Bio-diesel Research and Production in Kenya

Joseph M. Keriko

Jomo Kenyatta University of Agriculture and Technology

Nairobi,

KENYA

Minnesota, August 2007

Introduction

- There is an increasing interest worldwide in the development of biofuels that has led to a surge in demand for biodiesel in the past few years in both developed and developing countries Kenya included.
- This has been caused by:
  - a reduction in government duties on biofuels
  - increases in the percentage requirements for biodiesel blend (for CO_2 emission reduction)
  - the overall support for renewable energy sources and
  - the reduction in pollution
- Current research data shows that, it is possible to obtain biodiesel from virtually any locally available oliferous vegetation including:

  rape seeds, soya beans, sunflower, peanut, cotton, avocado, *Melia volkensii, Croton megalocarpas, Jatropha curcas*, Castor seeds (*Riccinus communis* L.), Coconut and Palm and even animal fats

- It may also be made from waste vegetable oils and fats from fish, chips or fried chicken

Situation in Kenya

Kenya does not have any known reserves for fossil fuels and therefore imports all liquid fuels. There is need therefore, for research and exploitation of this existing renewable energy considering the fact that:

- In 2005, 7.4% of Kenyan GDP was spent in importation of petroleum products
- This was over 25% of our foreign exchange earnings
- Diesel makes up 60% of the total oil imported into the country

Energy sector and sustainable development in Kenya

Sources of energy in Kenya

Three main sources of energy in Kenya (total energy consumption) include:

- Wood fuel (70%)
- Petroleum (20%)
- Electricity (9%)
- Others (solar, wind etc.) (1%)

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Why the need for bio-diesel now?

- Bio-diesel products are too increasingly valued for their environmentally friendly properties which can help meet the challenges resulting from air, water and soil pollution.
- Key properties of vegetable oils which contribute to their attraction as environmentally friendly alternative fuels and lubricants include:

➢ High biodegradability

➢ Low toxicity, both oral and dermal

➢ Low evaporation, reducing inhalation risk

➢ High flashpoint reducing risk of fire (160^{o}C)

➢ Reduced emissions, particularly carbon dioxide, sulfur oxides soot (particulate carbon matter) and poly-aromatic hydro compounds (PAH)

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A Brief of Bio-diesel exploitation in Kenya

It was in Nov. 2005, when Mr. Paul Armington of the World Institute for Leadership and Management in Africa (WILMA), with the collaboration of some members drawn from the Kenya Organic Products (KOP), Kengen, National Oil Co-operation of Kenya (NOCK), TARDA, JKUAT and with some officials from the Ministry of Energy, formed the GreenFuels Kenya Ltd. which focused on biodiesel exploitation from locally available plant seeds.

This group was joined later by other stakeholders and formed the National Biofuel Development Committee under the Director of Renewable Energy in the Ministry of Energy. WILMA exited and settled in Tanzania.

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Biodiesel From Yellow oleander *(Thevetia peruviana) seeds*

- This research work started in 2001 and was funded by World Bank (US$ 30,000)
- Yellow oleander plant (*Thevetia peruviana*) is exotic to Kenya having originated from Peru in S. America as an ornamental plant
- It belongs to the family of Apocynaceae
- It is locally called *chamama* in Luo Nyanza where if florishes quite well.
- It is a perennial crop, drought tolerant and require minimum inputs during field cultivation

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Yellow Oleander (*Thevetia peruviana)* Plant

Oil Composition and uses

- The seeds of Y. Oleander contains over 62% a triglyceride pale-yellow non-drying oil (about 20% of whole seed).
- The major fatty acid are stearic and oleic plus some little % of arachidonic acid.
- It contain about 8% of biologically active steroidal glycosides.
- The defatted and deglucosylated kernels contain up to 65.8% of proteins
- The oil is being utilized in the manufacture of soaps, paints and cosmetic

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Yellow Oleander (*Thevetia peruviana)* Seed Oil

Diesel Engine Performane of Y. Oleander oil

The result of engine performance at optimal engine load

Diesel blend (%)	speed (rpm)	power (Kw)	Torque (NM)	Fuel (l/h)
Pure diesel (O%)	2135	4.18	19.12	1.64
20	2075	4.07	19.12	1.29
40	2091	4.10	19.12	1.29
60	2089	4.10	19.12	1.37
70	2012	3.95	19.12	1.13
80	2070	4.06	19.12	1.50
100% oleander oil	2140	4.20	19.12	1.57
100% esterified oil	1958	3.95	19.12	1.56

Biodiesel Test Engine

Seed of yellow Oleander

Yellow Oleander Seeds

Current status

- So far, one stage of Y. Oleander seed oil development has been the de-hulling exercise which has been manual. However, recently we fabricated one and now in use to replace manual de-hulling method

Seed de-huller

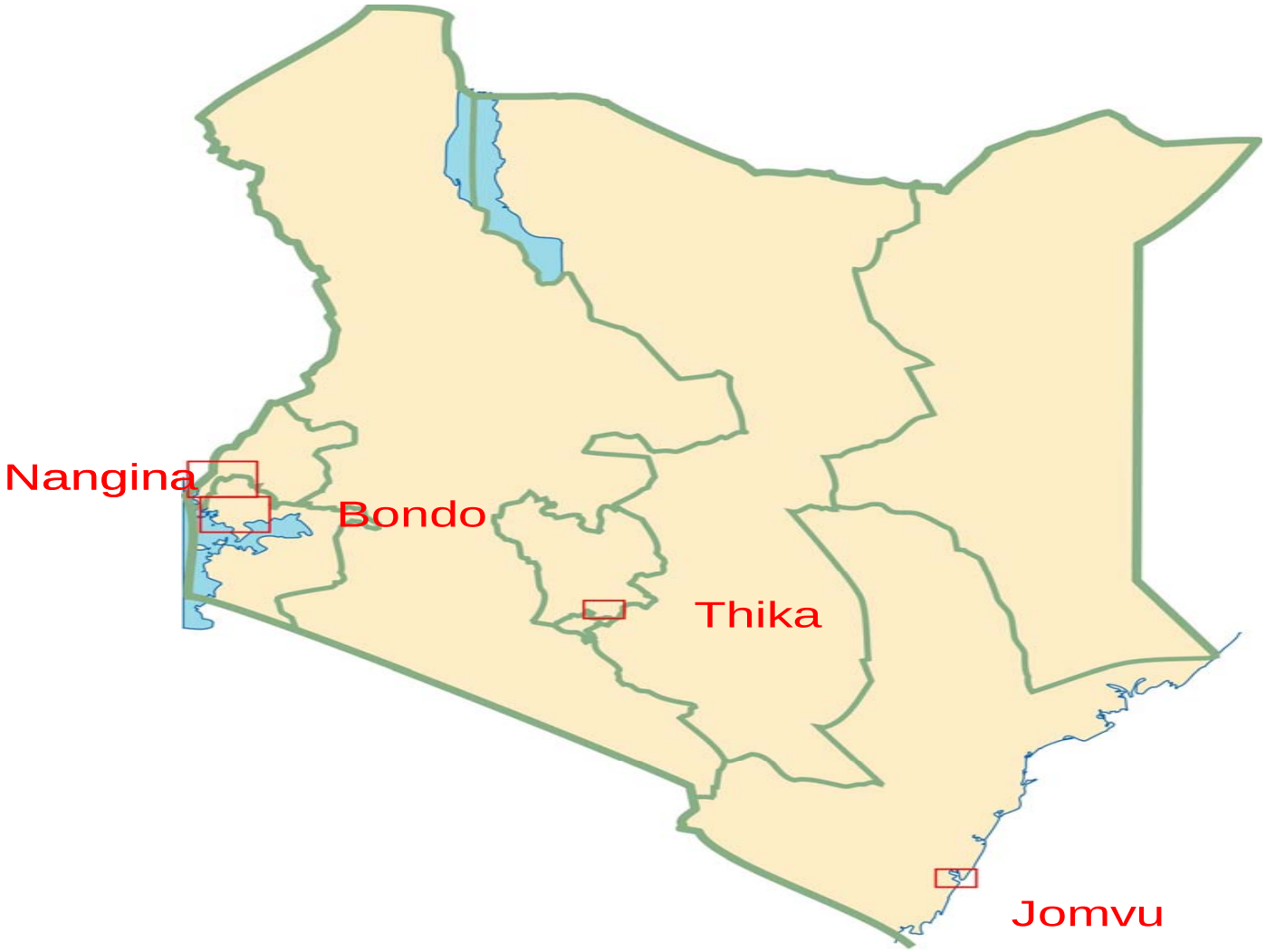
Machine De-shelled Seeds

Oil extractor

This has also been fabricated and is in use

A Bio-diesel Tractor

Location of agronomical trial pilot plots



Field Follow-up on the Plant Development

Other benefits of Y. Oleander plant

Other utilities of Y. Oleander plant:

- A good source of nector for honey making since it flowers throughout the year
- Source of firewood fuel
- Source of material for furniture making
- Provision of shades in homesteads, schools and shopping centres
- The cake can be used as source of animal feeds and/or manure etc.

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Other Target plants with bio-diesel potential

Bio-diesel research is also targeting the following plants:

1) **Castor oil** (*Riccinus communis* L.) seeds

- Local name: *Mbariki*
- A member of the Euphrobiaceae family
- A native of the Ethiopian region of tropical Africa.
- A very common plant along stream banks, river beds, bottom lands, hot areas with well drained soils with sufficient nutrients to sustain its vigorous growth.
- Its spiny seed pod or capsule is composed of three sections which split apart at maturity.
- Each section (carpel) contains a single seed and as the carpel dries and splits open the seed is ejected with force.

Castor oil plant (*Riccinus communis*)

Castor Oil Seeds

Characteristics of Castor oil

- It is the only source of an 18-carbon hydroxylated fatty acid with one double bond.
- Ricinoleic acid (12-hydrolecic acid) comprises approximately 90% of the fatty acid composition
- It is a non-toxic biodegradable renewable resource.

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2. Croton megalocarpus

- Local name: *Mukinduri*
- Was established by JKUAT and Kenya Organic Products (KOP) as a bio-diesel
- ICIPE is also doing research targeting medicinal aspects of this plant
- We’re still analyzing the properties of the oil but engine performance tests have been done

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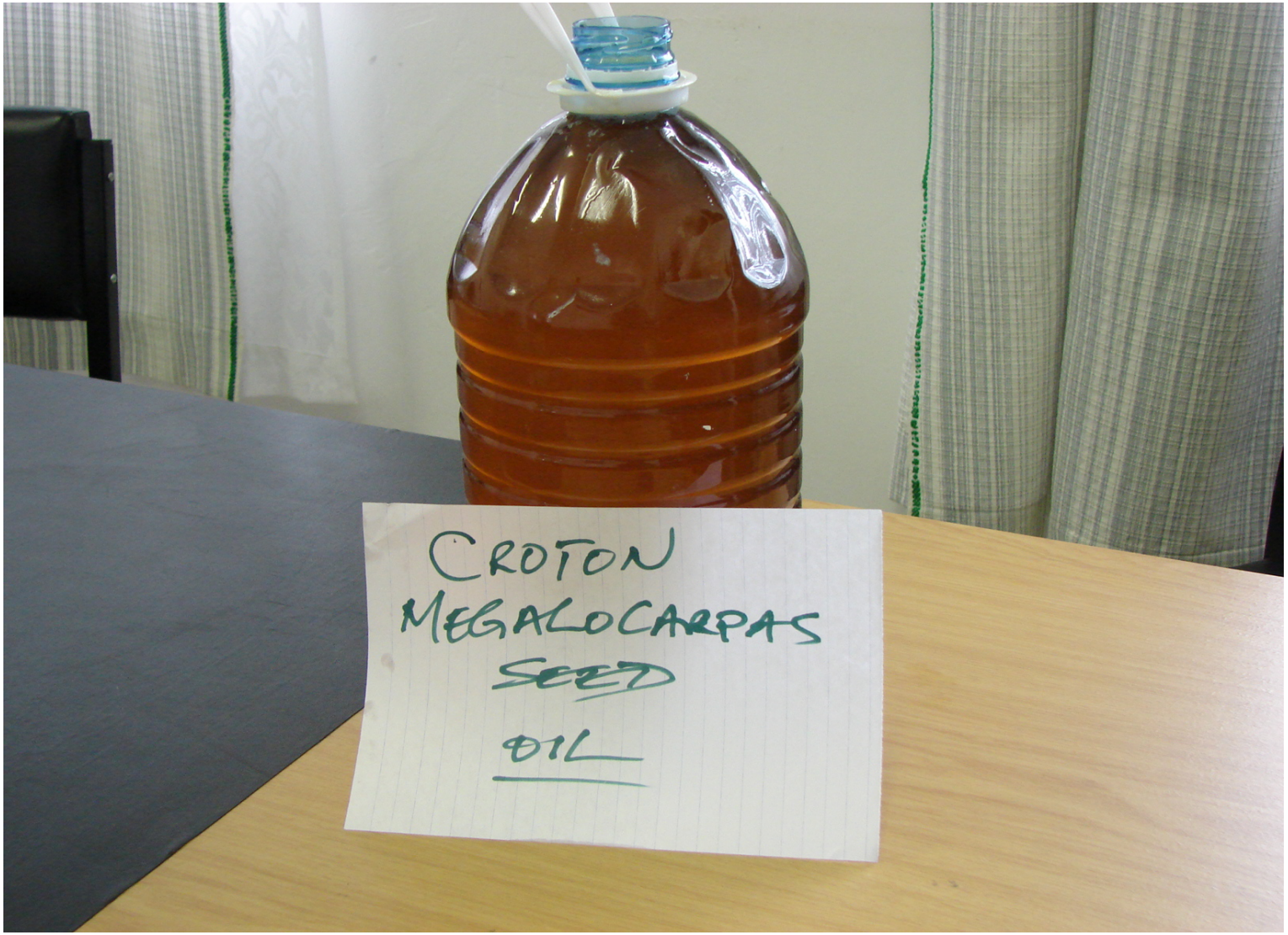
Croton megalocarpus Plant

Croton Megalocarpas Seeds

Croton Megalocarpas Oil



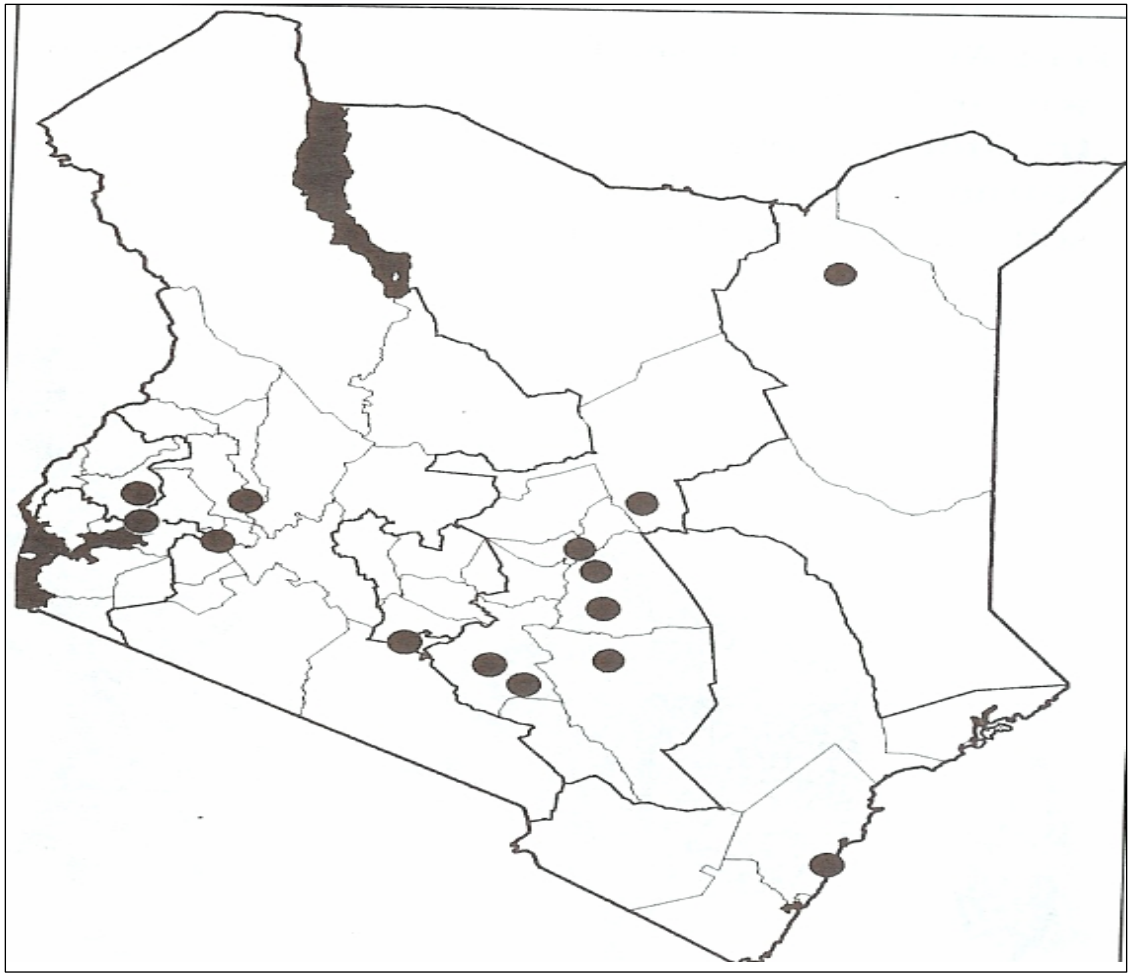
3. *Jatropha curcas*

- This is one main crops currently being promoted for bio-diesel production in several countries.
- There has been substantial political and social pressures to promote the growing this crop in India, Philippines, China, Egypt Tanzania and Zambia as a mean of economic empowerment, social uplifting and poverty alleviation
- It is native of central America (Mexico and the Carribean).

Jatropha curcas Plant

Jatropha curcas dry seeds

Distribution of *Jatropha curcas* in Kenya



Composition of Jatropha oil

The oil contains 21% saturated fatty acids (SFA) and 79% unsaturated fatty acids (UFA).

In Jatropha oil, the predominant fatty acids are:

* Oleic acid ($C_{18}H_{34}O_2$), (43.1 %)
* Linoleic acid ($C_{18}H_{32}O_2$) (34.3 %), and
* Palmitic acid ($C_{16}H_{32}O_2$) (14,2 %) of the total mass, respectively.

Depending on the variety, 0.06% up to 6.7 % of the oil can be free fatty acids.

Sulfur and nitrogen are present in amounts of 0.13 % and 0.11 %, respectively (Lide and Fredrikse, 1995, Kollar *et al.*, 1993).

4. Grain Amaranthus

Grain Amaranthus Seeds

Grain Amaranthus

- A potential oil crop but more preferable as a food crop.
- Its oil contain one rare oil called squalene which is only found in sharks
- It is a very nutritive as a food since it has high protein content
- We are extracting it for cosmetic application since it has UV protective potential

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Other alternative energy resources includes

- Solar energy
- Windmills
- Power alcohol and
- Biogas

Since they are all renewable, these alternative sources have the potential to contribute highly to social, economic and environmental dimensions of sustainable development.

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Exploitation of Biogas
(floating dome digester)

Polythene Bag Digester

Utilization of Biogas

Utilization of Biogas cont.

Power Generation Using Biogas

Solar Energy Exploitation

Conclusions

There are numerous benefits that are tied with the development of these plants as sources of bio-diesel including:

- Poverty alleviation
- Reduction of environmental pollution
- Create employment
- Save foreign exchange earnings
- Improve human and animals health
- Increase land use
- Reduce soil erosion
- Reduce ecological footprint etc.

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Thank You
for listening

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