

# Income Generation from Biofuel: Opportunities and Challenges for Poor Farmers in Southern Africa

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## Abstract

*Increasing rural household income is a primary objective for achieving many development goals, including reducing poverty, hunger, and food insecurity. Despite worries such as, intensive cultivation, bigger farms, deforestation, and less area for growing food, the production of biofuels (i.e from maize, cassava, Jatropha or sugar cane) provides new opportunities for resource-poor, small-scale farmers within the continent. There is, however, a need to strike a balance between food and biofuel production in order to avoid food shortage which will lead to dependency and famine. Access to information on what and how to produce as well as to secure market outlets will significantly influence the level of income generated by these farmers. The state will play a key role in providing physical and institutional infrastructure if small-scale farmers are to benefit from these opportunities.*

**Key words:** Transaction Costs, Biofuels, Physical, Institutional Infrastructures, Agriculture.

## Sumário

*O aumento da renda de famílias rurais é um objectivo primário para se alcançarem as várias metas do desenvolvimento, que incluem a redução da pobreza, da fome e da insegurança alimentar. Apesar de preocupações relacionadas com o cultivo intensivo, maiores campos de cultivo, desflorestamento, e um número reduzido de áreas para cultivo de alimentos, a produção de biocombustíveis (tais como de milho, da mandioca, da jatropha ou da cana-de-açúcar), oferece novas oportunidades para camponeses com poucos recursos e de pequena escala dentro do continente. Existe, entretanto, a necessidade de se fazer um equilíbrio entre a produção de alimentos e a de biocombustíveis de modo a se evitar a escassez de alimentos que pode resultar em dependência alimentar e na fome. O acesso à informação sobre o quê e como produzir, assim como assegurar mercados para venda de excedentes, vai influenciar significativamente o nível de renda gerado por esses camponeses. O Estado terá de desempenhar um papel preponderante ao providenciar infraestruturas físicas e institucionais desde que os agricultores de pequena escala sejam os beneficiários dessas oportunidades surgidas com a produção dos biocombustíveis.*

**Palavras-chave:** Custos de Transição, Biocombustíveis, Infraestruturas Físicas e Institucionais, Agricultura.

The production of biofuel from maize, cassava, sugar cane and *Jatropha Curcas*, to name a few, could bring investment, development and employment to rural areas with high levels of poverty, as well as reduce dependence on imported fossil fuels for countries with the right 'know-how' in industrial technology. There is still widespread concern that farmers in Africa will not benefit from the countries' biofuel investments. For centuries, Africa has failed to gain much benefit from its enormous mineral deposits as well as from agricultural products such as coffee, tea, cocoa, etc. The obvious question is whether today, with the introduction of biofuel schemes, income generation will be any different from the known past where Africa is just a source of raw materials, if no country has a plan to master the technology before any scheme is undertaken?

Bioenergy development will depend on how far the existing agro-industry in the country will be able to transform biomass to biofuel production, and the role that public and private investment may have on the development of the sector. These factors are key determinants on the economics of the biofuel industry and are fundamental to determine the potential for the eventual commercialisation of biomass-derived fuel, in particular, in developing countries (Felix, *et al.* 2007). An evaluation of the technology capacity focusing on criteria such as the human skills that are necessary to support a biofuel processing operation (i.e. skilled and unskilled labour); access to technologies from local suppliers and provision of services; and finally, access to processing inputs for operating biofuel plants, including chemicals, solvents, additives, etc., will be needed in each country wanting to promote biofuel production for its own benefits. Such an evaluation was conducted by Felix, *et al.* (2007) for Tanzania and indicated that the technological capability of the country is limited and as such, investment is needed to build human capital to ensure that technical personnel capable of handling industrial equipment and solving possible operational problems is available to support biofuel development because the availability of the necessary skills will also support the introduction of more advanced technologies to lower production costs.

Besides these concerns, the impact of biofuel production on arable and marginalised lands as well as on food security, needs careful consideration before undertaking such projects at a large-scale level. Before any unrealistic expectation is made, a careful assessment of the agro-fuel production is required. The objective of this paper is to underline some opportunities as well as challenges faced by small-scale farmers in southern Africa concerning biofuel production and the presence of physical and institutional infrastructure. In so doing, the paper introduces the concept of transaction cost economics.



## Global overview of biofuel production and perspectives

Global production of biofuels increased 17% in 2010 to reach an all-time high of 105 billion litres, up from 90 billion litres in 2009. High oil prices, a global economic rebound, and new laws and mandates in Argentina, Brazil, Canada, China, and the United States, among other countries, are contributing to the surge in production, according to research conducted by the World Watch Institute's Climate and Energy Program. (World Watch, 2010)

Few countries so far dominate the production of biofuel. The USA and Brazil are the largest producers of bioethanol by a large margin (i.e. USA 39%; Brazil 33%; China 8%; India 4% and France 2%). In 2010, the United States generated 49 billion litres, or 57% of global output, and Brazil produced 28 billion litres, or 33% of the total. Corn is the primary feedstock for US ethanol, and sugarcane is the dominant source of ethanol in Brazil. The EU produces almost 95% of the world's biodiesel. The largest increases in production volumes are expected in Brazil, the USA, the EU, China, India, Indonesia and Malaysia. Annual global production of bioethanol is projected to increase to 120 billion litres by 2020, and biodiesel to 12 billion litres. New producers have joined the stream in Latin America, and Caribbean countries are seizing opportunities derived from biofuel trade to diversify their sugar industry. South East Asian countries such as the Philippines and Thailand have introduced aggressive policies for biofuel and have begun production (Pesket *et al.*, 2007).

The EU, for instance, needs biofuel to meet its controversial target of sourcing 20% of its energy needs from renewable sources by 2020. Agriculture has a key role to play in reaching biofuel targets for many developed countries. Farmers in these countries are encouraged to grow the feedstocks for bioethanol and biodiesel. However, while biofuels provide excellent possibilities for farmers, there is a need to strike a balance between the need to produce for food and non-food uses. This means that developed countries with the technology will fulfill some of their biofuels demand through imports. Do African countries therefore represent only one of the supply bases for raw materials, or are they planning to acquire the technology enabling them to process biofuels for their own consumption?

In Joachim von Braun & R. K. Pachauri (2006), it has been stated that incorporating 5.75% of agrofuel in oil fuel would require 20% of the present grain area in Western Europe. By using the complete agricultural area of EU, only 30% of the present needs for fuel would be provided (Communique de Presse, 2008). As a result, if the EU manages to import agrofuels, the problem of competition with food would be moved to less developed countries such as Colombia, Indonesia, Brazil, and Malaysia, as well as African countries (i.e. Tanzania, Madagascar, Mozambique etc.), and in doing so, challenging food security in these countries.

## Transaction cost economics and the role of the State

Transaction costs are the costs of exchange, including costs of searching, screening trade partners, bargaining, transferring, monitoring, and contract enforcement. These costs can be *explicit* (i.e. transportation costs) or *implicit* (i.e. opportunity cost of time spent searching for partners or new market outlets). The higher these costs, the lower the occurrence of any exchange, and thus lower profits from trade (North, 2000: 89-91). The transaction cost approach suggests that marketing institutions and the State play a crucial role in decreasing transaction costs. Institutions are the 'rules of the game' and are broadly defined as the means of reducing transaction costs. They consist of a combination of formal rules (such as those regulating the structure of policy, property rights, and contracting), informal constraints (norms of behaviour or customary rules of the game), and enforcement practices.

Implicitly, physical and institutional infrastructures that can reduce transaction costs become even more important for markets to operate efficiently. Of crucial importance is also the role of the State in securing a sound environment for the private sector's involvement in the marketing of agricultural products. The State's definitions and protection of property rights are essential to exchange, because they help establish, interpret and enforce a set of rules and procedures governing marketing activities (Delgado, C., 1999: 18).

Many households in rural areas of the continent face high transaction costs in inputs, credit and product markets. Poor roads and communication systems, transport, capital constraints and a low level of education are some of the major constraints faced by small-scale farmers in southern Africa. Marketing facilities and skills are always lacking and extension services are in most cases inadequate (Delgado, C. L. & Siamwalla, A., 1997). With opportunities to produce biofuel crops, many of these farmers will be (if not already) venturing into commercial farming. As these farmers progressively become market-oriented, they will inevitably become subjected to trade costs. Thus, the level of transaction costs faced by a household will determine the combination of cash and subsistence crops they will produce. Trade is expected to increase as transaction costs decline, thus affording better terms of trade, in part because of the uniformity of institutional structures among trade partners. The transaction cost approach calls for adequate infrastructure, including transport and telecommunication networks that permit the efficient movement of information, goods and services.

## Income generation opportunities for small-scale farmers in southern Africa

Most African governments see biofuel as having the potential to increase agricultural productivity and export incomes, and thus strengthen their national economies, improving energy balances and rural employment. At the same time, climate change may be addressed through the reduction



of green house gas emissions (Matondi P.B. *et al.*, 2011). Two-thirds of people in the developing world who derive their incomes from agriculture and *Jatropha Curcas* based biodiesel have enormous potential to change their situation for the better – poverty can be broken by *Jatropha* cultivation as this crop has a huge potential for replication worldwide, improving the livelihood of many more. At the community level, farmers who produce this energy crop can increase their incomes and grow their own supply of affordable and reliable energy. At the national level, producing more biofuel will generate new industries, new technologies, new jobs and new markets. At the same time, producing more biofuel will reduce energy expenditures and allow developing countries to put more of their resources into health, education and other services for their needier citizens. This will only be possible if the country is not used as a source of raw materials alone.

Taking advantage of opportunities and the ability to adapt to changing circumstances are arguably two prime ingredients of success in business. Two decades ago, a ‘green revolution’ helped millions of farmers in Asia and Latin America emerge from poverty with basic innovations such as fertiliser, improved irrigation and hybrid seeds. To break out of endless cycles of drought, poverty and hunger, the continent desperately needs to modernise its age-old farming techniques. Research has already shown that there is enormous potential to produce fuel from a huge range of raw materials, especially some of the byproducts of agriculture, which are currently regarded as waste (Joachim von Braun and R.K. Pachauri, 2006).

Opportunities in biofuel production are varied and many (i.e. byproducts and residues of plants etc.). Farmers will take advantages of all the opportunities in the spirit of entrepreneurship when there are conditions as stipulated in the transaction cost economics. These are infrastructure (i.e. physical/institutional), access to credit, contract enforcement, law enforcement for property rights and security, and support groups. People will always be creative and innovative when faced with a variety of circumstances. However, faced with a decline in infrastructure, they will only develop skills or innovations based on necessity and not opportunities. Any development should aim at facilitating entrepreneurship and innovation based on existing opportunities.

Also, Peskett *et al.* (2007) contend that the potential for biofuel in the reduction of poverty is huge, whether through employment, wider growth multipliers or energy price effects. Moreover, while some of the factors and impacts of biofuel can be tracked at global level, its distributional impacts are complex, and point to the need for country-by-country analysis of potential poverty impacts. De Keyser & Hongo (2005, cited by Peskett *et al.* 2007) argue that biofuel production presents a win-win situation for developing countries by creating rural jobs, increasing incomes and thereby improving food security. There are also claims that biofuels will result in increased hunger as maize is diverted away from household food utilisation in developing countries to feed cars of households in the developed world.

## Biofuel crop enterprises

Biodiesel production comes at a time when in some parts of the continent such as Senegal, Mali, Tanzania, Kenya, Zambia, and Mozambique, land for food already faces competition from game reserves and meat production. In these countries, interest is growing in bioenergy to address both income and energy needs. From a list of potential crops for biofuels, some can surely compete with land for food (i.e. maize, soja, peanuts, and rice) and labour at the household level. Generally, the majority of small-scale farmers in sub-Saharan Africa own on average between one and two hectares of land (Matungul *et al*, 2001). Sugar cane will require more than the average size of available land to small-scale farmers. Table 1 shows how much can be produced per hectare of a given potential biofuel crop:

**Table 1. Potential biofuel crop enterprises with their estimated oil production per hectare**

Crops	Scientific name	Litres of oil/hectare
Maize (Milho)	<i>Zea mays</i>	145
Cotton seeds	<i>Gossypium Hirsutum</i>	273
Soybeans	<i>Glycine max</i>	375
Rice (Arroz)	<i>Oriza sativa</i>	696
Pumpkins (Abobra)	<i>Cucurbita pepo</i>	449
Mustard (Mostarda)	<i>Brassica alba</i>	481
Sesame (Sesamo)	<i>Sesamun indicum</i>	585
(Tung)	<i>Aleurites fordii</i>	790
Sunflower (Girassol)	<i>Helianthus annuus</i>	800
Peanuts (Pinhão)	<i>Arachis hypogaea</i>	890
(Colza)	<i>Brassica napus</i>	1 100
(Ricino)	<i>Ricinus communis</i>	1 320
Jatropha	<i>Jatropha curcas</i>	1 590
Coco	<i>Cocus nucifera</i>	2 510
Palm tree (Palmeira)	<i>Elaeis guineensis</i>	5 550

*Jatropha Business, 2009*

Recently, some African countries have adopted the *Jatropha* crop because it grows in infertile soil and in conditions of drought. Studies suggest that a third of the land sold or acquired in Africa is intended for fuel crops – some 5 million hectares (Friends of the Earth, 2010). Friends of the Earth have looked at cases of land acquisition in 11 countries across Africa, from Ethiopia to



Mozambique. While some of this land is sold outright to private companies, state companies or investment funds, most of it is leased and some is obtained through contracting with the farmer to grow specific crops. In Mozambique for instance, agrofuel, particularly sugar-cane and *Jatropha*, is seen as a way of reducing dependence on fuel imports. The country has allocated the rights to almost more than 107 348 hectares of what was previously community farming and grazing land to grow *Jatropha Curcas*. The following table shows the involvement of some foreign companies acquiring land to grow *Jatropha* in Mozambique. Several other projects with *Jatropha* production are ongoing and in 2009, the Mozambican government approved a legal framework to regulate operations in the biofuel sector (Katerere F. 2010).

**Table 2. Involvement of some foreign companies with *Jatropha* production**

Company	Country	Area	Crop	Source
D1 Oils	UK	5 348 ha	<i>Jatropha</i>	Cepagri. MINAG
Energem Resources	Canada	60 000 ha*	<i>Jatropha</i>	Interview <a href="http://www.energem.com/biofuels.asp">www.energem.com/biofuels.asp</a>
SGC Energia	Portugal	20 000 ha	<i>Jatropha</i>	Cepagri, MINAG
Elaion Ag	Germany	1 000 ha	<i>Jatropha</i>	<a href="http://www.elaion-ag.de">www.elaion-ag.de</a>
Galp Energia	Portugal	5 000 ha	<i>Jatropha</i>	Interview
Sun Biofuels	UK	6 000 ha*	<i>Jatropha</i>	<a href="http://www.sunbiofuels.com/project.html">www.sunbiofuels.com/project.html</a>
Aviam	Italy	10 000 ha	<i>Jatropha</i>	<a href="http://www.aviam.it/eng/progetto.html">www.aviam.it/eng/progetto.html</a>
Viridesco	UK	10 000 ha	<i>Jatropha</i>	<a href="http://www.viridesco.com">www.viridesco.com</a>

\* Subject to increase after discussions

Source: *Friends of the Earth Europe, 2010*

*Jatropha Curcas* is a shrub native to Central America, traditionally grown as a hedge in many countries of sub-Saharan Africa and Central and South America. It is a woody crop (20-30 years), perennial, and easy to set up in marginal areas. *Jatropha Curcas* can grow in wastelands – almost anywhere, even on gravelly, sandy and saline soils. It can thrive on the poorest stony soil and grow in the crevices of rocks. The plant thrives on a mere 250 mm of rain a year, and only during its first two years does it need to be watered in the closing days of the dry season. Ploughing and planting are not needed regularly, as the shrub has a life expectancy of approximately forty years. The use of pesticides and other polluting substances are not necessary, due to the pesticidal and fungicidal properties of the plant. While *Jatropha Curcas* starts yielding from 9-12 months, the effective yield is obtained only after 2-3 years. This plant has the benefit of a high oil yield per hectare. It is able to produce up to 1.5 tons of oil per hectare. The oil obtained by crushing the

seeds is excellent for energy production purposes. (Agrolis SRL, 2009). Furthermore, animals do not graze on it (Joachim von Braun and R.K. Pachauri, 2006).

This means that this plant will not compete with arable land, which is one of the main concerns in terms of food security. However, the intensity of the production will require labour being diverted towards this activity. This though, will benefit large-scale farmers as they can afford engaging extra costs for main power. According to a report published by FAO and the International Fund for Agricultural Development (IFAD), using *Jatropha* for biodiesel production could benefit poor farmers, particularly in semi-arid and remote areas of developing countries, *Jatropha Curcas L.* grows reasonably well in dry areas on degraded soils that are marginally suited for agriculture. The roots of the low-growing *Jatropha* trees reach water deep in the soil.

The surface roots assist in binding the soil and can reduce soil erosion. Unlike other major biofuel crops, such as maize, *Jatropha* is not used for food and it can be grown on marginal and degraded lands where food crops cannot grow (FAO & IFAD, 2010).

## **Competition with food production worldwide**

A study by the World Bank suggested that the expansion of biofuel would not only cause significant land reallocation with notable decreases in forest and pasture lands in a few countries, but also a reduction in food supply. However, the magnitude of the impact of this reduction would especially be significant in developing countries such as India and those in sub-Saharan Africa (Govinda R. Timilsina *et al.* 2010).

Food and biomass require the same resources for production – land, water and agrochemicals. Food and fuel need not necessarily compete, particularly when there is careful planning for ecological conservation and sustainable production methods. In many developed countries, the rising costs of fossil fuel, as well as concerns about energy security and climate change, are generating new interest in other forms of bioenergy, such as new liquid biofuels made from agricultural crop residues. One of the major concerns in this process is that using crop land to produce fuel has the potential to raise food prices, drive small-scale farmers off their land, and thus exacerbate hunger in the world. The production of biofuel crops does not necessarily lead to increased food insecurity. One option can be combining food production with energy crops. However, given the small size of allocated arable land, this option presents many limitations, but can be done with proper selection and technologies (i.e. hybrid seeds, fertilisers etc.). This also, however, presents quite a challenge for many African small farmers.

After a careful selection of what to produce, there is also a possibility of using food crop residues like rice and wheat straw, maize husks and sugarcane that can be converted into biogas, ethanol, and electricity. How many countries on the continent already have the capacity and the technology to receive or use these residues if available, and transform them to ensure a depend-





able market outlet for small farmers? In addition, small-scale farmers could also rotate food and energy crops. Research has already shown that some farmers in Latin America have been increasingly growing sugarcane in rotation with tomatoes, soya, peanuts, and other foods (Joachim von Braun and R.K. Pachauri, 2006). Lastly, if unable to rotate or combine crops, another possibility is to grow energy crops in more marginal lands. This, however, will require acquisition of extra land by the small-scale farmers and can lead to one of the major concerns, deforestation. Moreover, a report produced by the Forum for Agricultural Research in Africa (FARA, 2010) states that crops can be produced for biofuel on a significant scale in west, eastern and southern Africa without doing damage to food production or natural habitats. If proper policies and processes are considered, bioenergy is not only compatible with food production; it can also greatly benefit agriculture in Africa. "Bioenergy production can bring investments in land, infrastructure, and human resources that could help unlock Africa's latent potential and positively increase food production."

## **Conclusions and policy recommendations**

The development of biofuels has a potentially important role to play in poverty reduction- through employment, wider growth multipliers and energy price. However, based on the transaction cost approach, this paper concludes that in order to make a difference in the lives of rural people in general, and of small-scale farmers in particular, adoption of biofuel production alone would not be enough in generating income and thus alleviating poverty. Facilitating infrastructures (i.e. physical and institutional) in the rural areas are an important component of the fight against poverty.

The policy implications of the new opportunities and their challenges are that there may be substantial benefits in developing infrastructure to effectively link these production areas to market centres (via contract farming), and in improving market knowledge by providing more relevant, accurate public market information and farming skills. Transaction costs could be significantly reduced if better roads and marketing facilities were provided. Therefore, specific policies addressing the constraints and limitations of small-scale farmers through physical and institutional change, market information, development of rural markets, and provision of appropriate incentives are required. More research is, however, needed to identify the most efficient biofuel crops, which could generate high return for small-scale farmers.

Government should get involved in providing through extension undertakings, market information, and adoption of various technologies, as well as ensuring that the production of food will not be sacrificed in order to adopt biofuel production. Not engaging in this type of exercise will result in some rural areas with plenty of biofuel crops and no food for own consumption.

In summary, it is not just about production opportunities but also about the long-run access to market outlets for biofuel products in order to generate income and thus fight poverty. The chal-

lenge today is not so much whether bioenergy production can co-exist with food production, but rather how it can be set-up to help African countries realise their potential. Many of them do not have the technology to transform these agricultural products into fuel. This means that farmers in these countries will always depend on the demand of developed countries with the technology. This will surely lead to a repeat of situations faced by Africans farmers of cash crops such as cotton, coffee, cacao with all the international price volatility, trade restrictions and barriers. As a result, all the promises and expectations about biodiesel production in the continent will just be that, and be of no real benefit to small-scale farmers in Africa.

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