Eco-industrialism: The Potential for Inclusive Growth with Bio-Plastic Production in Brazil Using Sugarcane Ethanol

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Abstract

Eco-industrialism embraces the concept of spatially-concentrated and inter-connected industrial activities that collectively are eco-efficient in the use of resources, though not necessarily premised on renewable resources. One area of activity that has potential for renewable eco-industrialism is that of bio-plastics; specifically in this case the production of plastic feedstock from sugarcane ethanol along with downstream products manufactured from bio-plastic feedstock for industrial or consumer markets. Eco-industrialism, in addition, has little to say about the subject of inclusive growth – an important element in the social and economic dimensions of sustainability. Inclusive growth means bringing some of the wealth created by growth to the marginal elements of society. This paper examines the nascent sugarcane ethanol bio-plastic industry in Brazil with a view to understanding the potential of the sector for renewable eco-industrialism in general, and for inclusive growth to mitigate rural poverty in particular. It is concluded that while the sector and the underlying technology is only in the formative stages, there are reasons to suppose that there is potential for inclusive growth and alleviating rural poverty by broadening income flows and reducing income volatility risk to rural areas. The paper explains that the concept of eco-industrialism has thus far been limited in that it is not based on renewable resources per se. Hence in theoretical terms the paper seeks to explain the significance of two possible developments of the concept: a basis of on renewable resources; and an extension with 'inclusive growth'. The analysis is grounded in an understanding of contemporary definitions of bio-plastic and why it might be important e.g. in the automotive industry. Information on the technology and scale of production, etc. is used to compare the bio-plastic sector with the mainstream petrochemical plastic sector. We then present a case study of Brazil in which it is shown that an embryonic bio-plastic industry exists, though it is far from being an eco-industrial cluster. The subsequent analysis argues that there is a strong sustainability basis for developing a Brazilian bio-plastic eco-industrial complex based on sugarcane ethanol, and outlines some potential policy frameworks to further encourage the development of such a sector. It is concluded that there are broad social and economic benefits, such as greater inclusive growth and higher retention of added value within Brazil, alongside the environmental advantages of using sugarcane such as lower carbon emissions. The wider theoretical conclusions are that eco-industrialism based on renewable resources could be the foundation of a new form of materialism in modern society.

Keywords: *Inclusive growth; sugarcane ethanol; eco-industrialism; ethanol; Brazil.*

1 Introduction

This paper is about the potential and scope for future inclusive growth based on the use of sugarcane ethanol as a feedstock for the production of bio-plastic within the broader concept of eco-industrialism. At the theoretical level the paper highlights two issues. The first is the environmental limitation of eco-industrialism which is premised on spatially contiguous and functionally inter-connected processes for optimum resource efficiency, but which has thus far not embraced the problem of the use of non-renewable, finite, resources. The second is the social limitation of eco-industrialism, where scant engagement with the issue of inclusive growth is evident. The literature on eco-industrialism and related concepts such as eco-industrial parks therefore tends to fall short of durable sustainability, as is argued in the first section to follow this introduction. Thereafter the paper provides a brief account of the use of sugarcane ethanol as a feedstock for bio-plastic, where the premium price obtained for the material by key user end-markets in electronics and the automotive industry are highlighted. The paper provides in the section following this account a case-study of the situation in Brazil, the country with arguably the most well-developed sugarcane ethanol business but also a country that faces significant challenges with respect to social inclusion. The case study is exploratory in nature, not least because the use of sugarcane ethanol in bio-plastic on a commercial scale is a relatively new phenomenon. The intention of this paper is to show that there is a theoretical potential for renewable eco-industrialism based on sugarcane, and that at least in embryonic form there is a modest amount of evidence that such a potential is beginning to be exploited. The paper cannot provide an example of a fully developed eco-industrial complex of this type, because one does not exist as yet. In the section on analysis and conclusions it is argued, however, that the nascent character of this industry provides an interesting policy opportunity, in that eco-industrial clusters based on renewable sugarcane ethanol have potential both for vastly improved environmental performance and for significant social benefits.

2 Eco-industrialism

Eco-industrialism is the physical manifestation of industrial ecology whereby several distinct processes and products (and usually distinct organisations) are inter-connected by material flows that collectively result in reduced waste and higher resource efficiency, usually though not always within a spatially concentrated area. Eco-industrial is seeks to ensure that the waste from one process can become the input for another, and that energy and material use are optimised. Closely related terms include eco-industrial parks, industrial symbiosis or industrial ecosystems (Deutz and Gibbs, 2004). The concept takes its inspiration from the Kalundborg community in which this sort of inter-dependence developed over a period of time (Lowe and Evans, 1995). While the Kalundborg example largely evolved (Ehrenfeld and Gertler, 1997), planners and policy-makers have thereafter sought to induce similar developments elsewhere. As Ehrenfeld and Gertler make clear, the replication of the evolution of Kalundborg is by no means straightforward but this has not prevented policy-makers and academics alike pursuing the goal (Gibbs et al., 2005).

What is also interesting, and neglected, however is that the core industries within the eco-industrial complex at Kalundborg are: Asnaes Power Station, a 1,500-megawatt coal-fired power plant; a large oil refinery operated by Statoil; Novo Nordisk, a maker of pharmaceuticals and enzymes; and Gyproc, a plasterboard manufacturer. In other words, the entire complex is premised on the consumption of carbon intensive, non-renewable, fuels.

Moreover, while research into Kalundborg and other examples of eco-industrialism have tended to replicate natural biology and ecology by a focus on material and energy flows through the system, there has been rather less attention paid to the social dimension of eco-industrialism. There is a sense that there is a struggle for the soul of the discipline, between those who see industrial ecology as essentially a quantitative science bringing tools and methodologies to bear upon the analytical process (Frosch and Gallopoulos, 1989), and those who see industrial ecology as essentially a metaphor to provide insight, understanding and reflexive discourse (Ehrenfeld, 2004). The quantitative bias tends to result in a focus on stocks and flows within the boundaries of the 'system' as it is defined, but does not include a wider evaluation of the purpose of the industrial ecosystem in question or a social critique that might deal with issues such as equity. Research into eco-industrialism is characterised by the use of methodologies such as Materials Flow Analysis and Life Cycle Analysis, or related techniques that seek to quantify observable processes. Hence industrial ecology in general tends not to challenge the business or social status quo, and is therefore often inherently conservative rather than radical in a social sense.

In the Kalundborg case it is interesting that elements of the entire system integrate with and interact with the community via for example the use of waste heat to provide domestic heating, and of course via the significant employment potential of the entire site. In social terms, it is reasonable to expect that the creation of a spatially concentrated eco-industrial complex also demands significant trust and co-operation between different social actors and organisations. Given the position of Denmark, the location of Kalundborg, as perhaps the world's most equal society, the neglect of this social dimension to eco-industrialism is surprising. In the context of developing nations, the integration of eco-industrialism would have to consider the social implications, including the employment effects and the implications for wealth distribution.

Importantly, then, eco-industrialism does not appear to require that the products of this complex are themselves sustainable, or that the raw materials used are renewable, even if the approach does actively highlight the reduction of virgin raw material as an important benefit. The emphasis is on building up a network of mutually dependent entities that collectively and cumulatively are more efficient than when working in isolation. Individual products and materials offer differing degrees and types of sustainability as well. Hence in the realm of plastic a material may be 'green' if it is derived from recycled plastic that has already been used in a previous application (for example the use of PET bottles to make car bumpers); but it may also be 'green' (and arguably greener) if it uses a renewable feedstock in its manufacture. Therefore the use of sugarcane as a feedstock to make ethanol and thence bio-plastic offers an interesting possibility both as a green material, and as the basis for a renewable eco-industrialism. In this potential, sugarcane is not alone. It might be envisaged that forestry could be the basis of a different sort of eco-industrial complex for example, or that enzymes could be used to process waste organic products. However, the Brazilian sugarcane industry is already deeply embedded into the ethanol supply chain as a low-carbon fuel source for vehicles, and in many respects as the next section shows its sustainability credentials are better established than any other potential basis for renewable eco-industrialism. Not least, once the base ethylene has been produced there are many value-added plastic products that can be manufactured, as well as other plastic compounds.

3 Eco-industrialism and social impacts

As previously discussed, eco-industrialism focuses on material and energy flows rather than on the social implications of integrated systems. However, eco-industrial park development can provide direct economic and social benefits. For developing nations, the social effects of eco-industrial policies can be prominent due to significant employment effects. Indeed, the importance of the `green economy` has emerged as a central area of future economic development that directly speaks to the relationship between sustainable pathways and poverty alleviation strategies (UNEP, 2011).

Renewable energy sources can play an important role in a comprehensive strategy to eliminate energy poverty - an important aspect of poverty reduction programmes. Aside from enhancing the livelihoods of the poor, the growth of the renewable energy sector brings about many new employment opportunities. In this context of change, public policy can play a crucial role in the enhancing incentives for the renewable energy sector. UNEP (2011) indicates several important incentives such as feed-in tariffs, direct subsidies, and tax credits that may enhance the revenue profile of renewable energy investments. Bio-fuels and bio-plastics can play a prominent role in the shift toward renewable eco-industrialism due to a wide range of technologically proven applications, and can provide a substantial contribution to the greening of the energy and polymer sectors (UNEP, 2011).

As previously indicated, Brazil has a large experience with the production and use of bio-fuels. The initial bio-ethanol programme (the Proalcool policy initiative) of the 1970s has been able to substitute imported oil with locally-produced ethanol fuel, strengthening the international balance of payments and fostering the agricultural sector. Most of the production has been concentrated in the state of São Paulo and is characterized by large plantations that take up a significant amount of the arable area of the state. Despite the considerable aggregate success of the initiative, the micro-economic effect on poverty reduction and inclusive-growth has been limited as workers involved in the production of sugar cane have not received a considerable share of the profits. Most of these workers have collected low wages and have been subject to detrimental labour conditions, while the largest portion of profit has been concentrated to plantation and refinery owners. During the 1970s and 1980s, Brazilian rural workers did not have a social protection net of social benefits. As a matter of fact, the design of the bio-ethanol programme did not have any explicit consideration for labour conditions of the rural poor as the intention was to help an industry in crisis.

The lack of a robust labour policy framework to tackle the detrimental conditions of rural Brazil has been widely identified as a central deficiency of the programme. In this respect, one of lessons learned from the implementation of the bio-ethanol programme that can be taken in a world under pressure to respond to climate change has been that polices must not only challenge the business status quo, by supporting eco-industrialism development, but also take into account the social conditions in specific segments.

In the Brazilian historical environment, it is relevant to mention that at the same time that the bio-ethanol programme had been launched the government also sponsored a policy to support research on biodiesel. On 30th of October 1980, the Pro-oil program, Plan on the Production of Vegetable Oils for Energetic Use was implemented by the Brazilian federal government to research the feasibility of different vegetable sources for the production of biodiesel, fostering research on soy, rapeseed, canola, sunflower and *dendê* for automotive applications (IICA, 2007). B30 blends were proven to be technically feasible for the commercial engines available at the time. As a consequence, the first Brazilian patent on biodiesel was granted in 1983. During the same year, a pioneering flight from São José dos Campos to Brasília, in an Embraer bio-kerosene fulled Bandeirante Aircraft, showcased the technological capabilities of biodiesel (Parente, 2003).

Despite the remarkable prospective applications of biodiesel, the economic viability of producing biodiesel on large scale struggled with the reduction of the international price of oil in 1986. It became prohibitive for the government to promote a large scale programme for the adoption of biodiesel following the Proalcool model, as other fiscal preoccupations loomed (Pousa et al., 2007).

Recently, the interest in biodiesel has emerged again following climate change and political instabilities in high oil producing countries of the Middle East. In 2005, a national program to foster the production of biodiesel was put together to foster the production of biodiesel from wider range of vegetable sources, but mostly from soy beans. Brazil became a world leader in the production of soy, and there was spare land and capacity to increase production. The programme was also innovative as it sought to incorporate small-scale farmers in the supply chain of biodiesel with the production of alternative vegetable sources, such as cotton, castor and sunflower. This takes a different view on the labour impacts of a biofuels programme and on the benefit distribution.

The Biodiesel Programme has effectively organized the supply chain of biodiesel, as 5% of all diesel consumed in the country. Specific instruments have been crafted to foster the small-scale farmers' participation, including fiscal incentives for refineries that would buy form small-scale farmers, free distribution of seeds, funding and technical assistance on how to maximize production by governmental agencies. Despite recent changes in the programme, farmers have had little interest in participating in the production of castor beans, due to the lack of proper technical assistance, lack of long term contracts, mistrust in the supply chain, and problems related to climate (Zapata et al., 2010). The programme has recently been reshaped with the introduction of Petrobras as the central stakeholder. Despite the castor oil being bought under the biodiesel programme, refineries sell the oil to other industries that pay a higher price fro the castor oil, such as the cosmetics and pharmaceutical industries. As of 2010, some 103,800 small scale farmers have become part of the programme (SECOM, 2011).

The biodiesel experience in Brazil indicates that localized production of biofuels can enhance the potential for productive inclusion of small scale farmers, and in the context of developing nations, aid in poverty alleviation strategies. The possibility of using biofuels to other industries such as pharmaceutical, cosmetics, plastic and fuels opens several important financial streams that can be used by small-scale farmers, and may provide significant possibilities for inclusive policies. The experience also suggests that similar benefits could accrue with the development of bio-plastics based on sugarcane ethanol.

4 The Inclusive growth extension

Enhancing the livelihood of the poor can constitute a significant contribution by eco-industrialism for developing nations. Several stakeholders can be included in the supply chain of biofuel derived products including small scale farmers and workers involved in the production process of raw materials or other products. The use of biofuels for other industries opens up a set of potential revenue streams that may be significant in regards to inclusive growth polices, relevant for developing nations. In this context, the inclusive growth agenda seems is core policy concept that can be taken up in this the concept of productive inclusion as a core stream that runs in the policy geared towards small-scale farmers. The biodiesel programme in Brazil has followed some of this preoccupation as noted above.

The case of bio-plastics highlighted in this paper is an underexplored area in the larger bio-ethanol market. The nascent sector has a large potential with the enhancement of the `green economy` agenda, while tackling some of the traditional labour problems that have characterized the relationship between small scale farmers and the market in the agricultural sector in Brazil. A bio-plastic refinery can make use of localized production, which at least in they can enhance the economic conditions of small-scale farmers. The technical feasibility of localized production has been proven by the PLA that has the largest bio refinery that is in Nebraska, USA. The refinery makes use of corn for the production of bio-plastic. According to PLA (2011) the Blair bio-refinery gets 60% of corn from a local area, composed of producers form Nebraska and Iowa that are located less than 40 kilometres from the plant.

Significant trust and cooperation among the stakeholders has been an issue raised in the Biodiesel Brazilian case study (Zapata et al., 2010). The economic incentive instruments put in place by the biodiesel policy must take into account these aspects and should be taken into consideration for this matter. It is not possible to understand how can sustainable policy geared towards setting up sustainable structures can be structured and designed without the proper consideration of the social implications of those measures.

However, an important aspect that has been neglected in the literature in productive inclusion has been the role that industry can play in enhancing employment and labour conditions of workers and less on material and energy flows. Most of the literature is of has a wide focus on governmental polices that include poor small-scale farmers in the supply chain if agricultural products. The role played by industry is crucial in this interplay between the public and private sector, and have a large potential to generate positive effects on poverty alleviation.

5 Sugarcane ethanol and bio-plastic

Thus far the primary attraction of sugarcane ethanol has been as a renewable or low-carbon fuel source, particularly for vehicles. In this regard sugarcane ethanol has a lower carbon burden than most other liquid fuels, particularly with respect to Brazilian sugarcane. In 2010 the EPA declared Brazilian sugarcane ethanol to reduce by 61% carbon emissions compared with gasoline (EPA, 2010). Sugarcane ethanol has become the dominant fuel type for passenger vehicles in Brazil, and increasingly those involved in the sector are seeking to exploit export opportunities (Wells and Faro, 2011).

Developments in sugarcane varieties, scientific agriculture, bio-chemistry and process engineering continue to advance the knowledge base with consequential increases in productivity in ethanol production (Rajagopal et al., 2009). On the other hand, just as crude petroleum can be used to produce plastic feedstock and thence products, rather than refined and then irretrievably burned, so too can sugarcane ethanol. It is worth noting in passing that some of the low-carbon benefit of using sugarcane ethanol as a fuel for vehicles arises from the use of waste bagasse as a fuel that is burnt to drive electricity generator turbines on-site at the refineries, with excess electricity able to be sold to the national grid (Goldemberg et al., 2008). More recently, developments with bio-diesel chemistries and with second-generation bio-fuels have given rise to the possibility of using this bagasse differently, as a feedstock either for bio-diesel or ethanol. It is evident that the science and technology of using agricultural crops to derive liquid fuels is still developing, and the results might of course change the economic and environmental balance regarding the benefits of using sugarcane ethanol as a fuel or as a plastic feedstock.

The concept of producing various plastics from vegetable feedstock has been established at the laboratory scale for a long time. The incentive to develop the technology further has been constrained by the relatively low price of petroleum and by the relatively unsophisticated state of knowledge as far as industrial production is concerned. More recently interest in bio-plastic in general has grown as a result of increasing petroleum prices and growing legislative pressure to reduce the carbon content of products and services, and to reduce waste streams to landfill. Plastic continues to be a significant material in contemporary life. It is unlikely that plastic in general can be removed from all products because the utility that the vast array of plastic types offer cannot easily be replicated by other materials. Plastic consumption is a relatively small part of total global petroleum consumption (less than 5% of all petroleum), but the medium-term prospect of significant petroleum shortages on a global basis is a further factor in stimulating governmental and corporate interest in alternative sources such as sugarcane.

There are various chemistries that can be adapted to bio-plastic (or bio-polymers), of which vegetable-derived ethanol is but one. Initial studies on a lifecycle basis conducted in Thailand suggest that lactide (the monomer for the polymer poly-l-lactic acid (PLLA)) and PLLA can be made from sugarcane ethanol, and can be used in an increasing amount of applications (Groot and Borén, 2010). The biopolymer PLLA is one type of polymer of the family of polylactic acids (PLAs). Interestingly in the comparative lifecycle analysis PLLA from sugarcane showed significantly lower emissions of greenhouse gasses, and reduced material consumption and lower fossil fuel energy consumption, compared to petroleum-based polymers. The outcomes were highly sensitive to the extent of electricity production from the bagasse (waste cane). On the other hand, the agricultural basis of sugarcane production means that compared with petroleum-derived polymer resulted higher contributions to acidification, photochemical ozone creation, eutrophication, and farm land use. The potential of Brazilian sugarcane as a plastic feedstock other than ethanol has been recognised by those working within the realm of environmental chemistry. Koller et al., (2010) studied the biodegradable polymer poly-(3-hydroxybutyrate) (PHB) and concluded that embedding of the industrial PHB production into a sugar and ethanol refinery starting from the raw material sugarcane makes it possible to achieve a production price per kilogram PHB that is 4–5 times lower than known for prior PHB production processes. This research therefore suggests that ethanol is by no means the only polymer that can be derived from sugarcane. Moreover, at the experimental level the sugarcane fibres have also been used as a reinforcing material to make structural components, again suggesting further scope for expansion of the product range that can be derived. Hence while this paper has a focus on the ‘volume’ application of sugarcane ethanol as a feedstock to bio-polymer production via the manufacture of ethylene, the potential in terms of eco-industrialism extends well beyond this single material.

There are many different polymer types, and frequently multiple different polymers are combined to create distinct products, often of course in combination with non-polymer materials. Thus everyday products such as telephones, computers and cars combine many different polymer materials. It can be difficult, therefore, to identify products that are purely based on renewable polymers. An illustrative example is that of a new member of the Toyota family of ‘Ecological Plastic’, termed bio-PET, derived from sugar cane. Polyethylene terephthalate consists of 70 per cent terephthalic acid and 30 per cent monoethylene glycol, by weight; bio-PET is made by replacing the monethylene glycol with a biological raw material. The bio-PET is used to manufacture the lining of the luggage area of the new Lexus CT 200h introduced in 2010, though Toyota also claimed that it planned to introduce a model in which 80 per cent of the interior trim would be manufactured from this material (Wells and Morreau, 2010).

Importantly, bio-polymers command a price premium by virtue of their green credentials. There is therefore a hierarchy of uses of sugarcane in which the further the material is processed, the greater is the added value. This hierarchy goes from sugar, to ethanol, to bio-polymer, and thence to semi-manufactured materials (sheet, tube, etc.), components and sub-systems, and in some cases complete products (many toys are manufactured purely from plastic for example).

6 Brazilian case study

Sugar production in the State of São Paulo grew from around 45 million tons in 1975/76 to 300 million tons in 2007/08 while ethanol production in the State grew from about 7.5 million cubic metres in 1990/91 to 13 million cubic metres in 2007/08 (Goldemberg et al., 2008 p27 and p28). As such, the State of São Paulo accounted for about 62% of Brazilian production and 26% of global production of ethanol in 2007 and 2008. Put another way, ethanol and bagasse (the waste material from sugar production that may be subsequently burnt to produce steam and hence drive electricity-generation turbines) between them account for more than 25% of all primary energy in the State.

According to the CGEE (Centre for Strategic Management and Studies, Brazil), in the 1970s typical productivity was 2,000 litres of ethanol per hectare, whereas by the mid-2000s it had reached 8,000 litres per hectare (Poppe, 2006). Further productivity gains are expected to increase yields to above 10,000 litres per hectare. In turn, such productivity growth expectations have also given rise to expectations of increased overall output and exports, with up to three times the output of 2009 expected by about 2010/11 and a growth in exports from 16% of output in 2007/08 to 24% by 220/21 (Wells and Faro, 2011).

Historically the sugarcane refining sector has been fragmented, though the global financial crisis of 2007/08 encouraged consolidation. In 2009 there were 450 production sites controlled by 160 companies, of which 15% involved foreign participation (Silva, 2009). The majority remain as single-distillery businesses, but are often supplied by contract farmers and small-scale growers. Importantly, this means that production and employment is dispersed rather than spatially concentrated, and hence is significant for marginal rural labourers and small farmers.

Capturing a greater share of downstream value would be economically highly significant for Brazil and potentially put the country at the forefront of technological developments in this nascent sector. Much depends upon the degree of flexibility in production between sugar, ethanol, and downstream products in plastics. In the case of sugar and ethanol switching there is evidence that flexibility has economic value for the producers (Bastian-Pinto et al., 2009), which if also applied to bio-plastic production would be further advantageous. Not least, having a further outlet for sugarcane ethanol would help insulate the entire sector from fluctuations in supply and demand, with attendant benefits for inclusive growth. As yet there has been no comprehensive lifecycle assessment of the relative costs and benefits of using sugarcane for sugar, ethanol fuel, or ethylene plastic feedstock. Without doubt this is a complex issue, not least because the diversion of ethanol as a fuel to its use as a feedstock would result in more petroleum being used for cars with a consequential increase in CO2 emissions.

It is interesting to note that investments have occurred at least in terms of creating capacity to produce ethylene from sugarcane ethanol, although this falls short of creating a complete eco-industrial complex. In 2009 the US bio-chemical company Virent was reportedly interested in investing in the Brazilian ethanol sector (UNICA ED2320 05/05/09). Also in 2009, Pedra Agroindusrial was reportedly planning to invest US$300m to produce 40,000 tons per annum of biodegradeable plastic derived from sugarcane ethanol. In 2010 Coca-Cola Brazil announced plastic PET bottles would use 30% sugarcane ethanol, moving to 100% by 2020 (UNICA ED2528 25/03/10; UNICA ED2529 28/03/10).

7 The Brasken experience

The Brazilian company Brasken launched a bio-polyethylene in 2007 that is produced with the use of sugarcane-derived ethanol. The polyethylene produced at Brasken has the same chemical and physical characteristics of the traditional petrol fuel derived material, and has been widely used for automobile, cosmetics, packing and toys. The firm markets the bio-polyethylene as an en environmentally friendly product, with a large export potential.

In 2010, the company claimed to be the world leader in the production of bio-polyethylene as it opened a US$320 million biofuel ethanol plant, which has the capacity to produce 200,000 tonnes of bio-polyethylene. It is located in Triunfo, in the south state of Rio Grande do Sul. Not only the product but also the production process has significant environmental attributes including, energy reutilization and material re-use. According the calculations provided by Brasken, for each ton of green Polyethylene, 2.5 tonnes of CO2 are captured.

Brasken has had large preoccupations with the environmental and social dimensions of bio-polyethylene production, setting up several minimum social and environmental requirements for other firms that make up the supply chain of the product. According to a representative of Brasken, the firm has taken up consistent corporate environmental strategy measures consistent with the sustainable development so to enhance the environmental and social attributes of bio-polyethylene. The requirements are set up for both large scale suppliers and small-scale producers that also aid in the supply of ethanol. In this respect , the initiates taken up by Brasken, tackle two important areas that have traditionally been problematic in the rural brazil, the environmental practices taken up by suppliers and the labour conditions imposed in the more deprived workers in the supply chain.

1- Environmental issues: A code of conduct for the suppliers of ethanol that include the traditional areas of environmental degradation in the production of ethanol in the south states of Brazil. These include the prohibition of sugar cane plantations burning the cane prior to harvesting; biodiversity preservation measures in the plantations; good environmental management; and appropriate waste treatment and energy reutilization. In order to enhance the marketing potential of the bio-polyethylene, Brasken has set up a green label called “I’m green” to be carried on products that have been produced with the use of bio-polyethylene.

2 - Labour conditions: The company has released clear labour condition that shall be respected in regards to the suppliers. These include, follow international human rights and fair labour rights, labour work conditions, that includes minimum pay for manual cane cutters, decent work conditions regarding rest and housing for migrant workers, security and accident prevention official schemes, free distribution of safety gear and monitoring of their use, provision of safe transportation, decent meals (respecting minimum nutritional and temperature standards).

Despite the positive steps taken up by Brasken, It is important to indicate that the firm is not able to resolve the detrimental conditions of many of the poor sugar cane cutters in rural Brazil. This has been a traditional problem with the production of ethanol in the country.. These workers do not receive a large benefit of the bio-polyethylene production as most of the value added is on the biofuels refinery and on the production of the bio-polyethylene at Brasken. As previously indicated, the production of biodiesel has a large potential to tackle these issues as small-scale family famers can be inserted in the supply chain of the product at higher value added stages enhancing therefore the inclusive growth potential of such initiative.

8 Analysis and conclusions

In principle, economic development policy within a country should seek to increase the amount of local value-added and hence retain a greater proportion of wealth generated. Equally, diversification can be an important principle in economic development in order to provide a degree of resilience to exogenous forces for change. As we have argued elsewhere, dependence upon commodities makes a country vulnerable to short-term price fluctuations and long-term real price declines. These arguments have particular force when applied to those that tend to be marginal or almost excluded from the benefits of economic growth, as could be said to be the case for small-scale sugarcane producers and those working on sugarcane plantations in Brazil.

An analysis of the sugarcane value chain in Brazil concluded that the sugar-energy sector GDP in 2008 was US$28.15 billion, equivalent to 2% of the total Brazilian GDP. The estimated total value of sales of the various links that comprise the sugarcane chain reached US$86.8 billion. Going further downstream into plastics and thence into plastic products would considerably increase the value of the sector and allow companies in Brazil to differentiate themselves on global markets. Under current plans there is no doubt that the contribution of Brazilian bio-plastics to the world market is extremely small, amounting to around 600,000 tons per annum or less than 1% of the world total plastic production

Despite the fact that food security is a crucial preoccupation for developing nations, biofuels are a growing market and new technological options in this market have the potential to enhance future options for poverty reduction. While vulnerable groups can be protected with a range of policy options adopted to promote productive inclusion of excluded small scale farmers, bioplastics can enhance economic and energy efficiency. While it generates a constant financial stream to small-scale farmers, it can increase food security of these communities.

Bio-plastics are considered a feasible alternative as household income can be increased with high value added products from biomass, through small-scale local bio-refineries producing bio-energy or other bio-based products in poor marginal and remote areas. (Langeveld et al. (2010). Policies can be designed, in a way to foster the development of this market, structuring the supply chain of the product, while guaranteeing inclusive policies.

Biofuel production can potentially act as a catalyst for rural development, by generating new employment, providing renewable energy options in energy deficient rural areas, and greening and restoring degraded environmental areas. Although biofuel production has clear benefit to the agricultural sector, the net impact on poverty and food insecurity in developing countries is less clear (Dixon et al., 2010). Higher food prices would be beneficial to farmers who produce a net surplus of food, but detrimental to poor consumers and food-deficit farmers, who would have to balance more expensive food against less costly energy (Hazell and Pachauri 2006).

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