

Feasibility Study of Biofuels Energy Exploitation For Southern Africa's Prosperity- Case Study Zimbabwe

C.S.Shonhiwa¹, J.Kugara², L.R.M.Nhamo³ and S.Chinguwa⁴

¹University of Zimbabwe, Mechanical Eng. Department, Harare, 263, Zimbabwe

²University of Zimbabwe Chemistry Department, Harare, 263, Zimbabwe

³University of Zimbabwe, Chemistry Department, Harare, 263, Zimbabwe

⁴University of Zimbabwe, Mechanical Eng. Department, Harare, 263, Zimbabwe

shocle@yahoo.com

Abstract

The Southern Africa's Economy is slowly re-emerging from a protracted period of economic decline (in particular Zimbabwe) due to the raise in exploitation of biofuels energy resources. The energy challenge is especially acute in the transport sector, as most vehicles will continue to rely on liquid fuels for the decennia to come. Diesel and petrol (gasoline), obtained from fossil oil, will gradually be replaced by renewable liquid fuels, which are called biofuels.

Most of the Southern Africa Member States can grow most of energy crops. The ecology of the region can accommodate most crops. In some of the Member States land is still abundant e.g. in Angola, DRC, Mozambique, Tanzania, Zambia and Zimbabwe such that production of energy crops will not disturb food production. Agricultural research and the seed industry have untapped capacity to improve yields and productivity for all energy crops.

The purpose of this desk study was to assess the feasibility for the production of biofuels in the Southern Africa Region. The study reveals that the current petroleum consumption in Southern Africa is about 0.7 million barrels a day. After refinery this produces roughly 12 million tones of diesel a year. If all of this were biodiesel region needs it could be met from 400 factories with a capacity of 30,000 tones a year each. The cost of such a plant is 40 to 50 million Euros⁹.

The biofuels exploitation in the Southern Africa can completely change the living standard of the people. At macro-economic level, the production of biofuel could employ millions of rural labourers, thereby boosting economic growth. Moreover, most Member States can make huge savings on foreign exchange. The region's energy sector will be less dependent on external vagaries, and exchange rates, and will produce clean energy, which in turn will yield Kyoto-bonuses.

Key Words:

Biofuels, Jatropha curcas, Southern Africa, Prosperity

Introduction

Biofuels are liquid fuels of plant origin that can partially or totally replace fossil petroleum in all its uses. They can be ethanol, vegetable oils or bio-diesel. These fuels can be used in internal combustion engines for transportation and other related purposes.

Ethanol is produced from a wide range of feedstocks such as cassava, sugarcane and sweet sorghum, maize, wheat and sugar beet and is used as a gasoline substitute or as an additive. Biodiesel can be obtained from most vegetable oils including: oil palm, rapeseed, soyabeans,

sunflower and tree seeds (*Jatropha curcas*). It can be used on its own or blended to any proportion with fossil diesel.

The intention of the study is not to suggest that fossil fuels should be replaced by biofuels, but rather to allow countries to diversify their energy portfolio using locally grown products. Persistent fuel price increases, potential disruption of supplies and foreign exchange shortages threaten energy security and slow down the rate of economic development. Biofuels will not displace land and agricultural resources for food security, but will stimulate investment in agriculture by opening new markets for farmers who produce the feedstocks for biofuels and ensure access to food and better living conditions.

The major factors which have generally tended to limit consistent investment in the production of biofuels are fluctuations in the availability and prices of feedstock, production costs in relation to crude oil prices, value of by-products and their marketability, and level of productivity in agriculture, processing technology and lack of policies for bioenergy products. On the other hand though, the advantage of biofuel is that it can be produced from a wide range of feedstocks many of which are already being grown and whose production can easily be increased.

In the EU, the US and Canada, oilseed rape and soyabean oils are converted into biodiesel. The biodiesel capacity grew from almost 1990 to 1,800,000 tonnes a year in 2004, mostly in Europe. The EU is targeting to use 5.75% of biofuels in motor vehicles by 2010. Malaysia has constructed a palm oil extractor with a capacity of 500,000 tonnes. Ethanol programmes also continue to grow rapidly in the many parts of the world. The first target for bio-fuel producers in the OECD is to reach 5% of the fuel market, which is in line with most governments' commitments after the World Summit

on Sustainable Development (WSSD). Hence there is little doubt that the bio-fuel revolution will particularly benefit developing countries produce bio-fuel for their own consumption as well as for export. From nowhere, bio-fuel will soon become the most important agricultural commodity in the world.

Methodology

The researchers evaluated the potential of biofuel production and use in Southern African Region, and the bottlenecks that need to be addressed. They made a comparative analysis of the potential of the following energy-crops that grow in the region:

- Oil palm;
- Sunflower;
- Soyabeans
- *Jatropha curcas*;
- Sugar cane;
- Sweet sorghum; and
- Cassava.

Even though the exercise was a desktop study the information was supported by data collected after the visits made by researchers to some of the countries such as South Africa, Botswana, Mozambique, Zimbabwe and Malawi as these countries have recent experiences with biofuel.

The study started with the assumptions that crude oil prices are at \$40 per barrel, that Southern African Member States are not in a position to subsidize biofuel production and that they instead use the conventional fuels to earn income through duties and taxes;

The study made an impact assessment of the production and/use of biofuels, with specific emphasis on employment, environment, trade and economic growth.

The researchers gave particular attention to the following technical issues:

- The agro-ecological zones in the region;
- The spatial distribution of fuel production plants;
- The potential for small to medium agro-industries;

- The required quality and standards;
- The role of governments and private sector;

Results and Discussion

The use of vegetable oils in diesel engines is not new. Rudolph Diesel himself used vegetable oils to propel his engine in 1900. Argentina had castor oil fuelled diesel engines in 1916. In 1928, a French engineer published a paper stating that vegetable oils can be used as fuels in diesel engines⁸.

Modern production of biodiesel started in 1990 and production capacity has now reached a volume of 1.8 billion liters per year, mostly in Germany, Europe (1% of the motor distillate use, IEA). Big oil companies and car manufacturers are giving up their resistance against biofuel. While its production (in the OECD at least) is still more expensive than that of conventional diesel, it can be sold at competitive prices if exempted from certain taxes. The cost/benefit impact is much better in biofuel produced in developing countries. South Africa, the organizer of WSSD in 2002, is taking a lead in biofuels in the SADC region, followed by Malawi.

Biodiesel is simple to use, is biodegradable, non-toxic and it reduces air pollutants, like particulates, sulfur, carbon monoxide, hydrocarbons etc. It is sustainable and environment-friendly. Neat biodiesel is as biodegradable as sugar and less toxic than salt. Biodiesel can be used to regulate oil crop prices.

Other potential benefits are the improved energy security, lower emissions of greenhouse gasses and reduction in solid wastes. Biodiesel is also a job creator. While in many other countries it is expected that biodiesel will enter into strong competition with other crops for labour and land, the situation in SADC is such that this competition is not there. Labour and land are not limiting factors in the region with very few exceptions (in South Africa, Lesotho and Mauritius).

Biofuels for transport, including ethanol and biodiesel have the potential to displace a substantial amount of petroleum around the world over the next few decades; a clear trend in that direction has begun in Zimbabwe.

The current petroleum consumption in Southern Africa is about 0.7 million barrels a day. After refinery this produces roughly 12 million tones of diesel a year. If all of this were biodiesel SADC needs could be met from 400 (factories) with a capacity of 30,000 tones a year each. The cost of such a plant is 40 to 50 million Euros⁹. The production of bio-diesel can be done anywhere, as there is no minimum limit for the production plant. This again favors the rural areas. The regional oil seed production needed thereto would be 60 million tones (valued US 12 billion). A first bio-diesel plant proposed by SASOL in South Africa might create a market of 0.5 million tones of soya.

The company's choice for soya is determined by the fact that the by-products of soya extraction (soya cake, organic manure, glycerin) are easily marketable. Other agroecological zones in region might opt for other oil-bearing crops. Palm oil for instance has a much higher production per hectare than soya and groundnut and is more pest resistant.

As palm oil is a labour intensive crop, its use might have a large impact on employment. It is also cheaper than soya oil. The land to be put under oilseed crops would be 40 million hectares, as compared to the current 47 million hectares under crops. It would create an extra income for millions of regional farmers. Hence it will help the farmers to increase productivity on their food Crop land.

There is still potential agricultural land that is as yet unused. At present some 1.5 billion ha of land is used for arable and permanent crops, around 11 percent of the world's surface area. A recent assessment by FAO and the International Institute for Applied Systems Analysis (IIASA)¹¹ suggests that a further 2.8 billion ha are to some degree suitable for rain fed production, which is largely sufficient to satisfy the world's energy needs.

The pool of unused suitable cropland is very unevenly distributed. Sub-Saharan Africa and Latin America are still farming only around a fifth of their potentially suitable cropland. Five countries of the Southern African Development Community (SADC) have ample room for expansion. Table 1 assesses their potential cropland. The last column gives the hectares needed to satisfy their national energy needs (if sugar cane or oil palms are used as energy crops). All figures are given in millions of hectares.

Table 1. Production status of Energy Crop Yield (in 1000 tones) in Southern African Countries

Country	CROP						
	Palm oil	Sunflower	Soyabean	Maize	Sorghum	Sugar cane	Cassava
Angola	280	11		510		360	5,600
Botswana		7		10	32		
DRC	1,150		14.6	1,155	54	1,787	14,951
Lesotho				150	46		
Madagascar	21		0.05	349.7	1	2,460	2,191
Malawi		3.7		1,733	45	2,100	2,559
Mauritius				0.19		5,200	0.13
Mozambique		6.3		1,248	314	400	6,150
Namibia		0.05		33	6		
South Africa		675.5	220	9,737	449	19,095	
Swaziland				70	0.6	4,500	
Tanzania	65	28	2.1	2,800	650	1,800	6,890
Zambia		10	15	1,161	19	1,800	950
Zimbabwe		8	84	1,000	80	4,100	190
TOTAL	1,516	749.6	335.8	19,957	1,697	43,602	39,441

Most of the Southern African Member Countries can grow most of the energy crops. Sugar cane for example can be grown in most Member States but suitably in Angola, Malawi, Mauritius, Mozambique, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

Table 2 Yields of oil by crop and suitable country in Southern Africa

Crop	Yield (kg oil/ha)	Liters of oil/ha	Favourable country In SADC
Palm oil	5,000	5,950	Angola, DRC, Tanz, Zam
Coconut	2260	2689	Moza, Tanz
Cashew nut	148	176	Angola, Moza, Tanz
Sunflower	800	952	Angola, Bots, DRC, Malawi, Moza, Nam, SA, Tanz, Zam, Zim
Sesame	585	696	Angola, DRC, Moza, SA, Tanz, Zam, Zim
Soyabean	375	446	DRC, Malawi Moza, SA, Tanz, Zam, Zim
Cotton seed	273	325	Angola, Malawi, Moza, SA, Tanz, Zam, Zim
Peanut	890	1059	Angola, DRC, Malawi, Moza, Tanz, Zam, Zim
Castor beans	1188	1413	Angola, DRC, Moza, SA, Tanz
Avocado	2217	2638	DRC, SA, Tanz
Jatropha	1590	1892	All countries

Table 3. Cropland potential of five selected countries

Country	Land Area (mil ha)	Suitable Cropland (~ 20 %) (mil ha)	Area Under Crops Today (mil ha)	Area Required For Domestic Energy Supply (mil ha)
DRC	227	45	8	0.2
Angola	125	25	4	0.6
Tanzania	88	18	5	0.3
Zambia	74	15	5	0.2
Mozambique	78	16	3	0.2

Using information from both tables 1, 2 and 3, Member States, which are listed as suitable, can choose which crop they want to grow for bio-fuel. In a liberalizing sugar market, and as sugar quota are being phased out under the Cotonou Agreement, ethanol production provides a viable alternative in these countries.

Looking at the comparisons on a crop-by-crop basis the rankings were found as follows:

Sugar cane

Sugar cane tops the list because it is already being widely grown in the region and its production can easily be expanded wherever there is irrigation and water. Its impact on employment is high. Considering that ethanol is produced from a by-product of sugar, molasses, there is a double benefit in terms of income. Ethanol is already widely used as a petrol blend and the processing technology is known and available. Its direct benefit on foreign exchange savings are easy to calculate, depending on the blending rate adopted.

Soybeans

Soybean is ranked second because of the same reasons as above. It is already widely grown by both large and smallholder farmers as a food crop and an industrial crop. Soybean is used for vegetable oil and animal feed. Expanded use for biodiesel will create additional demand and stimulate production, and this can be achieved within one season by increasing the area under production.

Oil palm

Oil palm scores high for biodiesel in terms of oil yield and capacity to produce large volumes in those parts of the region with suitable climate. Factors not in its favour include the time lag to full production and the fact that most parts of the region do not have the right climate for palm oil production. It is ranked third place.

Sunflower seed

Sunflower seed is ranked fourth because compared to soybean its oilcake is not easily marketable for stock feed, but its production can be quickly expanded for biodiesel.

Sweet sorghum

Although not yet widely grown as a commercial crop, sweet sorghum can be grown in drier parts of the region with benefits for small-scale farmers. It can be used to complement sugar cane for the production of ethanol, while the by-products will be used for animal feed. It is ranked fifth place.

Jatropha

Jatropha is ranked in the sixth place because it has not yet been commercially grown in the region, although the potential is there. There is still a lot to be discovered in terms of its agronomic suitability to produce the required volumes for biodiesel.

Cassava

With the exception of Malawi, Zambia, and Mozambique, cassava is not considered a major crop in the region. A lot of work would still need to be done before it can be fully integrated into the production of ethanol. It is therefore ranked in seventh place.

Benefits of the use of biofuels

- The potential benefits of biofuels are immense, starting with their capacity to create rural employment,
 - Market for small-scale farmers and can be used to regulate oil crop prices.
 - Foreign exchange savings by governments (by reducing the volume of fossil fuel imports).
 - Improved energy security, lower emissions of greenhouse gasses. Biofuel is simple to use, is biodegradable, non-toxic and it reduces air pollutants, like particulates, sulfur, carbon monoxide, hydrocarbons etc.
 - It is sustainable and environment-friendly. Neat biodiesel is as biodegradable as sugar and less toxic than salt.
 - The regional energy sector will be less dependent on external vagaries, exchange rates, and will produce clean energy, which in turn will yield Kyoto-bonuses.
 - Most of the oil-bearing crops are nitrogen-fixing plants. Hence they enrich the soil. Moreover, the energy crops consist solely of the plants hydrocarbon. Nitrogen, phosphorus and mineral elements can return to the field.
 - Biofuel programs have all the potential to halt deforestation and desertification, as they can include the use of oilseed-bearing, drought resistant trees like jatropha and pongamia.
 - Finally, in the event of a famine in the region, the crops initially earmarked for biofuel production can be reallocated for human.

Conclusions

Biofuel holds enormous potential for Southern Africa for its economies in general. The authorities should treat it as a high priority.

Recommendations

However, before the launch of any major biofuel programme, policy decisions and plans on several issues need to be finalized. Identification and development of high-yielding varieties of crops, involvement of the private sector in sugar and oilseed production, ensuring remunerative price for the farmers on a long-term basis, setting up processing plants in major sugar and oilseeds growing areas, promotion of the use of vegetable oils for rural electrification and exercitation of water pumps, tractors and farm implements etc are some issues that need be resolved.

References

1. Carvalho, L. C., 2002. Sugarcane as Perfect Biomass for Energy Production, UNICA, Third LAMNET Workshop, Brazil, December, 2002.
2. Haga, N., 2004. Vegetable oil as a fuel in diesel generating sets. International Cogeneration, Combined Cycle and Environment Conference and Exhibition, Istanbul.
3. Henning, R.K., et al. A Guide to the Jatropha System and its Dissemination (Zambia). Produced for GTZ /Production and use of plant oil as fuel, Mali, Nov 1994
4. Henning, R.K., 1994. Fighting Desertification by Integrated Utilization of the Jatropha Plant.
5. Karsha, S., Leach, G., Rajan, S.C., 2005. Advancing Bio-energy for Sustainable Development: Guideline for Policymakers and Investors. Volumes I, II and III, Stockholm Environment Institute. Energy Sector Management Assistance Programme (ESMAP).