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Trócaire

Are biofuels a feasible option to reduce poverty in a changing climate? Learning from the Brazilian experience

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Biofuels can be made from different fuel crops. Sugarcane, corn, sweet sorghum, cassava are the most common feedstock for ethanol and palm oil, soybeans, jatropha, rapeseeds and sunflowers are commonly used in biodiesel production. In the case of ethanol, the feedstock undergoes a fermentation and distillation process right after harvesting. This process delivers anhydrous (99% pure alcohol) or hydrous (96% alcohol) ethanol. In the case of biodiesel, cold pressing or solvents are used to extract vegetable oil out of the feedstock which is then transformed into biodiesel through an esterification process (i.e. triglycerides of the vegetable oil are transformed into esters). The result is a fuel with characteristics similar to petrodiesel.

Biofuels are carbon neutral in the sense that the same CO2 absorbed by the feedstock plants during the photosynthesis is then released in the atmosphere while the biofuel is burnt during combustion in transport or stationary engines. However, their carbon neutrality has recently been questioned by several studies claiming that if biofuels are produced by clearing virgin lands and rainforests, their carbon balance would be negative because of the large amount of carbon that is stored in the soil and in areas with a high biomass density.(1) However, if biofuels do not induce direct or indirect deforestation and feedstock is grown on degraded land, then biofuels can have an important role in mitigating greenhouse gases. For example, according to a preliminary study carried out at Harvard University with datafrom the Food and Agriculture Organization of the United Nations, there are about 95 countries which have enough unused and good quality land that, if cultivated with biofuel crops, could in theory meet over 50% of current global oil demand. (2)

However, because of this great potential, several concerns havebeen raised recently about the impact that large scale biofuel production would have on food availability, especially for the poorest regions of the world.(3) Many independent studies point out that the current rise in food prices is partially attributable also to the share of grains and seeds used for ethanol and biodiesel production. Oxfam International (2007) recently announced that although biofuels can offer important opportunities to reduce poverty in adequate conditions, the emerging agro industrial biofuel model based on extensive monocultures represents a threat to poverty reduction.

Moreover, the environmental effectiveness of many biofuels has still to be demonstrated.(4) In the case of biofuel feedstock not grown on newly deforested areas and without taking into consideration land-use changes induced by displacing food crops,so far only sugarcane ethanol has the best potential to reduce total life-cycle greenhouse gas emissions and a net positive energy gain (8:1). Most of the other feedstock like corn seems to have an equal energy

balance. Corn ethanol, for example, reduces greenhouse gas emissions by less than 20% because fossil fuels are used as a fuel and fertilizers in the production process and the energy inputs are almost 80% of the energy output.(5)

Until early 2000, the production of ethanol was cost effective when oil prices were below, at or above $45-50 per barrel. The increase in oil prices over $100 per barrel has more than doubled the cost of fertilisers, which in turn has increased the production cost of sugarcane by about 25-30%. Considering that in the southeast region of Brazil the cost of sugarcane corresponds to about 61% of the production cost of sugarcane and that the Brazilian real has been devalued against the dollar, Brazilian ethanol is today cost competitive against oil by around $70-80 per barrel.(6)

Since 1975, the first year of Pro-alcool (Programa National doAlcool: the Brazilian National Alcohol Programme), the industry has grown about a hundredfold, from its initial production of 172,000 m3 to about 18 million m3 in 2007. About $20 billion were invested to create probably the most successful biofuel industry in the world.Despite this, some fundamental questions remain to beanswered.

- How has the ethanol industry helped reducepoverty in Brazil?
- What were the social benefits of the Pro-alcool programme?
- Have these social benefits been maximized?
- As climate change is already affecting agricultural productivity in many regions of the world, what are the challenges and opportunities of promoting biofuel crops?
- What role should governments, development organisations, the private sector and non governmental organisations (NGOs) play in promoting biofuels across the globe?

This article tries to provide preliminary answers to some of these questions by drawing lessons from the Brazilian experience in ethanol and biodiesel production.

The Brazilian Pro-alcool programme

The Brazilian ethanol industry began officially with the launch of the first phase (1975-78) of the Pro-alcool programme. It was created from strong political, technical and economic motivations that persisted, in different forms, for many

years. Among several factors, the two most important that pushed the Brazilian government to initiate its alcohol programme were:

1. The protection of the state-controlled but privately owned Brazilian sugar sector from collapse; and

2. High oil prices that were seriously affecting Brazil's balance of payments.

In the early 1970s, sugar prices were drastically lowered after the relaxation and temporary suspension of the sugar quota system.The programme therefore aimed at stabilising sugar prices by transforming the excess sugarcane production into an hydrous ethanol, a liquid fuel that could be blended directly with petrol without major modification for up to 20% of car engines. In addition to this, a 20% ethanol blend would have increased octane(i.e. enhanced the ignition properties of petrol) and eliminated the use of lead in petrol. Ethanol was therefore a win-win opportunity: the Brazilian government would have helped its sugar industry while decreasing the dangerous pressure on export crops that were used to pay very expensive oil imports during the energy crisis ofthe 1970s and 80s.

Ethanol was therefore purchased directly from the state-owned oil company Petrobras at a fixed price and mixed directly with petrol. Because at that time ethanol was far from being cost competitive compared to petrol, the Brazilian government put inplace a petrol-ethanol subsidy. Petrol was priced twice as high when compared to the United States and the extra cost was passed to ethanol producers to lower their production costs. Moreover,ethanol producers received loans at negative interest rates (15% in a period of inflation at 30%) which helped them build their plants.The ethanol programme went through different phases. During the first phase, production came mostly from ethanol plants annexed to sugar cane factories.Most of the ethanol was also of the anhydrous type. During the second phase (1979-85), the government set a very ambitious target (over 10 billion litres)which required the development of new independent plants not necessarily connected to sugar plants. The launch of 100% ethanol cars in the mid-1980s created also a solid niche for increasing ethanol demand in its hydrous form.

However, after 1986 the Brazilian government embarked on profound economic transformations of privatisation and liberalisation, into which an industrial policy programme like Pro-alcool did not fit. The reduction in the ethanol cross-subsidies, low oil prices, the ending of tax incentives for ethanol cars and low harvesting seasons all impacted against the increase in ethanol plant efficiency

and mandatory petrol blends. As aresult, alcohol production remained more or less constant at around 13 million m3 until the end of the 1990s, when higher oil prices, liberalisation of the alcohol industry and the development of "flex-fuel" cars (i.e. cars that can run on ethanol or petrol or a mixture of the two) consolidated the ethanol industry. By the beginning of 2006, flex-fuel vehicles represented 73% of all new vehicles sold.(7)

The current phase of the alcohol programme does not rely on any governmental price support mechanism or subsidies and other sectors do not pay any indirect costs. The government's main intervention is the requirement of minimum blends before petrol is sold to end consumers. Although ethanol delivers fewer kilometres per litre than petrol, consumers know that filling their car with ethanol is still economical because it costs 30% less than petrol. The price of ethanol therefore fluctuates with that of petrol. Brazil is also open to foreign investment and othe rcountries with mandatory biofuel targets are looking at the Brazilian ethanol market with great interest.

The social impacts of Pro-alcool

Pro-alcool has been a commercial success. Several economic,technical and policy factors helped the transition from a heavily subsidised sugar sector towards a subsidy-free ethanol industry.Several authors point out that the social benefits in terms of employment creation have been huge.(8) Towards the end of the1980s the ethanol industry was the third largest creator of jobs inBrazil with about 800,000 workers.

However, recent analysis shows that although jobs in sugarcane harvesting are the third best paid in agriculture after soybean and citrus, it is also true that about 50% of these jobs are precarious and/or seasonal.(9) Around 60-70% of sugarcane cutters come from the poorest sectors and since they are either illiterate or have not completed secondary school, years of manual labour may not help them move out of poverty. Moreover, several organisations have denounced the hardworking conditions in which sugarcane cutters have to operate.(10) In addition, ethanol production is concentrated in the hands of a small number of producers. Each processing unit now owns on average about 70% of the planted area that supplies its sugarcane needs. The remaining 30% comes from about 60,000 small producers (fornecedores). As large scale producers bought the land they needed to ensure sufficient supplies to run their plant at full capacity, today each processing plant owns about 12,000.ha. and each fornecedor who supplies sugarcane to the closest plant has just 27.5 ha.(11) Often the fornecedores are just the landowners and may not be directly involved in production, relying instead on a team of seasonal workers.

Brazilian ethanol production has developed a clear pyramid structure. A small number of firms (about 400) own a lot of landand control production with 60,000 small scale sugar cane producers working for them and about 800,000 seasonal workers taken on for basic harvesting work. This limits any sharing of wealth in the industry as 80% or more of the workforce is employed in harvesting, very low skilled work. A system that shares the social benefits more equitably would allow some of these sugarcane workers to be part of the production process aswell, maybe through local cooperatives and associations producing ethanol on a small scale and selling it locally.

Such concentrated production cannot be explained simply by economies of scale. According to the annual statistical data of ANP, the Brazilian National Petroleum Agency, hydrous ethanol costs were on average up to 25% more in those states that imported ethanol from the producing states of the south and southeast where most of the production is concentrated.(12) The three largest producers of ethanol in Brazil (SÃ£o Paulo, Minas Gerais and Parana) account for about 76% of the production but export 40% of what they produce. Transport and distribution costs and the retailers' mark up combine to make ethanol quite expensive in the importing states. Because ethanol produced at a small scale costs just 20-35%, small producers would benefit from producing and selling hydrous ethanol directly to consumers in specific regions. Today this option is not possible as ANP claims that a direct sale of ethanol is an incentive to tax evasion and poor quality from ethanol producers. Moreover, the price difference between small and large producers may decline if the fuel is consumed locally.(13) The real causes are to be found in broader socio-economical and historical contexts.

As pointed out earlier, the Brazilian government at the time of the first Pro-alcool phase found itself with very large budget deficits aggravated by high oil prices. It needed a quick solution to produce large volumes of ethanol in a relatively short time which proved to be a successful strategy. The quickest way of doing this was to support mainly large scale producers.

Secondly, the Pro-alcool programme financed mostly large scale plants according to some technical assessments made initially on facilities "annexed" directly to the sugar plants. These annexas could produce ethanol 10%-30% cheaper than independent distilleries due to smaller capital investments. It was difficult to change the direction of the national ethanol investment agenda once the Brazilian government began subsidising large scale plants.

Thirdly, the association of large scale sugar producers pushedthe government to place most of the subsidised

investments directly in their large-scale production facilities (existing and new developments). This was a strong political lobby which showed its ability to influence political decisions in favour of its own interests. The small scale sugarcane producers were not organised and unable to respond to this pressure.

Fourthly, too little attention was paid by the government to understand the real feasibility and social benefits of promoting smaller scale production units. The lower feasibility at the smaller scales was due also to the lack of credit and under capitalisation of the smaller farmers by government agencies.(14)

Recent experiences from the Brazilian southeast show that small scale ethanol production is more important socially than the large industrial complexes. They require less investment and are a significant factor in improving the living standard in rural areas where these small distilleries have been established.(15) Moreover, family-owned farms are among the world's most efficient sugar producers. Smallholder farms in Thailand compare favourably with large and medium size sugar farms in Australia, France and the United States.

In some respects, focusing on large scale production has not been an optimal choice for Brazil. Subsidising a small number of microdistilleries would at the very least have been beneficial to test alternative production models. Building smaller scale projects would redistribute assets more evenly, disseminate technology and build specific capacity. One of the key lessons to be learned from the Brazilian Pro-alcool programme is to explore the benefits of building a biofuel industry not only from a large scale production perspective but also from that of the local benefits created by smaller plants.

The National Programme for Use and Production of Biodiesel

In 2003, the Brazilian government launched the National Programme for Use and Production of Biodiesel based on two main policy instruments:

A system of incentives given to biodiesel producers;and

Mandatory targets - 2% substitution ofconventional diesel by the end of 2007, 3% by1 July 2008 and 5% by the end of 2013.

Probably capitalising on its experience from Pro-alcool, the Biodiesel programme has three main goals:

- To enhance environmental sustainability and social inclusion;
- To supply the biodiesel market with good quality products atcompetitive prices;

- To promote the production of biodiesel in different regions oft he country using a diverse range of raw materials.

Although the ethanol programme also addressed the social dimension (i.e. social inclusion), this aspect occupies a central part in the biodiesel programme. The market mechanism on which the programme works consists of:

Financing at attractive interest rates and with flexible guarantees for up to 90% of the whole production cycle and plant needed for biodiesel projects. Specific credit lines are available to family farmers who want to produce feedstock.

Under the programme biodiesel producers buying specific quantities of feedstock from family farmers in the poorest regions of Brazil receive social certification and pay reduced tax on the fuel produced. The tax exemption varies from 32% to100%. The percentage is calculated on the type of feedstock and the production region: the poorest regions and the most appropriate feedstock for those regions receive the highest tax exemption. ANP, the National Petroleum Agency, regulates the market in this initial phase through reverse auctions where the suppliers must offer prices that are lower than the initial value and the winners are those bidders who offer the product for the lowest price. They are entitled to sell the biodiesel to the government at the agreed quantity and price.

In principle some of the tax exemption benefits are passed from the biodiesel producers to the family farmers through a public private partnership. Although the government does not determine how this partnership should be created, there is some evidence of what are optimal structures.16 The local/ state government should start by indicating an area for feedstock production by giving land concessions. The local bank then pays a small salary by way of a loan to all the family involved for a specific period of time, e.g. 3 to 7 years. A special arrangement is then made between the biodiesel producer and the bank, where the producer guarantees to purchase 100% of the feedstock at the international market price. When production starts, the biodiesel producer retains 20% to repay the bank loan. The local municipality is responsible, preferably, for selecting the families work the land. The biodiesel producer should also be responsible for the technical assistance and preparation of the over all agricultural production framework.

The social impacts of the bio-diesel programme

Although Brazil's biodiesel programme is rather new and it is impossible to draw

any firm conclusions, some general observations can be made. The programme is capable of providing some clear social and environmental benefits. According to Bermann some small farmers have increased their income by 30% or more by joining the programme.(17) The 2% target will be probably achieved by 2008, (18) preventing several million tons of CO2 per year from being released into the atmosphere. As foreign investors explore the opportunity to develop biodiesel plants in Brazil through the biodiesel programme, the social impacts can be maximised if the programme shows it can work effectively in reducing poverty.However, some serious challenges need to be addressed,sooner or later. First of all, it seems that many small farmers are not participating as they should in the programme. Independent estimates say that less than 5% of the total feedstock production comes from this group.(19) A possible explanation is that the government has created a policy framework but not the operative framework needed to increase the feedstock production of family farmers. Moreover, it appears to be difficult to organise thousands of small farmers to bring a specific product to the market in a relatively short time, so the implementation phase is taking longer than expected.

Secondly, a redefinition of the most appropriate feedstock maybe necessary. The Brazilian government has given some indications (castor bean, sunflower, soya, palm) but none of these seem to be an optimal choice. Castor bean has a low productivity (800 kg/hectare) and high viscosity that persists to some extent even after the transesterification. (20) Sunflower yield is also low (800 kg/hectare) and requires at least 500 mm water through out the season. Moreover, its yield is sensitive to moisture stress during the flowering period. These conditions are unlikely to bemet in the most arid regions of Brazil, where 50 to 80% of the precipitation (600 mm/year on the average) can fall in a period of just two to three weeks. Similar comments can be made about soy (500-600 kg/hectare). Palm is probably one of the most productive and cost-effective feedstocks (2,000 kg/hectare) but the climate for growing palm is restricted to coastal areas, some distance from the poorest regions. New plantations would require some deforestation, which would be an environmental contradiction. Other higher yield plants such as jatropha could improve total productivity. However, PNPB (Programa Nacional de ProduÃ§Ã£o e Uso de Biodiesel, the National Programme for the Use and Production of Biodiesel) still does not recognise jatropha as a source of feedstock because of the limited knowledge in Brazil about it.

Thirdly, since about 80% of the production costs of biodiesel are directly linked to the cost of the feedstock, the recent high prices for vegetable oil are

undermining the economic feasibilityof biodiesel. For example in 2007-2008 the average price of soybean oil was well above $900 per ton (Chicago Board of Trade price),making biodiesel uneconomic compared to petrodiesel, even at $120 per barrel of oil. Other seed oils have followed price patterns similar to soy oil. It is more profitable for vegetable oil producers to sell their crop to the food industry rather than to biodiesel producers. For this reason, during the November 2007 biodiesel reverse auction, ANP had to start from a much higher price than wholesale petrodiesel, at about $1.2 per litre. The auction closed at about $0.8-1/l. The high feedstock prices may explain why biodiesel plants in Brazil have been working at 18% of their capacity (240 million litres instead of 2 billion litres) throughout the whole of 2007.

Fourthly, the market is developing some inefficiencies. The largest producer has about 49% of Brazilian biodiesel production, showing a potential convergence to a market controlled by just 2 or 3 companies. Moreover, the fuel is transported over long distances, from the north/northeast to southeast, to ensure the 2% mixture across the whole country. This pushes up the overallcosts, decreasing the CO2 neutrality of biodiesel.

For this reason, PNPB may need to address some key issues in terms of feasibility. Since about 80% of the production costs of biodiesel are directly linked to the cost of the feedstock, the recent high vegetable oil prices are undermining the economic feasibility of biodiesel. At the current international soybean oil price of over $1,000 per ton, biodiesel is uneconomic compared to diesel. In the first months of 2008, the production cost was about R$2.40-2.50 per litre ($1.2-1.25 per litre) which is already higher than the end-users' price for diesel. With the B3 mandatory blend, this adds an extra 0.08 reais per litre to diesel and the extra cost of production is passed on to consumers. Again, this issue is related to oil crops and promoting the best available feedstock for the region. Using oil crops that do not have alternative markets would be an optimal choice. However, with current high vegetable oil prices it will be difficult for farmers to change crops unless they have better income inducements.

Moreover, giving fiscal incentives only to biodiesel producers has proved insufficient. Farmers may have to receive other direct incentives to start growing the amount of feedstock required to achieve the B3 blend in 2008. This may create dependence on government subsidies and it would be appropriate for the national and state governments to plan a phasing out of such an incentives system. Large scale soybean producers supply most ofthe feedstock to the Brazilian biodiesel industry. Currently, several biodiesel producers buy feedstock from small producers only to keep the SFC

(social fuel certification) and many resell or exchange the feedstock they bought from small farmers for soybeans or soy oil which is still one of the cheapest vegetable oils available on the market. Over the short term a structured technical assistance programme is needed to help make farmer smore efficient and competitive in the national market.

The biodiesel programme was launched under the government of President Lula, which still actively promotes and supports it. The current government has always been socially concerned and recognises that ethanol production has concentrated income.The government promoted the biodiesel programme as a strategy to achieve fairer income distribution by creating a new biofuel industry that would confirm Brazilian leadership in biofuels and also innovative social programmes.

Although the plan is producing some benefits, it also reveals an increasing level of complexity. The main problem for small farmers who are strongly linked to the biodiesel programme is their inadequate capacity to produce enough feedstock to help Brazil reach its 5% target by 2013. The 2% mix can be easily metfrom current production but biodiesel producers are greatlyconcerned about the capacity of small farmers to deliver theamount of oilseeds they need. However, since the decentralisedfamily farmer model may have a slower dynamic than acentralised agro-industrial one, the fuel transportation industrymay soon push the government to reduce the input of familyfarmers to biodiesel feedstock production. This risk could beovercome by some adjustments in the programme, such as structured capacity building to assist small communities in feedstock production and a more integrated production model.

The way forward

The production of biofuels in Brazil has achieved some important social targets and ethanol has generated several thousand jobs. Many companies which currently supply and distribute biodiesel have acquired a percentage of the commodity from small farmers. However, it seems that the social benefits of this growing industry may have not been maximised. Because the ethanol industry was built on the existing industrial sugar producing sector, most of the incentives and subsidies went to large industrial sugar factories in the south and southeastern states.This has helped concentrate income in the wealthier regions of Brazil and has created a system where 76% of ethanol productionis based in three states that export it all over the country. This makes ethanol quite expensive especially to consumers and, as already mentioned, does not distribute wealth equally. This can be quite risky. As interest in biofuels

is increasing across the world, there is greater attention paid to those countries which have had a positive experience, such as Brazil. However, many questions need to be answered before flagging the Brazilian model as a role example of ethanol and biodiesel production.

First of all, there is the question of scale. Ethanol production does not seem to have very large economies of scale. Compared to large producers, small producers produce ethanol at an additional cost in the range of 20-35%. However, local distribution and lower marketing costs may off set the increased costs of smaller scale production. Currently, none of the producers are allowed to sell ethanol directly to consumers on the grounds of maintaining quality and the possibility of tax evasion. If small scale producers or agro-energy cooperatives were allowed to sell ethanol to consumers, there would be substantial benefits in terms of rural development. However, it will be necessary to create a new niche in the ethanol industry that addresses the needs of smaller scale producers. This will involve appropriate technologies, innovative financing mechanisms, capacity building and incentives for small alcohol producers.

While ethanol production is based on a consolidated technology that benefits from thirty years' research in sugarcane improvement, biodiesel relies on a new technology. The first commercial biodiesel plants were constructed in the early 1990s.There have been very few crop enhancements to increase total yields so that research and development will play a substantial role in the future. All this is limiting the feasibility of biodiesel plants that must therefore rely on government incentives or subsidies to produce fuel. High commodity prices also make biodiesel less commercially feasible compared to diesel, even with current high oil prices.

This scenario makes the role of small farmers quite difficult and decreases the feasibility of production even further. Creating a direct and fair link between small producers and the biodiesel industry offers great potential to advance rural development. However, such a link cannot happen on its own. The government needs to create specific capacity building and technical assistance programmes to include small feedstock producers in the production chain according to a specific road map and set targets.The industry has now begun to ask the government to lower the current target of social inclusion, which today requires that up to 50% of the feedstock is bought by small producers. This may make sense for the biodiesel industry but could operate against the rural poor.

Starting from this perspective, the government, international organisations, NGOs and the private sector need to work together to find creative ways to

develop this great potential for the rural poor. Pilot projects developed with the support of solid organisations need to demonstrate the cost- competitiveness of small scale production. As this becomes clear, it will be possible to develop a new niche industry where small farmers can become the real producers of environmentally friendly fuels.

There are several dozen different feedstocks that can be used to produce biofuels and many more will be discovered and tested. Some, such as jatropha, have quite a high yield and may grow in semi-arid regions that will suffer a decrease in rainfall due to climatic changes. Government programmes and international donors should assist communities in building capacity on their use.Integrating biofuel production with social development and poverty reduction is possible but not without choosing the most appropriate means to promote this growing industry, to the benefit of consumers and those living in the poorest regions of the world.

Footnotes

1. See Fargione et al. (2008); Searchinger et al. (2008)
2. Hausmann and Wagner (2007)
3. OECD-FAO (2007)
4. OECD (2007)
5. Ibid.
6. UNICA (2007)
7. Xavier (2007)
8. See Da Motta and Rocha Ferreira, (1988); Demetrius (1990); Moreira andGoldemberg (1999)
9. World Bank (2005)
10. Oxfam (2007); FBOMS/Heinrich Boll Foundation (2006)
11. Kaltner et al. (2005)
12. ANP (2007)
13. Demetrius (1990); Wight (1982); Ortega et al. (2007)
14. Rosillo-Calle and Hall (1987)
15. Ortega et al. (2007); FBOMS/Heinrich Boll Foundation (2006)
16. Bermann (2007)
17. Ibid.
18. ANP (2007)
19. 19 Craide (2007)
20. Transesterification, the general name for the industrial process to produce biodiesel, is the reaction between a trigliceride (vegetable oil) and an alcohol, usually

methanol to produce esters (biodiesel) and glycerol.

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