest should be aroused and which activities in view of a specific industrial development should be supported. Such a support will also include possible fringe benefits, tax concessions or other financial incentives.

3. Conclusion

It may have become clear that the production of energy crop has the potential of improving the living conditions of people in developing countries and that it can also stimulate the economic development. For this supportive guidelines and programs will be helpful.

But it can also cause negative effects which can be very serious for the country, in which the energy crop is produced but also beyond its boundaries. It should be tried to establish regulatory frameworks, which would help to prevent the development of such negative effects.

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Policies and Strategies for Sustainable Energy Crop and Agroforestry Systems in Africa

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General background on biofuel programs impetus

Over the last two years, the world has witnessed an unprecedented interest in initiating biofuel programs in most developing countries. A number of reasons could be attributed to this sudden interest, but the likely drive factors on top of the list have mostly been a long term increase in world oil prices and increased perception on the need to cut down green-house gas emissions using flexible mechanisms under the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol.

Most countries in Africa have also been keen to jump on the biofuel band wagon, citing countries like Brazil as case examples of how biofuel programs can help to boost their much needed economic and social development. Most times biofuel programs have been envisaged to usher in an array of opportunities, including the following;

i) an all time opportunity for meeting growing needs of energy, especially raising modern energy access in rural areas

ii) a means to reduce and offset the high cost of importing fossil fuels

iii) e means of enhancing employment opportunities; e.g. of Brazil ethanol program

iv) an important avenue for providing productive energy in rural areas and thus create opportunities for entrepreneurship

v) an opportunity for clean development projects that can be undertaken by most countries on the continent and hence alleviate global warming and indoor air pollution

vi) an avenue for waste land reclamation and improving food productivity

While it has been acknowledged at many fronts that biofuel programs can offer most of the above mentioned opportunities, a number of concerns have also been expressed within the same biofuel context. Such concerns included impacts on food prices, genetic modification for enhancing crop yield, land use conflicts and environmental degradation brought about by need for large tracts of land for energy crops. Potential biofuel investors in Africa have been concerned by the unproven record of return on biofuel investments in Africa, being able to get enough land for economic viability and what has been expressed as mixed signals from the CDM Executive Board on the issue of Life Cycle Analysis for biofuel CDM projects.

Such concerns as mentioned have spurred different organisations and institution to come up with biofuel strategies for ensuring sustainable biofuel programs. Such effort has involved a cross section of bodies, including regional economic organisation, the United Nations agencies, international non-governmental organisations, regional and international energy networks, etc. In 2004 for example, the Southern African Development Community (SADC), though one of its agencies Food, Agriculture and Natural Resources (FANR), released a study on the feasibility of the production of biofuels in the SADC region, recognizing that the SADC region was reputed to have the largest untapped potential of biofuels in the world.

The SADC SADC Biofuel strategy, completed in 2005, acknowledged need for considerable investment for successful implementation of biofuel initiatives and called for all SADC nations to develop biofuel strategies that would make the sub region more self reliant in energy production. South Africa became one of the first member countries to respond to this call, whereby in 2005 the cabinet gave for developing a national biofuel strategy, and by late 2006 the first draft was completed. The South Africa biofuel strategy aimed at re-energize the agricultural sector and paving the way for a home-grown biofuels industry. The biofuel initiative was envisioned to create some 55,000 jobs and contribute to economic growth.

One common aspect in most strategies, whether nationally or internationally developed, is the critical importance for countries to have in place measures that address, not only economic benefits accruing from having biofuel programs, but also concerns on both social and environmental issues. Because of the nature of the farming systems in Africa, need for appropriate strategies/policies for sustainable energy crop and agroforestry systems in Africa, cognizant of national circumstances, becomes even more important for the region. Some of the issues to take into consideration in developing biofuel strategies in Africa include;

- biofuel strategies that support sustainable energy, environment, forestry, water and land use/agriculture, etc
- specializing in crops in which it has a country has competitive advantage, can easily be sustained and have favourable energy yields
- biofuels strategies to be developed in consistency with existing policies and legislation on water resources, land use, forestry, agriculture etc
- need for benefits from biofuel initiatives to clearly stand out and pass the sustainable development test

There are a number of specific areas that would be need special attention, as shown below.

A) Air pollution and GHG emission reduction

On air pollution, one would need to give consideration on benefits accruing from use of biofuels relative to fossil fuels like diesel and coal. If ambient or indoor air quality was a prevailing problem (kitchen killer problem) then the benefits would be obvious.

On the other hand, if the biofuel program was driven by need to reduce greenhouse gases, one would need to give careful thought to Life Cycle Analysis in determining net energy consumption and GHG emission associated with the energy crop (growing, transporting and processing biofuels). Where forests are cleared for energy crops it is very unlikely that the GHG emission reduction will be realized. In most cases perennial energy crops will have a higher potential of GHG emission reduction than permanent crops.

B) Land for energy crops

Important here is to make sure that biofuel programs do not result in deeper poverty for certain communities in the country, especially the poor farmers. It is very likely that large-scale farming operations ill have impact on the available productive land and may thus lead to crowding out subsistence farmers. It has been suggested that degraded should be the first option for large scale crop farming and help in the rehabilitation of soils. Questions one would need to ask include which land is most suitable for energy crops, and how such land should be used? One would need to be careful that and ensure that the cultivation of land for biofuels do not significantly encroach upon food production or create pressure on arable land, thus perhaps upsetting the food production equilibrium of small-scale and subsistence farmers.

In Tanzania a firm seeking to invest in an ethanol energy project found it quite hard to secure a land big enough for the cultivation of sugarcane, the main raw material to be used in the biofuel project. Legal procedures the firm had to follow to acquire land for such an investment made the process quite difficult. The government’s position was that there would be no short-cut and they could not start without following these procedures, including compensating and relocating local residents.

C) Biofuel programs and issues on land ownership

Rather than biofuel production resulting in the concentration of land ownership and land access into fewer hands, agroforestry should be encouraged, especially to current owners of land in rural areas. Governments could enhance rural development by favoring small scale biofuel initiatives since these are more likely to have higher social economic returns than large scale biofuel initiatives. Development of agroforestry and intercropping that includes different types of plants (trees and bushes) as well as species could result in win-win situation whereby both cash and energy crop production would be promoted simultaneously.

D) Energy crops and water conservation

It is important that biofuel programs be implemented in a manner that would ensure any production of does not result in degradation/contamination or depletion of water sources. It would also be important to ensure such programs do not lead to water use conflicts (e.g. diversion of water away from food production or other current activities). Standing regulations on water sources and use would need to be followed, including robust environment impact assessment (EIA) before embarking on any large scale energy crop projects.

E) Biofuel programs and biodiversity

One effective way of minimizing impacts of biofuel programs on biodiversity would be to capitalize on indigenous energy crops in a particular area, and avoid the need to introduce new crops. This is because in most places what may be regarded as high energy yield crops will be alien crops in a given area, and hence the risk of introducing invasive species. One would thus need to investigate promotion of locally grown energy crops. Sorghum for example, is common in most places on the African continent. Similarly, biofuel strategies would need to have clear guidelines on matters pertaining to genetic modification (GM crops), in order to avoid contamination of food crops. It would also be important to avoid clearing of large areas of natural forests/habitats to pave way for energy crop farming, since such practice are likely to have negative impacts on biodiversity. The world energy has already witnessed such unpopular practices in South Asia where there has been significant clearing of natural forests for oil palm plantations.

Energy crop infringement on biodiversity has already been a sore issue in some countries in Africa. In Uganda, for example, a row over the conversion of rainforests into biofuel plantations created a serious political crisis in 2007. The president of Uganda granted a large piece of land in one of the country’s protected forests to a sugar cane company for a biofuel project. This resulted in demonstrations against the plan in the capital city of Kampala, whereby shops were ransacked a man stoned to death and the police killed two demonstrators. It is quite sad that such deaths were a direct result of a “biofuel program” and this incident emphasizes the need to have clear and transparent guidelines for biofuel programs, ensuring the safeguarding of sustainable development principles.

F) Pertinent issues on food security

Popular here is the citation of the US bioethanol program and the tortilla prices in Mexico. There are different schools of thought on whether the two were correlated, but whatever the case may be, one can not discount the fact that biofuel programs may have impacts on food prices, the “Food, Feed, Fuel” challenge. The biofuel and food prices challenge is of particular importance to African countries where lack of surplus food production is common in most countries on the continent. South Africa, which used to enjoy a surplus maize harvest for a considerable number of years, has found its maize production going down in recent years.

Biofuel programs are likely to have impacts on food prices in a situation whereby farmers find it more profitable to sell food crops to biofuel producers, or if there is a significant diversion of crop production from food and to production of energy crops.

Conclusion

The above discussion provides just a few examples on why it is important for countries to develop appropriate strategies before embarking on biofuel programs. Such strategies need to consider both long short and long term impacts of implementation. It should also be recognized that there can no be, for all countries in Africa, a single sustainability answer on how to implement biofuel programs. National circumstances have to be taken into consideration, and countries need to develop sustainable development criteria that meet those circumstances.

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Biofuel and Biomass Development and Utilisation in China

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Excerpt from Presentation (available at www.compete-bioenergy.net)

In January 2006 China’s first ‘Renewable Energy Law’ came into force which stated renewable energy exploration and utilization as the national energy development priority.

This national strategy put bioenergy as a prime option for sustainable development. China has a large potential for biomass resources such as 0.6 billion tons of crop straw.

China’s approach in the field of biomass and bioenergy focuses on the following technologies:

- Direct combustion for electricity generation
- Gasification for methane production
- Liquefaction for bio-ethanol and bio-oil production

Bioenergy success stories in China include nearly 12 million households benefiting from biogas production for cooking and lighting applications.

In the field of biofuels China had started an ambitious bio-ethanol programme in the year 2000 with the set-up of several bio-ethanol production facilities with a total production capacity of about 1 million tons per year. The main resource for bio-ethanol production until today is stale grain (e.g. corn, wheat) which is a very limited resource not sufficient to satisfy the strong demand for biofuels all over the country. The following lessons where learnt from the first phase of the biofuels programme:

- China’s corn price is steeply rising due to the demand from various bio-fuel projects
- The Chinese Government stopped approval of new production facilities to convert corn into ethanol (existing facilities remain in operation)
- China will focus on bioenergy technologies based on non-grain materials (Major crops: sweet sorghum, sugarcane, cassava, crop straws)

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Biodiesel Initiatives in India – Problems and Prospects

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Excerpt from Presentation (available at www.compete-bioenergy.net)

In 2003, the Committee on Biofuels set up by the Government of India recommended the following focus of biofuel development in India:

- Ethanol [sugarcane (molasses)] for blending with petrol (gasoline)
- Biodiesel (*Jatropha curcas)* for blending with High Speed Diesel

Current Status - Ethanol

2003

- 5% ethanol blending in petrol made mandatory in 9 states and 4 UTs w.e.f January 2003.
- Around 0.2 million kl of ethanol procured during 2003-04

2004-05

- Sugarcane production suffered due to drought conditions in several parts of the country
- Mandatory blending later made subject to availability.

2005-06

- Ethanol supply expected to improve during 2005-06
- Procurement of ethanol to restart

Current Status - Biodiesel

a) State Government Initiatives

- Formation of nodal agencies for bio-diesel development/ draft bio-diesel policies (e.g. Chhattisgarh, Uttaranchal, Rajasthan, AP, TN etc.)
- Different Approaches
  - Uttaranchal: un-irrigated degraded forest land – JFM model
  - Chhattisgarh: Waste land, fallow land, agriculture land – JFM, contract farming
  - AP: Jatropha – agriculture land; Pongamia – Forest department

b) Industry initiatives

- R&D (engine trials, process technology, etc)
- Jatropha plantations
- Bio-diesel production facilities

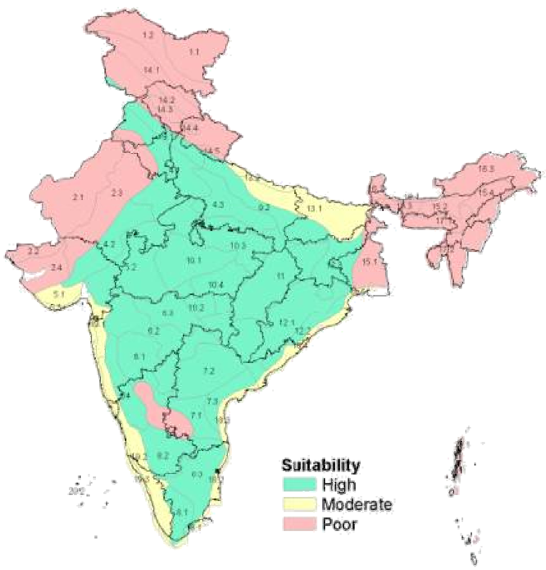
c) Wide variations in reported Jatropha yield

- Variations from 1 –12 tonne of seed/ha
- Variations due to inputs and agro-ecological conditions
- Difficult to cross-check claims (Very few existing mature plantations)

d) Concerns of farmers

- Buy-back arrangements and returns
- Example of palm-oil often quoted in South India

In India, studies on the identification of suitable regions for Jatropha (see figure below) and Pongamia have been performed with respect to soil, climate and physiographic parameters. Areas of high, moderate and poor suitability have been identified, with semi-arid and sub-humid tropical areas suitable for Jatropha and Pongamia.



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Sustainable International Bioenergy Markets

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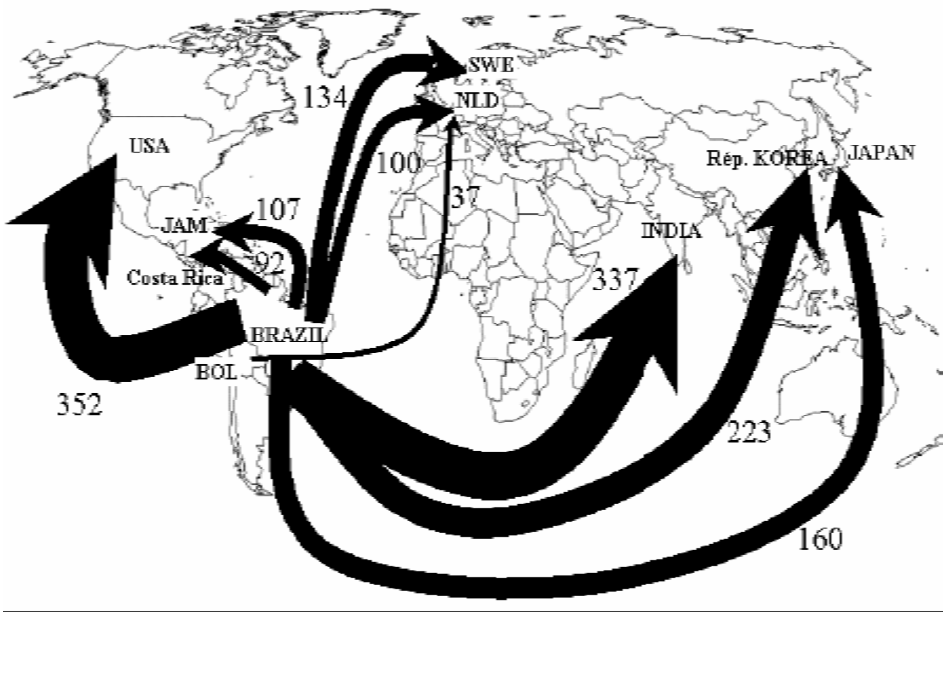
Excerpt from Presentation (available at www.compete-bioenergy.net)

International bioenergy markets are developing fast and growing bio-energy demand and international supply chains create unique opportunities for both producer regions and importers.

The following figure shows the worldwide bio-ethanol flows 2004 in kton (courtesy of UNCTAD). With a global production of 32 billion litres, 3 billion litres were traded



The current global energy demand is approximately 420 EJ, of which about 10-15% (45 ± 10 EJ) is covered by biomass resources (Traditional biomass: 29 EJ; Commercial non-modern: 9 ± 6 EJ; Commercial: 7 EJ; Liquid biofuels: 0.5 EJ).

Today, the following main uncertainties exist with respect to the future potential of biomass:

- Water resources
- Management of biodiversity
- Interaction with conventional markets (food, forestry)
- Proper GHG accounting and land-use management
- Balanced economic development (macro & micro scale)

Several issues are of crucial importance for global biomass availability:

- Major contribution of bio-energy to global energy supply possible.
  - ⇒ Major transitions required to exploit potentials.
- Improved food production systems & rate of deployment in developing countries are essential.
  - ⇒ Integration of biomass production into agriculture (implying integrated rural development schemes targeting traditional agriculture).
- Use of marginal/degraded land & biomaterials.
- (Net) biomass supply per region strongly determined by local factors; large differences between regions.
- Economic potential depends on production cost reductions, policy and fossil fuel price developments.

Current issues in international bioenergy trade:

- Many opportunities for trade (and stabilizing markets).
- Many barriers remain.
- Transparancy (and thus information) vital to market parties (and govt.).
- Fierce international debate on sustainability; intensive dialogue and interaction.
- Different perspectives (and interests) on governance, policy and priorities; overview is needed.
- Entrepreneurs and policy makers are now dealing with development of regional or national biomass markets in a rapidly developing international context.

Conclusions

- Diversity in ecological and socio-economic conditions to be recognized (asking for regional approaches in a global setting; stakeholder approaches).
- Sense of urgency is needed; market forces are already steering development of international bio-energy markets.
- Flagship projects (to demonstrate multiple benefits and framework(s) under different conditions.
- Promising future; but policy needs to choose and coordinate (agriculture, trade, climate, energy and development are interlinked).
- Strong need for international collaboration and action: IBEP, Biofuels Init., IEA, G8 partnership, WTO, etc.

For more information on the IEA Task 40 on ‘Sustainable Bioenergy Trade’, see: www.bioenergytrade.org

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