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BIOFUELS AND DEVELOPMENT: QUESTIONING ENVIRONMENTAL AND SOCIAL SUSTAINABILITY FROM A DEVELOPING COUNTRY PERSPECTIVE

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Biofuels and Development: Questioning Environmental and Social Sustainability from a Developing Country Perspective

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ABSTRACT

An increasing number of countries have been supporting the extensive production and use of biofuels hoping to reduce greenhouse gas emissions, ensure energy security and help the rural poor. While the validity of such policy goals is largely shared, many critics doubt that biofuels are the solution and rather question the environmental, social and overall developmental impacts of biofuel expansion and related government support to the sector.

This paper examines the role of each of the above three policy goals in driving the biofuel industry and analyses the developmental impact of biofuels especially on weak economies. It also critically addresses some recent developments and measures taken to ensure the social and environmental sustainability of biofuels.

The main conclusion of the paper is that under the status quo many developing countries reap limited benefits from the biofuel industry for various reasons, including their limited role confined to the first stage of the value chain in biofuel production, and the dominance of large-scale plantations in biofuel feedstock cultivation. However, as production patterns and means vary, so does the impact that biofuels have on individual developing countries. Therefore, the paper concludes with a number of recommendations for measures that developing countries can take in order to maximise the benefits of biofuels.

Keywords: Biofuels, development policies, developing countries.

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TABLE OF CONTENTS

ABBREVIATIONS

EU	European Union
FAO	Food and Agricultural Organisation
GHG	Greenhouse gas
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
LDCs	Least Developed Countries
OECD	Organisation for Economic Cooperation and Development
OPEC	Organisation of the Petroleum Exporting Countries
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
US	United States
US$	United States Dollar
WTO	World Trade Organisation

1 INTRODUCTION

The term biofuel refers to a "wide range of alternative transport fuels made from organic matter such as crops and agricultural residue" (Childs and Bradley, 2007: 10). The most commonly known forms are ethanol and biodiesel, and to a lesser extent methanol and biobutanol. While ethanol is largely made of sugarcane, corn and other starch plants, biodiesels are made out of oil seeds like soybean, palm oil, rape seed and sunflower seed (Cheng and Timilsina, 2010). The two leading producers of ethanol are the United States and Brazil, together accounting for around 79% of the world ethanol production (Harmer, 2009). The EU on the other hand is a major producer of biodiesel, taking a share of around 89% of the global biodiesel production (Von Braun and Pachauri, 2006). Within the EU, Germany takes the lead in biodiesel production (Nuffield Council on Bioethics, 2011).

The production of biofuels, in particular ethanol and biodiesel, has grown extremely fast since 2000. For instance, the volume of ethanol produced in the United Stateshas doubled between the years 2000 and 2005 and further tripled over the period 2005–2010 (Renewable Fuels Association, 2010). Also, the production of biodiesel in the EU has grown fourfold between the years 2000 and 2005 and then threefold again over the period 2005–2010 (Nuffield Council on Bioethics, 2011). The rapid growth in the production of biofuels is expected to intensify in the years to come. According to projection made by the International Energy Agency (2010), the production and use of biofuels will grow by more than 400% over the period 2009–2035.

This intensification of biofuel production is not a purely market-driven incident. It is rather a result of policy choices by the EU, the United States and some other countries which are promoting the extensive use of biofuels to address national and global policy concerns. For example, under its 2003 Directive on biofuels (Directive 2003/30/EC), the EU sets a clear objective of promoting biofuel production so as to replace petroleum and diesel as transport fuel. Under same Directive, the EU sets two core policy goals which are planned to be met through biofuel production. These goals are: reducing greenhouse gas (GHG) emissions in the transport sector and decreasing dependence on imported energy. In addition to these two objectives, a third policy goal, that of enhancing rural development through involvement of small and medium-sized enterprises, has been added under a subsequent Directive (Directive 2009/28/EC).

While the objective of reducing GHG emissions is part of the global climate change mitigation package, the second goal (reducing dependence on imported energy) is more of a political and economic concern at the national (or Union) level. Given the fact that global energy consumption is growing, especially in emerging economies, and the price of oil prone to shocks, domestic production of biofuels is considered to have a promise of reducing import bills and also improving energy security (Rajagopal et al., 2007).

On the basis of these objectives, both the EU and the United States set ambitious targets to expand biofuel production and use. Accordingly, while the EU intends to increase the share of biofuel consumption in the transport sector from 2.5% in 2007 to 10% in 2020 (Directive 2009/28/EC), the United States aims to expand the volume of renewable fuel used for transport from the level of 15 billion litres in 2006 to 28.4 billion litres by 2012 and by an additional 136 billion litres by 2020 (United States Energy Policy Act, 2005). Other countries like Brazil, China and India also have set their own national targets of boosting domestic biofuel use (Von Braun and Pachauri, 2006).

Policy interventions are not limited to setting consumption targets, however; they extend to providing incentives for biofuel producers. Based on the justification that the production cost of biofuels is much higher than petroleum based fuels, major producing countries support their biofuel industries through the imposition of high tariffs on imported biofuels, provision of tax credit schemes, government loans and loan guarantees (Harmer, 2009). The global expenses on biofuel subsidies were estimated at around US$20 billion in 2009, which is projected to increase to an average of US$45 billion per year in the period 2010–2020 and further to an average of US$65 billion per year over the period 2021–2035 (International Energy Agency, 2010). The EU takes a leading role in protecting domestic biofuel production through, among others, imposing a specific tariff of around US$1.10 per gallon of ethanol and 6.5% ad valorem on imported biodiesel, together with tax credits of different amount within each member state (Mitchell, 2008). The United States applies a duty of US$0.54 per gallon on imported biofuels and also provides tax credits of US$0.45 and US$1.00 per gallon of blended ethanol and biodiesel, respectively (Harmer, 2009).

In recent years, many developing countrieshave followed the footsteps ofthe EU and the United States in adopting domestic biofuel policies which propagate the same policy goals of reducing GHG emissions, decreasing dependency on imported energy and promoting rural development through biofuel production and use.

While countries are expanding the production of biofuels, sceptics are concerned about their intended and unintended consequences. Many criticise biofuels for causing further GHG emissions, a loss of biodiversity, contributing to rising food prices and displacement of local populations.

After identifying the particular dimensions through which biofuels can benefit or harm the environment and human welfare, this paper explores the stakes of developing countries in the biofuel business. It also looks at recent and projected developments in the biofuel industry towards more sustainable production and how such developments can affect the interests of developing countries as suppliers of feedstock and potential biofuel producers.

The next three sections explore, one by one, the three core objectives of biofuel production: section 2 looks at the prospects and challenges for developing countries associated with the biofuel objective of reducing GHG emissions. Section 3 is devoted to issues of energy security and the place of developing countries in the production and use of biofuels. Section 4 examines how developing countries may gain or lose out from biofuels in terms of rural development. Recent developments in making biofuels more sustainable are addressed in section 5. Finally, the conclusion and policy recommendations in section 6 suggest how developing countries can benefit more from the prospects of biofuels and at the same time overcome the challenges.

2 ARE BIOFUELS EFFICIENT SOLUTIONS TO ENVIRONMENTAL PROBLEMS?

Promoting the clean environment agenda is one of the three policy goals that biofuel production is expected to fulfil. In particular, the EU regards increased use of biofuels as one mechanism of ensuring compliance with its commitments under the Kyoto Protocol (Directive 2003/30/EC). However, in recent years doubts have been increasing against the characterisation of biofuels as environmentally efficient sources of energy. While there is agreement, by and large, that biofuels have certain environmental advantages compared to conventional fossil fuels, they also have their own environmental costs. The following two sub-sections briefly examine the advantagesand challenges attached to biofuel production in fulfilling its clean environment mandate.

2.1 Environmental advantages of biofuels

One of the most alarming environmental problems of the day is climate change which is mainly a result of GHG accumulation in the atmosphere through emissions and a reduction of carbon sinks (Nuffield Council on Bioethics, 2011). While 80% of total GHG emissions are attributed to CO_2 emissions from fossil fuels, the transport sector accounts for around 15% of such GHG emissions (Metz et al., 2007). In this context, biofuels are deemed to reduce GHG emissions by replacing the use of fossil fuels in the transport sector which is generally considered carbon inefficient. Biofuels are characterised as carbon neutral because the carbon emitted from their use is considered as not being additional to the atmosphere but cyclical since biofuel feedstocks absorb carbon from the atmosphere while planted (Childs and Bradley, 2007). This is different for fossil fuels which emit additional carbon as they are extracted from underground.

According to the US National Research Council, the use of corn-based ethanol is believed to reduce carbon emission by 12–20% compared to the emission level from gasoline usage, while use of biodiesels made of soybean have a potential of reducing carbon emission by 41%(Office of the Legislative Auditor, 2009). Accordingly, biofuels in general are estimated to contribute around 3% to the overall emission reduction, with an increasing carbon saving prospect for the future (International Energy Agency, 2009).

2.2 Environmental challenges

The characterisation of biofuels as carbon neutral is opposed by some for it only takes into account the carbon emitted during end use or combustion which then is offset with the carbon absorbed by feedstocks used as biofuel inputs (Nuffield Council on Bioethics, 2011). Such a calculation is criticised for not being comprehensive since there are several other channels through which biofuels can add to carbon emissions (Childs and Bradley, 2007). Hence, if all these channels are properly accounted for, biofuels may no longer be carbon neutral and may cause environmental degradation. This section looks at three of these channels, land use change, extensive use of chemicals, and GHG emissions in biofuel processing.

2.2.1 Land use change induced by biofuel production

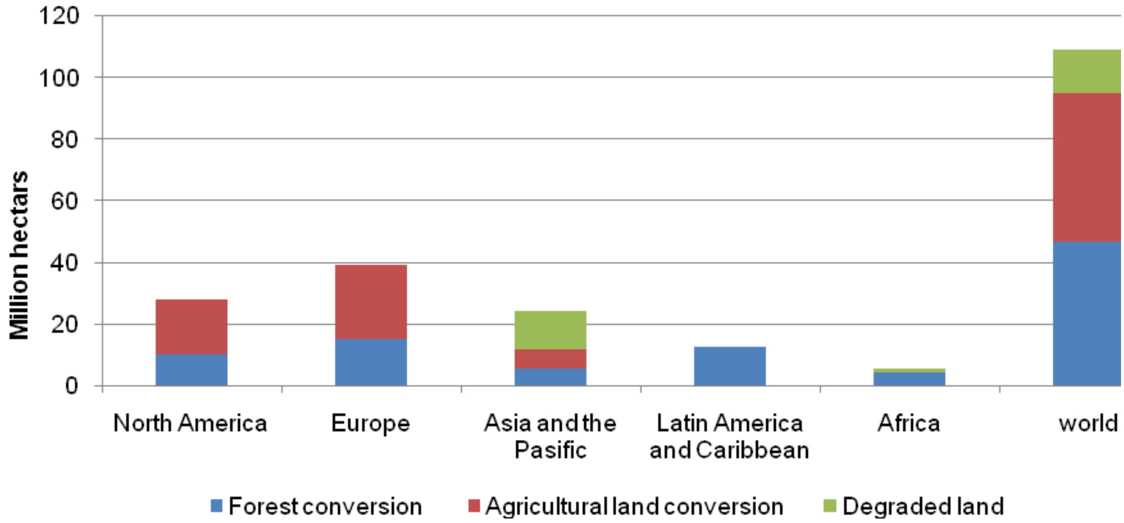
The one thing that most writers agree about is that biofuel production requires land intensive investments. The greater the percentage of biofuels in blends, as targeted by the EU, the United States and other countries, the higher its production and thus the pressure it puts on land (Searchinger et al., 2008). According to an estimation made by the OECD, it would take around 72% of EU's and 30% of the United States' total agricultural land if these countries were to meet their target of replacing 10% of their transport fuel with biofuels (OECD, 2006).

The effect of biofuels on land use change can be either direct or indirect (Nuffield Council on Bioethics, 2011). While direct land use change refers to the direct conversion of land for planting biofuel feedstocks, indirect land use change involves the conversion of land for food production or another purpose which is indirectly triggered by biofuel production in other places (Searchinger et al., 2008). An example of local level indirect land use change is the clearing of forestland by farmers following displacement from their farmland due to biofuel production. Indirect land use change may also be trans-national, such as when increased biofuel demand or production in one part of the world causes conversion of land use in another part of the world through price effects (Bowyer, 2010).

Extensive production of biofuel feedstocks has a considerable effect in changing the nature of lands through deforestation, clearing of grasslands or use of uncultivated land, which in turn can cause further carbon emission from cut plants, reduction of the carbon storage capacity of lands, and reduced biodiversity (Bowyer, 2010). In terms of carbon balance, conversion of any form of land – be it a forest area, grassland or even abandoned land – has the effect of increasing carbon emissions, though of different magnitude. According to one study, the carbon emitted from the clearing of grasslands for biofuel production is estimated to be offset only after 93 years of ethanol use, while it requires 48 years of ethanol use to offset the carbon emitted from the use of abandoned land (Office of the Legislative Auditor, 2009).

The consequences are even worse when it comes to deforestation, which has several environmental implications in addition to increasing carbon emissions. In this regard, recent intensification of deforestation in places like the Brazilian Amazon and Indonesia is attributed to rapid expansion of biofuel production (Rajagopal et al, 2007). According to FAO's 2011 State of the World's Forests report (FAO 2011), land use for biofuel production in Latin America is estimated to expand by 12.3 million hectares in 2030, all of which is expected to come from forest conversion. Also in Africa around 56% of the increase in land demand for biofuel production in 2030 is expected to be met by forest conversion.

Figure 1: Estimated land use conversion towards biofuels until 2030



Source: FAO (2011)

To make things worse, biofuel feedstocks with higher emission reduction potential, for instance soybean, require more land to grow, compared to other feedstocks like sugarcane which demand less land to grow but have minimal emission reduction potential (Al-Rifai et al., 2010). Hence, there is a trade-off between the carbon saving potential and land impact of the different forms of biofuels.

2.2.2 Extensive use of chemicals

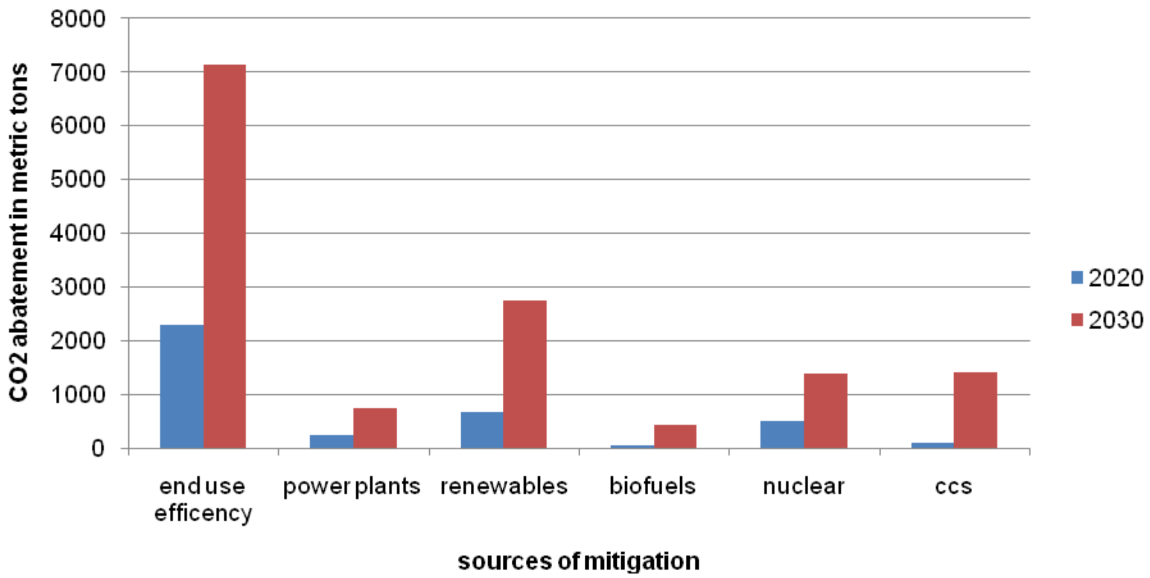
Beyond their carbon emission effect through land use change, biofuels are also deemed to increase GHG emissions through extensive use of chemicals, such as nitrogen and phosphate, for fertilisation and as pesticides (Rajagopal et al., 2007). Most agricultural land used for the cultivation of biofuel feedstocks is highly treated with nitrogen to ensure high yields. For example, according to the US Department of Agriculture, 95% of US corn production for ethanol uses nitrogen fertiliser (Office of the Legislative Auditor, 2009). This causes the emission of nitrous oxide, one of the GHG with the most powerful global warming potential, to the atmosphere (Nuffield Council on Bioethics, 2011). The chemical intensive nature of biofuel crop farming is also contributing to reduced quality of soil and water bodies (Childs and Bradley, 2007).

2.2.3 GHG emissions caused by biofuel processing

Biofuel production is not only land and chemical intensive but also energy intensive. Although the process of converting biofuel feedstocks into liquid fuel almost always requires some form of energy, the amount of energy demanded varies across different biofuels depending on the crop used as an input (Kartha, 2006). Whereas the process of converting grain to ethanol is estimated to consume around two thirds of the energy it produces, biodiesel production from soybean and palm oil takes around one third and one ninth of their energy output, respectively (Childs and Bradley, 2007). While the amount of energy consumed in biofuel processing is a central issue in the debate on energy efficiency, what is even more important for the environment debate is the type of energy employed and the resulting carbon balance. Accordingly, while the use of coal in biofuel processing is estimated to have a negative carbon balance with a 3% increase in net emissions, utilisation of natural gas and biomass is found to have a positive carbon balance of 28% and 52%, respectively (Office of the Legislative Auditor, 2009).

In general, the net effect of biofuels in reducing GHG emissions appears minimal given the different channels through which it also contributes to carbon emissions (Franco et al., 2010). In fact, when compared to other sources of mitigation – including energy efficiency in end use, efficiency in power plants, use of nuclear power, development of other renewables and carbon capture and storage – biofuels are considered to contribute the least to carbon saving (Figure 2).

Figure 2: Carbon saving from different sources



Source: International Energy Agency (2009)

Given the minimal role biofuels play in reducing GHG emission, it is questionable whether the clean environment mandate is the fundamental policy drive behind extensive production of biofuels. The next section examines the second and perhaps the most sensitive policy goal for biofuel expansion.

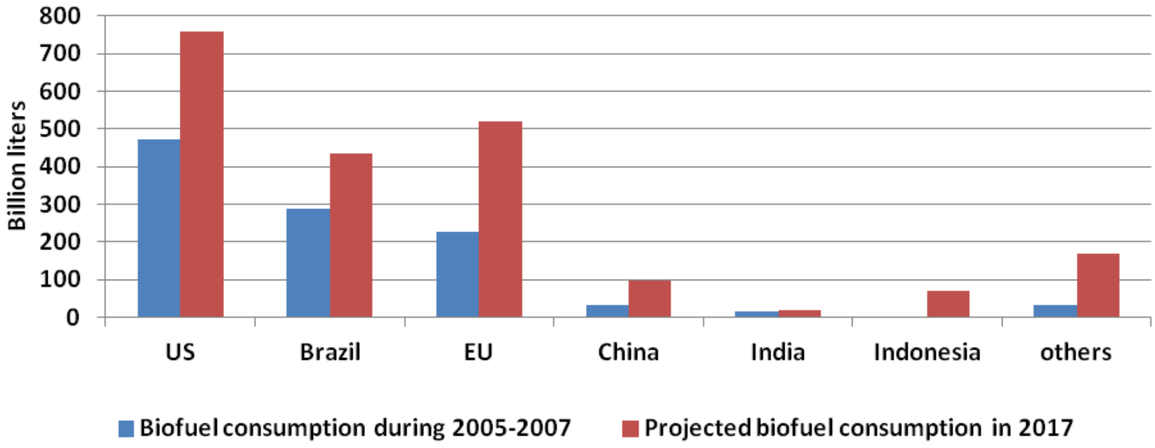
3 BIOFUELS AS A MEANS TO ENERGY SECURITY: WHOSE ENERGY SECURITY?

Given their contentious role in reducing GHG emissions, the role of biofuels can be seen to centre on reducing the oil import bills of countries and contributing to improved energy security by serving as an alternative source of energy in the transport sector. With rapid economic growth, industrial expansion and urbanisation in emerging economies and some other developing countries, global energy consumption is ever-increasing and estimated to further grow by 71% over the years to 2030, with developing countries contributing three-quarters of such growth (International Energy Agency, 2006). Such increasing demand for energy, coupled with declining oil reserves and geopolitical factors surrounding oil production have contributed to the volatile nature of oil prices with frequent spikes (Smith, 2009). Uncertainties in oil prices are partly attributed to strategic decisions of OPEC members to limit oil production below their optimal production capacity, which causes global scarcity of oil and price hikes given the declining supply from non-OPEC oil producing states and growing energy demand (Smith, 2009). In particular, the world has witnessed a significant hike in oil prices during 2004–2008, with oil price reaching US$145 per barrel in 2008, which according to the IMF signifies the beginning of a "period of increased scarcity of oil" (IMF, 2011: 89).

It is during this same period that the production of biofuels has intensified as an alternative transport fuel. This is essentially because biofuels are considered as relatively "cheap" and "reliable" sources of energy with a promise of reducing oil demand in the transport sector which now takes around 50% of the global oil supply (IMF, 2011). The price trend especially during 2007–2008 has incentivised biofuel industries as oil prices have been well above the floor price at which biofuels can stay commercially viable – US$35 per barrel for ethanol from Brazil, US$55 for US ethanol and US$80 for EU biodiesel (Piesse and Thirtle, 2009). Whilst the price of oil has sharply declined after its peak in mid 2008, it again took a rising trend and has persistently stayed over US$80 per barrel since the beginning of 2011 (Oil Price Net, www.oil-price.net).

Even if volatility and hikes in oil prices are common concerns for all oil importing countries, only few have taken a leading role in the biofuel industry. In 2007, around 90% of the global biofuel output was produced in three countries (UNEP, 2009): the United States (43%), Brazil (32%) and the EU (15%). The remaining 10% were produced by China, Indonesia, Malaysia, Argentina, Singapore and Canada. The United States and the EU are however not just the biggest producers of biofuel, they are also the biggest importers. Brazil on the other hand is the biggest exporter of biofuel, followed by China, Indonesia, Malaysia and Argentina (UNEP, 2009). This is indicative of the fact that the consumption of biofuels in the United States and the EU exceeds their domestic supply (Figure 3). Biofuel consumption is also high in Brazil, however still below domestic production.

Figure 3: Biofuel consumption, 2005–2007 and 2017, in petajoule



Source: UNEP (2009)

The projection made for 2017 reveals almost a doubling of biofuel use from the 2005–2007 level with a similar country distribution, except that the EU will replace Brazil as the second largest biofuel consumer. Accordingly, one can conclude that biofuel production is dominated by a few countries and its use is currently limited to these same countries.

Many developing countries take part in the biofuel production process as suppliers of crops, that is, the first stage of the value chain. The share of developing countries in the export market for some biofuel crops like coarse grain and oilseeds is estimated to increase and even exceed the share of OECD countries over the years to 2017 (OECD and FAO, 2008). This is essentially because of a higher potential for yield improvement in many developing countries, especially in Africa, despite the general trend of declining growth in crop yield in most parts of the world (UNEP, 2009). Most African countries have a comparative advantage in biofuel feedstock cultivation because of, among others, the relative abundance of arable land, inexpensive labour force and favourable climate. According to one study, expansion of biofuels and increasing demand for feedstocks is estimated to require additional land of 18–36 million hectares by 2020 and further 19-44 million hectares by 2030, of which around two thirds will come from developing countries (International Institute for Applied Systems Analysis, 2009).

As such, many developing countries, especially in Africa, have an immense potential to benefit from the production and export of biofuel feedstocks. This gives developing countries a fairly important place in the biofuel business as feedstocks are key inputs for biofuel production, accounting for a significant share of the whole cost of production – around 60% for ethanol and 70%–80% for biodiesel production (Childs and Bradley, 2007).

Yet, moving up in the value chain can provide developing countries with several opportunities including satisfying their increasing energy demand and thereby reducing oil bills; creating further employment opportunities in biofuel plants; and raising foreign earnings through exports of the value added product. Brazil can be a good example in this respect with its saving of more than

US$100 billion from its import bill and creation of employment for around 1 million people after starting domestic processing of ethanol in the 1970s (Moreira, 2006).

Countries in sub-Saharan Africa can especially gain from domestic processing and use of biofuels as energy prices are relatively high in the region (Mitchell, 2011).

Increased export earnings are the other benefit developing countries can get from engaging in biofuel processing. According to UNCTAD (2009), developing countries could have increased their export earnings by a minimum of US$14.3 billion and a maximum of US$294.2 billion in 2010 (based on different trade scenarios) if they had exported processed biofuels rather than feedstocks.

Nevertheless, the markets of major biofuel consuming countries are not all open for potential exporters. As we have seen in the introductory part, both the EU and the United States have several measures in place to protect their local biofuel producers. Though most developing countries, especially LDCs, have preferred access to the US and EU markets and thus are not affected by tariffs on biofuels, they still lose their competitive advantage due to intensive subsidisation of biofuels in the EU and the United States. This is essentially because the subsidies provided by the United States and the EU are tied to production volumes and therefore have the effect of boosting domestic production and creating artificial reduction of prices, making it hard for unsubsidised biofuels from developing countries to compete on same level. According to one estimation, developing countries have a potential of earning more than US$520 billion from biofuel exports in 2020 if the EU and the United States cease to directly subsidise domestic producers. Such earnings would, however, be reduced to less than half that amount if the current support measures continued to exist (UNCTAD, 2009). As such, it is clear that tariffs and subsidies play a restrictive and distortive role in the future export of biofuels from developing countries to the EU and US markets.

In general, the prospect of developing countries to actively take part in biofuel processing highly depends on their capability to attract high capital investment, while their prospect of effectively exporting biofuels to the United States and the EU is reliant on liberalisation of biofuel policies in importing countries. Yet, expecting a swift liberalisation measure from these countries/regions might be too optimistic as the latter might be reluctant to completely outsource biofuel processing to other countries which will render them dependent on foreign supply – eroding the whole aim of ensuring energy sovereignty (decreasing dependence on imported energy). As such, the prospect of abandoning domestic support by the United States and the EU, and opening up of markets for biofuels imported from developing countries should not be taken for granted.

4 BIOFUELS AND SUSTAINABLE RURAL DEVELOPMENT: CAN THE TWO GO TOGETHER?

The third and relatively less publicised policy goal of biofuels is promoting rural development. The EU aspires to meet this policy goal through involvement of small and medium-sized rural enterprises in biofuel production (Directive 2009/28/EC). While it is true that biofuels offer some opportunities for the rural population, they may also have an adverse impact on rural welfare. This is an important concern in a developing country context where the rural population is large and predominantly poor. The next sub-sections explore three main dimensions through which biofuels can affect the rural population in developing countries.

4.1 Food security

Production trends in biofuel industries can easily affect the price of food commodities as biofuels largely depend on edible feedstocks as an input and also compete with food production for the same agricultural resources. In fact, one of the most serious consequences of biofuels has been their impact on rising food prices. Following years of rapid expansion of biofuels, the world faced a hike in the price of some important food commodities in 2007–2008. The effect of the price hike was quite dramatic as global food prices had been relatively stable over the preceding two decades (Piesse and Thirtle, 2009). Even though expansion of biofuel production was not the only reason behind the price hike there is a general consensus on the key role which it played. However, there are different estimates on the exact contribution of biofuels to the price hike. According to IFPRI, biofuels accounted for 39% of the total increase in the price of maize and for around 20% of rice and wheat price increases (Al-Rifai et al., 2010). The IMF, on the other hand, attributed 70% of the rise in maize prices and 40% of the increase in soybean prices to biofuel production (Lipsky, 2008).

Biofuels affect the price of food commodities through different channels, including through an increase in the demand for food items that are used as biofuels inputs; a decline in supply of food commodities that are not used in biofuel production and through consumption substitution.

On the demand side, increased biofuel production raises the demand for corn and oilseeds as they are intensively used in the production of ethanol and biodiesel. In fact, the biofuel industry is becoming the largest consumer of these feedstocks. For instance, in 2007 one third of the United States' total corn production was consumed by the ethanol industry (Piesse and Thirtle, 2009). Even if the global maize production grew by 55 million tons in 2007, the consumption of maize in the US ethanol industry alone increased by almost the same amount, pushing the global price of maize upward (Mitchell, 2008) – the global maize price increased almost threefold during 2005–2008. The same holds true in global oilseeds production, 7% of which was consumed by the biodiesel industry in 2007, contributing to the tripling of the price of palm oil and soybean during the same period (Piesse and Thirtle, 2009).

On the supply side, biofuels affect the price of food commodities which are not used for biofuel processing, mainly through resource diversion. Expansion of biofuel production puts pressure on agricultural inputs, especially land and water, and thus reduces the availability of these resources for food cultivation. This in turn results in a decline in output and a rise in the price of food crops (Franco et al., 2010). For instance, increased planting of biodiesel oilseeds in major wheat exporting countries has attributed to lesser expansion of land for wheat production and thus a decline in total output and a rise in price of wheat (Mitchell, 2008).

The third and more indirect channel through which biofuel production can cause a rise in food prices is through substitution of consumption. As the price of one food commodity rises, consumers normally shift their consumption pattern and demand increases for substitute goods, thereby pushing the price of substitutes upwards. An example of this is the increase in demand for and price of rice in 2007–2008 following the rising price of wheat and corn (Mitchell, 2008).

With the further expansion of biofuels in the years to come, global food prices are also expected to increase. This has a considerable implication for food security in developing countries, especially if a broader understanding of food security is applied, which not only comprises the physical availability but also the economic and social accessibility of sufficient, safe and nutritious food (FAO, 2003).

It is generally true that increases in the world market price of food commodities may not be directly transmitted into developing country domestic markets because of market imperfection problems such as segmentation of markets and the existence of non-traded food items. But to the extent that it does transmit, its welfare impact is very high. This is because a significant portion of household income in developing countries is used for food consumption and thus a rise in food prices can easily push households into poverty (Ivanic and Martin, 2008). According to a projection by Leturque and Wiggins (2009), future expansion of biofuels to meet the 10% target will increase domestic food prices in sub-Saharan Africa only in a small amount compared to the price impact in the EU, North America, Latin America and South East Asia. However, the poverty impact will be felt more in sub-Saharan Africa than in other regions for the above mentioned reason.

The impact of biofuel production on food prices is of particular concern for developing countries also because the price effect is particularly high on maize, which is a staple food in many developing countries, especially in Africa, and thus represents a significant share of the total food expenditure (Ivanic and Martin, 2008).

As such, biofuels pose some threat on the food security of poor populations in most developing countries by affecting both the physical availability and economic accessibility of food items.

4.2 Rural income

Despite their impact on food prices, extensive production of biofuels and the resulting increase in the price of feedstocks are mostly seen as having a positive impact on the rural poor through increased farm income and employment (Hazell and Pachauri, 2006). In most developing countries, where a significant portion of the poor live in rural areas, increased farm income is considered central to nationwide development and poverty alleviation. On this basis, some argue that the effect of biofuel production on increasing food prices is tolerable since such price effect will be offset by growing farm incomes (De La Torre Ugarte, 2006). Leturque and Wiggins (2009) have quantified the potential increase in farm incomes, estimating that the earnings of sugarcane and palm oil producers can raise from US$5 or less per day to US$7–US$16 per day by supplying biofuel processors instead of selling in traditional markets. However, it is important to determine to what extent the rural poor are engaged in the production of biofuel feedstocks. The net welfare impact of biofuels on the rural poor will be positive only if the increase in their income outweighs the increase in food cost or if they are net-food producers, which is often not the case.

Recent experience from many developing countries shows that cultivation of biofuel feedstocks is dominated by large-scale corporate farming and there is limited opportunity for small-scale farmers to directly benefit from biofuels (Franco et al., 2010). It is becoming the norm for corporate producers to cultivate feedstocks in large plantations, often of more than 10,000 hectares of land and sometimes going up to 500,000 hectares (Deininger and Byerlee, 2012). Hence, a large share of the increase in farm earnings from biofuels goes to corporate producers and not small farmers. There are however some cases where small-scale farmers are well integrated into the biofuel business. One case is in Brazil where more than 30% of sugarcane for ethanol production comes from around 60,000 small-scale farmers (Moreira, 2006). Another case is in Mali, where more than 4,000 small-scale farmers supply jatropha to a foreign biofuel company through a contract farming arrangement and also hold 20% share in the company by forming a union (Vermeulen and Cotula, 2010).

Another argument that has been made is that rural populations can benefit from biofuels through increased labour participation in large-scale feedstock plantations (Franco et al., 2010). While that is generally true, given the seasonal or irregular nature of employment conditions in most plantations, the net effect in terms of enhancing both rural income and sustainable livelihood can be more promising if small-scale farmers are better integrated in to the supply chain.

4.3 Access to land

Expansion of biofuel production and resulting land use change can be detrimental not only to the environment but also to the right of local people to have access to land (Franco et al., 2010). This is an important concern in a developing country context where biofuel feedstocks are largely produced on large-scale commercial farms while a vast majority of people lead a poor and land-based rural livelihood. In most developing countries land has an importance in the life of the rural population which goes much beyond its market value. It is often a reflection of social identity, source of water, energy and grazing, as well as a means to have access to credit (Vermeulen and Cotula, 2010).

According to IFPRI, 15–20 million hectares of farmland in developing countries have been transferred to large-scale investors, mostly foreign, since 2006 (Vermeulen and Cotula, 2010). Increased biofuel production is one of the main drivers for the recent intensification of large-scale land acquisition in developing countries, especially in sub-Saharan Africa (Deininger et al., 2011).

Because land is not subject to private ownership and purchase in most developing countries, especially in Africa, transfers are largely carried out through long-term lease agreements negotiated and contracted between host governments and investors. In such cases, the interest of local people will be at stake as prior holders or users of a land. Lately, there is almost a general consensus on the principle that local people should be effectively consulted and compensated when land they hold or use becomes the subject of an investment transfer (AU, ECA and AFDB, 2009; FAO, IFAD, UNCTAD and World Bank Group, 2010).

However, because land holdings are not fully registered in many developing countries and customary land rights not formally recognised at all levels of government (Deininger et al., 2011), local people are in reality vulnerable to displacement without consultation, compensation or other alternative arrangements. In case consultations are held, they are mostly meant to inform local people but not involve them in real decision making (Vermeulen and Cotula, 2010). Yet, even in cases of transfer of "marginal lands" which in the eyes of host governments involve no displacement of or harm for local people, the latter tend to suffer in terms of loss of grazing land and source of fuel wood, water and traditional medicine (Von Braun and Meinzen-Dick, 2009).

In sum, large-scale land transfers for biofuel production can have an adverse impact on the socio-economic and cultural livelihood of rural populations, especially when land transfers are carried out without regard for local concerns.

5 TOWARDS ENVIRONMENTALLY AND SOCIALLY SUSTAINABLE BIOFUELS: SUSTAINABLE SOLUTIONS OR TECHNOLOGICAL FIX?

The preceding sections have pointed out the major prospects and challenges of increased biofuel production. In recognition of the challenges, some developments are underway to ensure the environmental and social sustainability of biofuels. Among these, second-generation biofuels and the EU certification scheme are particularly important; these are addressed in the following sections.

5.1 Second generation biofuels

Second generation biofuels are advanced forms of biofuels which are made from crops like switch grass, jatropha, agricultural residue or wood residue (Cheng and Timilsina, 2010: 3). Their major difference from conventional or first generation biofuels is that they are not extracted directly from the edible parts of feedstocks but from residues or waste (Nuffield Council on Bioethics, 2011).

These advanced forms of biofuels are considered both environmentally and socially more efficient than first generation biofuels as they are relatively less demanding in terms of land use, energy consumption and use of food stocks. For instance, production of biodiesel from jatropha is believed to minimise deforestation and conversion of arable land for biofuel production, since jatropha can be grown on marginal or semiarid land not used for food production (Von Braun and Pachauri, 2006). Also, ethanol production from switch grass or cellulose is considered to enhance the energy efficiency of biofuels as it takes considerably less energy to convert cellulose into ethanol than converting corn or sugarcane (Childs and Bradley, 2007). Accordingly, under the 4th IPCC Assessment Report, use of second generation biofuels is regarded as one of the strategic ways to increase the carbon efficiency of the energy sector in the future (Metz et al., 2007).

Second generation biofuels are efficient solutions to food security concerns since they neither use food stocks nor cause diversion of arable land from food production. Hence, as they do affect neither the demand nor the supply side, they are assumed to not affect food prices.

Yet, even these advanced forms of biofuels are not as ideal as they are sometimes presented. There are several technological challenges attached to their production which can in turn limit their future expansion and prospect. For instance, conversion of cellulose into ethanol involves a very complex process compared to the processing of corn or sugarcane, which makes the whole production process more expensive and thus economically less attractive to producers (Nuffield Council on Bioethics, 2011). Besides the high cost of production, the economic viability of expanding cellulosic ethanol especially from agricultural residue which is land and carbon efficient, is limited by the low level of ethanol yield (Cheng and Timilsina, 2010). The same holds true for jatropha whose prospect for market expansion is limited by low yield if it is to become land and environmentally efficient and grown on degraded land (Wiggins et al., 2011).

These points are illustrative of the fact that the land and input efficiency of second generation biofuels does not come without a trade-off. The productive or economic return of almost all second generation biofuels is quite limited, which makes it unlikely for such advanced forms of biofuels to replace conventional biofuels any time soon, unless with intensive government subsidies or the development of advanced technologies to improve yield. Hence, much hope is placed on future agricultural and industrial technologies to fix the environmental efficiency and social sustainability of biofuels. A typical example is the ongoing effort to produce biofuels from algae which is found to provide a high biodiesel yield, with no competition for land, but under a huge investment cost (Nuffield Council on Bioethics, 2011). According to one estimate, investment for the production of advanced forms of biofuels involves a cost that is ten times higher than the cost of producing first generation biofuels (VDB, 2008). This puts into question the prospect, if any, of small-scale producers in such a technology and thus whether future biofuels can fulfil their mandate of enhancing rural development through inclusion of small and medium-scale producers.

5.2 EU certification scheme

The second mechanism recently put in place to mitigate the challenges associated with biofuels has come from the EU, which (belatedly) recognised the unintended adverse impacts of biofuels on the environment and human welfare. Under its 2009 Directive on biofuels, the EU set up a certification scheme for the sustainable production of biofuels. Under this scheme, eligibility for biofuel subsidies and compliance certification are made conditional on the fulfilment of certain sustainability criteria by biofuel producers. These criteria are:

- contribution to reduction of GHG emissions by at least 35%, and further by 50% in 2017 and 60% as of 2018;
- non-use of feedstocks originating from land that is rich in carbon stock or biodiversity (including wetlands, primary forests, woodlands, grasslands with high biodiversity and areas designated for protection of endangered ecosystems or species); and
- non-use of food stocks originating from peat lands (Article 17 of Directive 2009/28/EC).

While this certification scheme is the first of its kind and a good move towards addressing the challenges associated with increased biofuel production, it is very limited in its scope and application (Munting, 2010). First, the scheme is very soft in that it has no direct effect of deterring unsustainable production of biofuels. While it certifies biofuels produced in a sustainable manner, it neither penalises nor restricts the sale or use of biofuels which are produced without fulfilling the sustainability criteria. One may argue that making sustainability of production one eligibility criterion for biofuel subsidies has a deterrent effect since the biofuel industry is heavily reliant on subsidies. Even then, given the fact that subsidies are provided only for domestic producers, the certification scheme falls short of effectively regulating the sustainability of biofuels imported from other countries.

The certification scheme is also criticised for setting a very narrow list of sustainability criteria despite the far-reaching challenges biofuels pose (Munting, 2010). To begin with, almost all the criteria address environmental concerns only and thereby ignore the social challenges associated with biofuel production, including food insecurity and rural displacement (Munting, 2010). However, a closer look at the criteria reveals that even the environmental challenges are not fully addressed under the scheme. For instance, by requiring the production of feedstocks on lands which are not rich in carbon stock or biodiversity, the scheme only regulates environmental problems associated to direct land use change, leaving out concerns of indirect land use change.

Also, only cases of direct land use change dating after 2008 are covered under the criteria. As per Article 17 of the EU Directive, biofuel can be certified as sustainable if its feedstock comes from forestland that was converted for biofuel production before 2008. Hence, the certification scheme plays only a preventive role and does not redress previous land use changes.

In general, the ability of the existing EU certification scheme to mitigate the unintended adverse impacts of biofuels is limited, given its narrow scope of coverage and weak application. Such scheme currently being applied only on domestic producers, it indeed puts EU producers in a relative disadvantage compared with foreign producers, including those in developing countries. As such, caution is needed while expanding the scope of application of such scheme to imported biofuels, as well as when setting high environmental and social standards since such can have detrimental impact on the export capacity of small-scale producers especially in developing countries (Wiggins et al., 2011).

6 CONCLUSIONS AND POLICY RECOMMENDATIONS

Both first and second generation biofuels have their own prospects and challenges in fulfilling the three core policy goals of reducing GHG emissions, ensuring energy security, and promoting rural development. Under the clean environment objective, first generation biofuels have a carbon saving potential as they release no additional carbon during combustion. However such potential is limited by the direct and indirect emissions which first generation biofuels cause during land use change and fuel processing. Second generation biofuels, on the other hand, hold a much higher carbon saving potential as they can be grown in marginal areas causing no threat of conversion of land with high carbon storage capacity, including forests and grasslands.

In relation to energy security, biofuels bring a prospect of reducing oil bills by serving as a cheaper and reliable alternative to traditional transport fuels. With current technology, first generation biofuels have a higher energy yield potential than advanced biofuels. Most second generation biofuels provide a very low energy yield if they employ marginal lands to cultivate feedstocks or use agricultural residues for processing. Recent trends show that only few countries are producing and using biofuels as alternative sources of energy, and developing countries have not yet taken full advantage of this opportunity due to lack of capital required for investment in biofuels.

There are some trade-offs between the prospects of first and second generation biofuels when it comes to rural development. While first generation biofuels can potentially benefit rural populations through increased farm income, at the same time they cause a rise in food bills and loss of access to arable land. Second generation biofuels, on the other hand, are relatively neutral in terms of food prices and land use; they however are capital and technology intensive and thus less accessible to developing countries as feedstock suppliers and small-scale biofuel producers.

Because of the dominance of large-scale commercial plantations in feedstock cultivation, most developing countries have not capitalised on the prospect of first generation biofuels in increasing earnings of the rural poor. With a predominance of large-scale feedstock plantations, small-scale farmers in the rural parts of developing countries tend to lose out from rising food prices and loss of access to land while unable to grasp the opportunity of increased farm income.

As a result of the foregoing, it is not clear how the biofuel business will progress in the long run. But with the existing technology, advanced biofuels have a very low prospect of becoming commercially viable any time soon. Hence, first generation biofuels are expected to prevail in the market in the foreseeable future. On this basis, this paper proposes the following policy recommendations to enable developing countries better benefit from biofuel prospects while overcoming the challenges:

First, with the aim of promoting the rural development dimension of biofuels, developing countries will need to look for possibilities of integrating small-scale farmers in to the supply chain for biofuels. Contract farming can be one option where small-scale farmers supply their output to biofuel processors on the basis of a contract made a priori. This can be beneficial in terms of rural livelihood since small-scale farmers will retain control of their land and potentially get better access to agricultural inputs and know-how.

Second, increasing the capacity of developing countries to also engage in biofuel processing is beneficial from the view point of both developed and developing countries. Developing countries can immensely benefit from engaging in biofuel processing through, among others, satisfying their increasing and costly energy demand, creating employment opportunities and increasing export earnings. Given the rising demand for biofuels and limited availability of land, there is already an import demand in developed countries which can be satisfied by efficient production in developing countries. But considering the need for capital and technology to start and run biofuel industries, developing countries may need to attract foreign investors or solicit for foreign partnerships. Also, given the prevailing uncertainties in the oil market and related investment risks in the biofuel industry, potential biofuel processors could also seek incentives from host governments, as is the case in the United States, the EU and other biofuel producing countries. Even if the provision of direct subsidies may not be financially feasible for most developing countries, there are several other ways of creating incentives for foreign investors like extending provisional tax credits, building infrastructure as well as having clear and stable economic policies. Here, donor agencies can play a positive role in supporting infrastructural development which is essential to facilitate production and distribution and hence attract foreign investors in to the biofuel industry. This can fall under the Aid for Trade framework at the multilateral level, which calls for a provision of technical and infrastructural support for developing countries so that they can take full advantage of global trading opportunities like the one from biofuels.

Also, the EU and the United States should consider reduction of biofuel tariffs and excessive dependence of their biofuel industries on subsidies. Given the trade distortive nature of production subsidies, their reduction or elimination will allow meaningful market access for biofuels coming from developing countries and also benefit the EU and the United States with access to cheaper biofuels. Hence, both developed and developing countries can benefit from a more liberal trade regime and resulting increased trade on biofuels. This should be seen as part of the broader move towards decoupling subsidies from production under the WTO.

Developing countries on their part need to create a more favourable policy environment for investments in biofuels. This includes provision of policy support or investment incentives such as allowing duty free importation of capital goods and giving temporary tax credits to facilitate establishment of industries (the nature of tax credit proposed here is different from the one being provided by the United States and the EU since it would only be available for new biofuel industries, without being tied to production). Developing countries should also ensure clarity and stability of their policies on biofuels and investments in general which is an important factor to attract high capital investments.

Developing countries should also promote the creation of synergies between biofuel industries and other sectors in the economy so that risks and uncertainties in the biofuel market can be reduced. Brazil is a good example where most ethanol industries also engage in sugar production and generation of electricity, thereby reducing risk in the biofuel business (Moreira, 2006).

Developing countries should also use regulatory policies and measures to reduce the potential adverse impacts of biofuels on the environment and human welfare. This may include:

- Restricting the cultivation of biofuel feedstocks to areas not used for food production, not high in biodiversity and where a negative impact on rural livelihoods is not expected, and also regulating the intensity of chemicals applied in feedstock production;
- Promoting the planting of energy and food crops in rotation;
- Setting safeguard schemes whereby feedstocks produced as biofuel inputs may be exceptionally diverted into the local food market in times of severe food shortage (such an exception is already allowed under the WTO in relation to export ban); and
- Ensuring that the local population is effectively consulted and adequately compensated in unfortunate cases of displacement.

Finally, while the EU's certification scheme is a good move towards ensuring the environmental and social sustainability of biofuels, it needs to be broadened in scope and application in order to serve its intended purpose. This may include the incorporation of social concerns such as diversion of land from food to feedstock cultivation and undue displacement of local people under its sustainability criteria. But while becoming firm in application, it should not be unnecessarily technical or costly in a way that hinders the export capacity of developing countries.

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