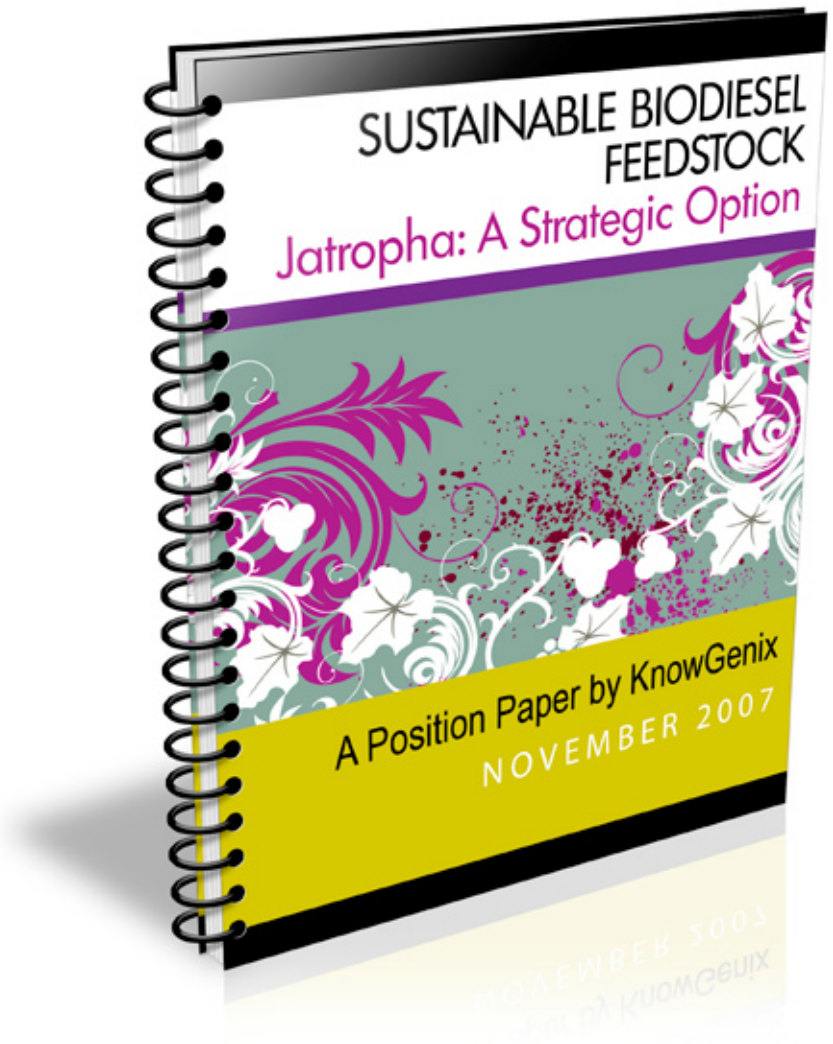
SUSTAINABLE BIODIESEL FEEDSTOCK
Jatropha: A Strategic Option
A Position Paper by KnowGenix
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in line with JatrophaWorld 2008.

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Introduction

The global energy sector stands polarized with proponents of fossil fuels and renewable energy finding it difficult to meet on common grounds. The rise of the biofuel industry was a spin off from the radical reassessment of traditional energy sources which were defined by large environmental footprints. Despite the promise biofuels are not a panacea, but another choice among a host of energy options.

This position paper discusses the sustainability of non-food crops such as Jatropha against the backdrop of current biofuel policies and initiatives in developing regions. It looks at the broader issues concerning the advocacy of food and non-food crops needing large scale chemical inputs based on fossil fuels, large scale deforestation and mono-cropping techniques to feed the planned mega biodiesel projects.

It attempts to answer the following pressing questions about Jatropha based projects.

- Is Jatropha really the best among energy crops and does it leave the least environmental footprint?
- What are the impacts of large scale Jatropha plantations being planned in developing nations to feed the energy demands of the western world?
- How does the Jatropha economics work for the developing nations?
- To what extent is it more conducive in reducing GHG emissions?
- Is Jatropha cultivation and propagation sustainable globally to feed the needed market demand?
- Is biotechnology the answer to optimize Jatropha cultivation?

A. The biofuels business: present dynamics

The biofuel business is a complex web continuously reacting to the traditional oil business, as rising oil prices spur demand for biofuels. Meeting the ever increasing demand for biofuels calls for mega mono-cropped energy plantations, at the cost of prime forest land, and land for food production. It would also call for initiatives in crop cultivation technologies and competitive sourcing of appropriate feedstock - all of which can alter the biofuel economics.

The worldwide development of biofuels has raised a myriad of issues by stakeholders. Complex trade-offs are demanded by the production, distribution, and utilization of biofuels and its feedstocks. Besides, the biofuel economics has become so location specific for its sustainability that it rules out the possibility of common approaches.

Today the debate centers on the sustainability of food and non-food crops to drive biofuel markets in the coming years. Besides the challenges arising out of cultivation and propagation of non-food crops,

there are national level policy issues and social and organizational aspects of managing mega energy plantations, as also environment and biodiversity issues.

Currently known plans call for the addition of 820 million gallons before the middle of 2008. In 2005-06, Germany accounted for 61 % of biodiesel consumption. Other significant markets included France, the United States, Italy and Brazil. By 2010, the United States is expected to become the largest single market, accounting for roughly 18 % of world biodiesel consumption.

Europe currently accounts for 90% of global biodiesel consumption and production. A conservative industry estimate indicates that biodiesel could represent as much as 20%-22% of all on-road diesel used in Brazil, Europe, China and India by the year 2020.

In Brazil, China and India massive government measures are being enacted to institute Biodiesel as a part of the country's long-term energy strategy. These countries are just getting started with their biodiesel development plans.

Re-emergence of Jatropha

The focus is now on non-food crops with Jatropha being rediscovered as the new pin up boy of renewable energy proponents. Contemporary trends across the world indicate a pronounced shift towards Jatropha as a more viable and sustainable feedstock for biodiesel compared to other food based crops such as Palm, Soya, etc.

The present mixed reaction to Jatropha, not only highlights how swiftly investors are shifting gears due to shortcomings of other renewable contenders, but also highlights the uncertainties over the economic viability of large Jatropha plantations.

Asia and Africa have now emerged as key investment hotspots for Jatropha. These investments need to be based on realistic and conservative estimates of Jatropha production, resource inputs such as water and chemical, labor and also in the cost-benefit analyses of end product and by product.

While the debate on food versus fuel occupies centre stage there are new concerns being raised about the viability of non-food crops for fuel production. Though touted as a significant feedstock for biodiesel, Jatropha projects are coming under closer scrutiny.

A major concern about the mega plantations is that, besides large scale deforestation and using land for energy crops, these ventures are more likely to feed into the western world, which are today the biggest investors and consumers.

Increasingly, the issue of sustainability in biofuel feedstocks cultivation accompanied by food versus fuel debate has become a rallying point for all stakeholders in this business. Long term sustainable

strategies will be central to the economic and ecological viability of these ventures. Sustainability of Jatropha as a biofuel crop in a country will depend on its national policy on biofuels, social and organizational aspects of setting up large scale plantations, environment and biodiversity issues, etc. Research has been directed towards enhancing the rate of propagation and optimizing the yields. Current trend in Jatropha cultivation is focused towards the use of improved germplasm for optimal yield of nuts with an optimal amount of oil, and matching this germplasm to sites with fertile soils and adequate moisture to enable it to reach its genetic potential to produce optimal yields.

Today genetic fingerprinting technology enables the identification of different Jatropha cultivars through genetic markers, much like commercial bar codes. The technology has the potential to increase significantly the efficiency of breeding programme to develop high-yielding Jatropha cultivar.

B. Biofuels trade: a feedstock analysis

Global biodiesel trade has been low with EU dominating the trade flows. Near term projections of trade in Asia indicate a growth due to demand from the transport sector. Over the longer term, Africa and Asia are projected to be major players if the multitude of projects in developing countries like Burkina Faso, China, Ghana, India, Madagascar, Malawi, Swaziland and Zambia are any indication. These countries are all adopting location specific models to promote Jatropha as an ideal feedstock for biodiesel.

Major biodiesel feedstocks, such as Jatropha, Palm oil, Sunflower, and Soy are predominantly grown in developing regions, while the investments and consumption are driven by developed nations. It is the tropical developing world which is bearing the ecological footprints of bioenergy feedstocks whereas much of the new capacities are coming up in the OECD nations. Of late India, China and Brazil are fast emerging as major players. Currently, OECD countries account for most of the world's consumption of biodiesel, and about 85% of its production.

It is obvious that the growth projections of the biofuel industry are likely to place enormous pressure on the environment and biodiversity in developing regions, which will have to factor in environmental values in its pricing mechanisms.

Biofuels: International Trade

A number of industrial and developing countries have initiated programmes to promote biofuel production and consumption, setting targets for increasing the contribution of biofuels to their transport fuel supplies.

Today the global biofuel market utilizes so-called first generation technologies and relies mainly on agricultural food or feed crops for feedstock. Second generation biofuels, still far from commercially viable, are poised to open up many new opportunities. They can be sourced from a much wider

variety of feedstocks which vastly expands the potential for fuel production and for abating greenhouse gas emission.

Biofuel and agricultural trade liberalization is expected to increase world prices of agricultural commodities. Higher feedstock prices in turn could slow the growth of the global biofuel market. Biofuel production growth has already begun to change the price relationships among various agricultural commodities. Prices are expected to rise more steeply for the food products that developing countries import than for the commodities they export.

In the future, second generation biofuels could use agricultural residues and other feedstocks that are not used as food or feed. Feedstock costs comprise more than half the costs of producing both ethanol and biodiesel. More generally, biofuels have not been commercially viable without significant government support.

Any effect on feedstock prices arising from agricultural or biofuel policies has an immediate effect upon the economics of biofuel production.

Trade policy to drive biofuel feedstocks

Globally the following two types of policies drive biofuels:

- Policies to replace consumption of petroleum fuels, and
- Policies to stimulate biofuel production domestically, producer subsidies, import tariffs to protect local producers, and research to develop new or improved technologies.

Agricultural policies in industrial countries have tended to depress international crop prices. Major feedstocks are primarily used as human food and animal feed, and the by-products of biofuel manufacture play a significant role in biofuel economics. Recent trends in diversion of a crop to the biofuel market is beginning to link that crop's price to the world petroleum market.

Barriers to trade are expected in the form of certifications being proposed on environmental sustainability, prompted by concerns about burning and clearing of rain forests to plant Palm and Soybeans in Southeast Asia and Latin America. Growth of biofuel production based on current technologies will face several challenges, such as limits to land utilization and resource inputs. Proponents of biofuel trade liberalization anticipate that it will increase competition, optimize costs and allow efficient producers to consolidate their market shares.

Biofuels: Demand drivers

Biodiesel demand is spurred by the following critical factors such as,

- Tax incentives
- Regulations on the quality or share of biofuels in transport fuel
- Government procurement policies

- Exemption from or refund of the excise tax on diesel
- Tariff liberalisation

Biofuels and environmental impact

Assessing the long term environmental consequences of biodiesel feedstocks production is a complex task. Life-cycle reductions in carbon-dioxide emissions depend on the source of the feedstock, production pathways, and the assumptions made regarding alternative uses of the land from which the feedstock was produced, especially if the land had previously been forested.

In the case of current feedstocks employed the GHG balance is particularly difficult to ascertain. The uncertainty is because of nitrous oxide emissions associated with growing oil bearing plants. These are dependent on the rate of nitrogen fertilizer application. In this context Nitrogen fixing plants, including legumes like Soy, and non-leguminous plants, like Jatropha and Jojoba, have been found to be more acceptable.

The effects of modest increases in trade on land requirements would depend on what oils are used as feedstock. It is more likely that there will be a global rearrangement of oilseed production with more tropical plant oils going into fuel than into the food chain. Castor bean and Jatropha plantations are being initiated mainly in semi-arid areas on degraded land. Both plants adapt well to semi-arid climates, and a few millimetres of rain each year is enough for reasonable yields.

The social and environmental benefits of biofuels in South-East Asia is now under scrutiny. The environmental impact of diverting land, to the production of oil feedstock for transformation into biodiesel, depends on more than just yields. In many countries the cost of water used in growing crops for the production of biofuels is heavily subsidized. In this context Jatropha, needing minimal inputs is more promising.

As the pressure on land for biofuels increases, there will be long term effects on biodiversity due to changes in or loss of habitats. This will vary considerably from mixed, low-intensity agriculture to intensively farmed mono crops, or from tropical rainforest to managed plantations.

C. Sustainability in non-food crops

Biofuel feedstocks: Making sustainable choices

Making the right choice of biofuel feedstocks is a complex task and poses critical questions for policy makers to address? These are:

- Which crops are best suited?
- Are they amenable for genetic modification?
- How can small-scale farmers be engaged without excessive transaction costs?
- What will motivate industry to make long term commitments?
- What are the revenue models for each crop?

- What competing technologies or products might change the competitive landscape unexpectedly?

Several aspects contribute to being competitive with fossil fuel energy sources. Biofuels projects need to have suitable economies of scale and be able source reliable supply of plant material (feedstock) to keep processing facilities running at high capacity in order to keep unit costs of production per litre of biofuel as low as possible.

The requirements of scaling up could effect a corresponding drive to large-scale farming. It could also lead to the replacement of food crop cultivation with biofuel crops on large areas of land, driving up food prices for those who can least afford it.

Is the present position sustainable?

In 2006, the worldwide output of biodiesel refineries was about 4.0 million tons (1.15 billion gallons) of distillate product, which required about 3.5% of the world's vegetable oils. This production helped displace about 4 days of the world's on-road and off-road diesel consumption. About 4.3 million hectares of land was required to grow all the oilseeds needed for this displacement.

EU's Agricultural Commission estimates that as much as 18% of total agricultural land will be switched from food to energy crops, to meet EU-25 plans of all transportation fuels to be biofuels by 2010. Europe, along with the rapidly growing US biodiesel industry, and countries like China and India that import vast amounts of vegetable oil for food purposes, have begun to look at imports for additional sources.

Negative impact of Jatropha

In Africa and Asia there are serious concerns about jatropha's environmental and social impacts. There are questions about growing jatropha without irrigation. Indian studies show that, without irrigation, the average yield after five years is 1.1 to 2.75 tonnes per hectare, compared with 5.25 to 12.5 tonnes per hectare with irrigation.

While it is promoted as a sustenance crop for farmers in practice, it has in fact become yet another plantation-based agribusiness commodity, tightly controlled from seed to fuel by mega corporations.

Biofuel certification systems

Of late there has been pressure on the industry to adopt voluntary certification schemes. Sustainability standards are often subject to regional norms and the need for internationally accepted standards are needed to enable trade.

- A host of issues crop up regarding setting standard. These include,
- Eligibility for setting standards
- International criteria for adoption

- An international body to accredit the certifiers

However, concerns have been raised about the following:
- Enforcement of mandates
- Effectiveness of certification that could be undermined by displacement of biofuel products
- Uniformity of certification scheme
- Misuse of certification schemes and sustainability standards regulations

What is needed is a worldwide certification that can be effectively enforced. Selective certification gives the appearance of sustainable production to some, while allowing others to continue the practice of unsustainable production.

Second-generation technologies hold promise

The impact of many first-generation technologies has led to the belief that second generation technologies may be better received. It is true that these so-called second-generation technologies could, in theory, make it possible to avoid competing land use claims by growing biomass feedstocks on marginal and degraded land and using residual biomass materials. In practice it is yet to be validated.

These second generation technologies are still in the demonstration phase. It remains to be seen whether they will become economically viable over the next decade. Furthermore, commercialization of second-generation technologies is still at the drawing board stage with only pilot and demonstration plants being built at present.

Leveraging biotechnology for non food crops

Non-food crops have been cited in many contexts as having the potential to provide alternative economically viable uses for farmland. Biotechnology holds much promise to enhance the utility of conventional non-food crops e.g. through selective or marker-assisted breeding of grain and oil seed crops for higher yields of starch and oil.

However, there are several concerns being raised and these relate to
- Policy / regulatory pressures influencing the non-food crop agenda
- Evaluation of potential impacts of biotechnologically developed non-food crops compared with conventional crops (e.g. for energy crops)
- Environmental impact, energy efficiency, etc.
- Availability of biotechnologically developed non food crops in the near future

D. Policy initiatives

Government policies play a large role in the financial attractiveness of biofuels production and trade. Domestic production is supported through both border protection and production subsidies.

Regulations mandating usage, or blending percentages and fuel-tax preferences to stimulate production, are used by many countries. In most cases these policy measures do not distinguish among biofuels according to their feedstocks or production methods, despite wide differences between them in environmental costs and benefits. This implies that governments could end up supporting a fuel that is more expensive and has a higher negative environmental impact than its corresponding petroleum product.

There is a need to evolve strategies to re assess first generation biofuels. International organizations such as the IEA, OECD, FAO to name a few need to arrive at a common understanding of the limits of both traditional and second-generation biofuels in their planning and analysis of energy sector in future.

In the case of second generation technologies there is a pressing need to evaluate long term sustainability of feedstocks by focused research. Research efforts are needed to validate the environmental benefits for each biofuel production pathway, feedstock and location. More importantly, the key is to have clear policies on unified norms for certification of biofuels.

Future efforts need to be marshaled to study wastelands, including land tenure as well as productivity, sustainability, and environmental impact dimensions. Besides continued search for additional biofuel crops to diversify feedstock sources and reduce the risks will be important. Debate over biofuel feedstocks need to address the key concerns outlined below.

Concern 1: Rise of biofuels and food security

Food security and food prices have been a major concern with food crops being used for biofuels production at the cost of feeding the populace. Biofuels, either, based on food crops or non-food crops will increase demand on land and wate,r both of which are at a premium for average citizens in developing nations. With land being diverted for fuel, energy crops will be produced at the cost of food crops, driving the prices of food crops beyond the reach of most people.

Concern 2: Competition for land and agricultural resources

Large scale cultivation of crops for biofuel will trigger new competition for agricultural resources; between food production and biofuel production. Even with the strategy to focus more on non-grain oil crops such as Jatropha, which can even grow in marginal lands, massive production would require conversion of large agricultural and forest lands to grow these crops on a commercial scale.

Concern 3: How biofuels impact energy security

Concerns about the influence of biofuels on energy security has been raised mainly by the OPEC cartel. Net importers of oil from developing nations see biofuels as an energy alternative to enhance their energy security. The key challenge for these counties will be the promotion of biofuel use at a level that does not significantly strain the environment.

According to The International Energy Agency, biofuels were likely to be competitive with petroleum at prices, between US$60 and US$100 a barrel, though present findings indicate that biofuels production has not made any dent on the price of crude oil.

Concern 4: Biofuels and subsidies

There have been calls for liberalization of biofuel trade, and imports to be subsidized though there have been no responses from many governments. For developing countries, liberalization of the biofuel trade would allow the most efficient producers to expand operations beyond their borders. It would also promote increased efficiency and contribute to lower prices, allowing greater source diversification worldwide.

Concern 5: Biofuels and GHG reduction potential

In recent years there have seen major forays into research on biofuel feedstocks cultivation, processing backed by large scale plantations, and plants. However, this has been accompanied by concerns over its potential to reduce GHG emissions, as replacement potential of biofuel is still small.

Concern 6: Biofuels and environmental footprint

Efforts to increase consumption of biofuels will drive production, which in turn will lead to increased deforestation, soil degradation and depletion. Besides, land being at a premium, there will be a move towards intensive chemical and water based cultivation. Energy plantations need large scale mono-cropping, which hastens biodiversity loss. Feedstocks such as Jatropha are reported to add nutrients back to the soil, reduce the need for irrigation, and help curtail soil erosion.

Concern 7: Biofuel feedstocks and marginal land usage

The practice of growing energy crops on marginal lands has become an important area of research, especially as concerns about food security and biodiversity mount. Indonesia is planting Jatropha on non-forerstry and non-agricultural land. Mali is beginning to experiment with Jatropha on abandoned lands, and India is not far behind.

If planted densely Jatropha can be more of a problem, preventing growth of grasses and shrubs needed for livestocks. With land unavailable, the pressure to resort to dense cultivation is high, leading to concomitant problems.

Concern 8: Biofuels and crop suitability

Though the preferred options for biodiesel are Rapeseed, Soybeans and Palm, there are significant developments based on other crops for use as biofuel feedstock. Focus has been on non food crops such as Jatropha, where tremendous amount of research is being conducted on soil types, farming systems, and cultivation scenarios.

Key criteria for biofuel feedstocks are the following:

- Economic viability- yield per hectare- input requirements

- Suitability for different biofuel applications
- Versatility, drought and pest resistance
- Competing uses, price volatility

Concern 9: Biofuels and Government intervention

Production of biofuels is heavily dependent upon government support: from policies supporting decentralized production or local use, to those encouraging the organization of cooperatives. Subsidies have often benefited agribusiness firms, rather than small farmers or landless workers. Subsidies can be limiting, and impact the potential for permanent price competitiveness of biofuels. The challenge for the government is to balance sustainable development of the industry without having to prop up an inefficient sector through subsidies.

Concern 10: Biofuels and influence on local economies

Meeting the targeted blending mandates of 5% by 2020 would need a five-fold increase in biofuel output and investments close to US$ 20 bn. Today feedstocks account for over 50% of the cost of production and further rationalization of feedstocks production is needed.

Policy corrections include rural infrastructure, credit availability, and land holding patterns. Farmer ownership of processing facilities also reduces feedstock supply risk.
In conclusion

The rush to energy crops, either food or non food crops, threatens to cause food shortages and damage to biodiversity with limited benefits. Any diversion of land from food or feed production to production of energy biomass will influence food prices. The growth of the biofuels industry is likely to keep these prices high and rising throughout the next decade (OECD/FAO, 2007).

Higher oil prices will both raise the production cost of biofuels and exert upward pressure on agricultural commodity prices. In the context of such trends, non-food crop such as Jatropha may yet prove the best option if it can be produced and processed in a sustainable manner. Technology and economics of Jatropha have thrown up several questions. Further research is needed to validate the promise of Jatropha.

Bibliography

1. Benge, Michael D. “Assessment of the potential of Jatropha curca for energy production and other uses in developing countries.” Washington, DC: August, 2006. http://www.echotech.org/
2. Challenges and opportunities for developing countries in producing biofuels. United Nations Conference on Trade and Development, 27 November 2006. http://www.unctad.org/en/docs/
3. An introductory guide for assessing the potential of biofuels in developing countries, USAID, 2006
4. Pro-poor biofuels outlook for Asia and Africa: ICRISAT’s Perspective, A Working Paper, 13 March 2007

About the Author

This Position Paper, ‘Sustainable Biodiesel Feedstock. Jatropha: A Strategic Option’ was written by Dr.R.Rajagopal, Chief Coordinating Officer of KnowGenix. KnowGenix, Mumbai, India, is a growth strategy service firm with practices in chemicals, materials and energy. It offers a host of services including business optimization, competitive intelligence, knowledge documents and executive training to clients in oil, gas and chemical value chain. For details visit **www.knowgenix.com** or send an e-mail to **strategy@knowgenix.com**.

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Biodiesel is the buzz word today with the hype over large scale biodiesel investment creating volatilities in the agri-food chain where several crops compete for food versus fuel usage. With the maturation of traditional cultivation technologies, pressure on available arable land and food-based crops has been severe.

The jury is still out on the ideal crop for developing a sustainable biodiesel model. Though experts vouch for palm oil, support for Jatropha on social and environmental grounds is very high. Debate, analysis and interpretation of the complex issues surrounding Jatropha's potential are the focus of **JATROPHAWORLD 2008**.

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