SUSTAINABILITY OF BIOFUELS AND BIOPRODUCTS: SOCIO-ECONOMIC IMPACT ASSESSMENT

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ABSTRACT: Many countries worldwide are increasingly engaging in the promotion of biomass production for industrial uses such as biofuels and bioproducts (chemicals, bioplastics, etc.). Until today, mainly biofuels were supported by European policies, but support for bioproducts is still lacking behind. Thus, also the public sustainability debate concentrated on biofuels, but so far not on bioproducts. Driven by the strong public debate on sustainability aspects, biofuels are confronted with many environmental and socio-economic impacts. For instance, social impacts, which can be both positive and negative, include property rights, labour conditions, social welfare, economic wealth, poverty reduction, etc. In order to address these sustainability aspects of biomass production for industrial uses, different national and international efforts towards certification systems have been evolving, including the European Renewable Energy Directive (RED). However, besides many efforts on environmental aspects, there is a general lack of socio-economic considerations. This gap is addressed by the EU-FP7 Global-Bio-Pact project in a comprehensive approach involving partners from Europe, Latin America, Africa, and Asia. The main aim of the Global-Bio-Pact project is the improvement and harmonisation of global sustainability certification systems for biomass production, conversion systems and trade in order to prevent negative socio-economic impacts. Thereby, emphasis is placed on an assessment of the socio-economic impacts of raw material production and a variety of biomass conversion chains. This paper presents an overview of socio-economic sustainability issues of biofuels and bioproducts worldwide based on first results of the Global-Bio-Pact Case Studies in Argentina, Brazil, Canada, Costa Rica, Europe, Indonesia, Mali, and Tanzania. These Case Studies investigate the whole value chain from feedstock production to intermediate and end products. They include the production and conversion chains of jatropha, palm oil, soy, sugar cane and lignocellulosic biomass which are investigated at different scales.

Keywords: biofuels, bioproducts, sustainability, international cooperation, socio-economic impacts

1 INTRODUCTION

During the first years of the 21st century the major global challenges have been fresh water supply, food security, climate change, energy security and rural development. In order to address these challenges, there is an increased necessity to move away from petrochemical resources for energy, fuel and chemicals. Thus, many countries worldwide are engaging in the promotion of biomass production for industrial uses such as biofuels and bioproducts. Although biomass raw materials offer the opportunity to replace petrochemical resources for a large variety of bioproducts (chemicals, bioplastics, etc.), significant market penetration has up to now only been achieved for liquid (and gaseous) biofuels in the transport sector, and only in a few countries, such as in Brazil, Argentina, USA, and in Europe.

However, due to the limited availability of fossil fuels, the production and use of bioproducts and biofuels will inevitably increase in the future. This shift from fossil resources towards biofuels, bioproducts and other renewable energies are associated with positive and negative impacts on economies, environmental issues, and social aspects.

In order to avoid or minimise the negative impacts, the first important step is to identify and describe the impacts.

For bioproducts, only very little is known and understood about the impacts, since the market is still very small and young. As opposed to bioproducts, a strong public debate on sustainability aspects for biofuels emerged in the last few years. This debate focused on negative social and environmental impacts. In consequence, several initiatives were set-up which are engaged in developing tools to ensure sustainability of biofuels. One option to ensure the sustainability of biofuels is the application of certification systems. Such systems have already been introduced for other products, such as e.g. for wood (FSC[1]).

One of the most important governmental initiatives was the introduction of the "Directive on the promotion of the use of energy from renewable sources"

[1] Forest Stewardship Council

(Renewable Energy Directive - RED) of the European Union [1], which also includes sustainability aspects of biofuel production [2].

The RED includes concrete *environmental* prerequisites for biofuels. It also includes reporting obligations for the Commission on the impact on *social* aspects in the Community and in third countries of increased demand for biofuels (Article 17). Based on the results of these reporting obligations on social sustainability, a revision of the Renewable Energy Directive is foreseen to possibly include additional criteria ensuring the socio-economic sustainability of (biomass and) biofuels.

In order to evaluate impacts of biomass production and processing for biofuels and bioproducts reliable data and profound research is needed. Currently, most sustainability schemes face the lack of reliable data on two issues, namely on (1) socio-economic impacts of biomass production and conversion and (2) the use of biomass for bioproducts, since currently mainly biofuels and not bioproducts are investigated. Furthermore, the true impact of the industrial use of biomass and bioproducts on global food security (e.g. for 1st and 2nd generation biofuels) as well as the detailed interaction and relationship between certification schemes and world trade in biomass and bioproducts is not well understood. Van Dam et al. [3] made an overview of developments in certification schemes and stated that involvement of local stakeholders is lacking, although it is required to define priority impact categories. An overview of socio-economic principles that are considered in current certification systems is shown by [4].

These main knowledge gaps for the development of sustainability criteria and effective certification schemes are addressed by the Global-Bio-Pact project in a comprehensive approach involving partners from Europe, Latin America, Africa, and Asia. The activities of the Global-Bio-Pact project serve as coordination platform to directly provide recommendations on how to integrate socio-economic sustainability criteria in the Renewable Energy Directive.

2 THE Global-Bio-Pact PROJECT

The main aim of the Global-Bio-Pact project is the improvement and harmonisation of global sustainability certification systems for biomass production, conversion systems and trade in order to prevent negative socio-economic impacts.

Thereby, emphasis is placed on a detailed assessment of the socio-economic impacts of raw material production and a variety of biomass conversion chains. The impact of biomass production on global and local food security and the links between environmental and socio-economic impacts are analysed. Furthermore, the Global-Bio-Pact project investigates the impact of biomass production on food security and the interrelationship of global sustainability certification systems with the international trade of biomass and bioproducts as well as with the public perception of biomass production for industrial uses. Finally, Global-Bio-Pact develops a set of socio-economic sustainability criteria and indicators for inclusion into a future effective certification scheme, and the project elaborates recommendations on how to best integrate socio-economic sustainability criteria in European legislation and policies on biomass and bioproducts.

The Global-Bio-Pact project "Global Assessment of Biomass and Bioproduct Impacts on Socio-economics and Sustainability" (Contract No. FP7- 245085) (Figure 1) is supported by the European Commission in the Seventh Framework Programme for Research and Technological Development (FP7). Global-Bio-Pact is coordinated by WIP Renewable Energies and runs from February 2010 to January 2013.

Figure 1: Global-Bio-Pact logo

3 Global-Bio-Pact CASE STUDIES

In order to work towards sustainable biomass production, concrete on-site examples showing main areas of concern are good tools to practically analyse relevant socio-economic issues of biomass production. The Global-Bio-Pact Case Studies focus on different bioproduct/biofuel life cycles and describe socio-economic impacts, their interlinks with environmental impacts, and trade issues, as well as on implications in terms of sustainability and applications of certification schemes. Positive and negative socio-economic impacts on micro-, meso- and macro-level are currently assessed for all Global-Bio-Pact Case Studies.

3.1 Case Study Methodology

The following in-depth Case Studies for socio-economic impacts are investigated in the framework of Global-Bio-Pact:

- Biodiesel from soy in Argentina
- Palm oil and biodiesel in Indonesia
- Bioethanol from sugarcane in Brazil
- Bioethanol from sugarcane in Costa Rica
- Jatropha oil and biodiesel in Tanzania
- Jatropha oil and biodiesel in Mali
- Lignocellulosic ethanol refinery in North-America
- Pyrolysis refinery in Europe

Since the impacts of the production of biofuels and bioproducts depend on the scale, different levels are analyzed in all Global-Bio-Pact Case Studies. In each Case Study country of the Global-Bio-Pact project assessments at national, regional level, as well as at the local, company or project level are currently implemented.

The Case Studies at the *national level* were selected in order to balance the geographical distribution (Africa, Latin America, Asia, Europe, N-America), feedstock sources (soy, palm oil, jatropha, sugarcane, lignocellulosic feedstock), conversion technologies (e.g.

fermentation, pressing, transesterification, hydrolysis, gasification) and products (biodiesel, pure plant oil, ethanol, bioproducts, 2nd generation technologies). Thereby, the assessment focuses on existing conversion technologies since these are the current hotspots of socio-economic concern, but also include impacts of future technologies which are not yet commercially available.

In the Global-Bio-Pact project, the *regional level* was defined as a homogenous region in climate, soil, and socio-economic parameters. The size of the region depends on the country and can be a province or district.

At the *local level* the system boundary is an area of a farmer, company, association or project. The local area refers to the area where the biomass feedstock (including by-products) is produced and converted into the final or intermediate product. In each Global-Bio-Pact Case Study country different local Case Studies (projects, companies) were selected and investigated. Thereby, the local Case Studies can be within or outside the regional boundary. The investigated topics at the local level are:

- Economics
- Employment generation
- Working conditions
- Health issues
- Food issues
- Land use competition and conflicts
- Gender issues

Thereby a main outcome of the Case Studies at the local level will address the following issues:

- Relevance of impacts
- Interlink between socioeconomic and environmental impacts (positive and negative correlations)
- Determination of thresholds
- Impact mitigation options
- Impact of biomass certification

The Case Studies are currently elaborated by national partners of the Global-Bio-Pact project. The following chapters present a state-of-the-art on these case studies. The final reports on the Case Studies will be published by end of 2011 and will be available at the Global-Bio-Pact website.

3.2 Case Study: Soy in Argentina

National level

The Case Study in Argentina is on biodiesel from soy and its related products, since Argentina is a main player in biodiesel production with a capacity of 1.6 million tons/year (2009) and investments that forecast a total production of 3 million t/a in 2011. A main focus of the Case Study in Argentina is an analysis of the soybean complex at national level due to its magnitude and importance for the whole country. The Argentinean soy complex and economy is one of the more dynamic sectors of the country, generating almost 30% of the external currencies income due to exports and representing almost 30% of the agro-industrial sector GDP. Argentina is the world's leading exporter in soybean oil, soy meal and soy biodiesel and the third exporter in soybeans.

Without doubt the soy value chain is an important instrument for development since it creates infra-structure. Biodiesel is a very recent activity in Argentina and the main driver for soybean expansion is the soybean price.

A survey is being conducted regarding the public perception of biodiesel in the country which has a relative low recognition in the general media.

Figure 2: Soy bean (Argentina) [A]

Soybeans are a food/feed crop and only a minor by-product of soy is currently used for energy purposes. The main product of soy is soy meal for fodder and food production. The soy industry in Argentina can be divided into three classes, each with different strengths and weaknesses:

- "Oil Crushers": representing the large multinational oilseed crushers with the largest plants and ample access to feedstock;
- "Large Independents": large plants but without access to their own feedstock
- "Small Independents": small and medium producers with none of the above, counting on government support at policy level.

Figure 3: Biodiesel plant (Argentina) [B]

Regional level

The main productive area of Argentina (Santa Fe Cordoba and North of Buenos Aires provinces) as well as the regional production chain in the North Western part of Argentina has been selected as regional Case Studies.

The first one is placed in the main region of soy production were more than 80% of Argentinean soy is produced and about 90% of the crushing capacity is installed. The second area belongs to a regional production facility placed between the provinces of Santiago del Estero and Catamarca. The following objectives of these regional case studies are:

- Identifying the principal drivers that promote the expansion of the crop in the area
- Identifying the specific ratio of feed/food and oil products giving special attention to the final use of the products
- Identifying the overall impact of commodity export
- Assess direct and indirect job creation at regional level due to crop expansion.

3.3 Case Study: Oil palm in Indonesia

National level

Palm oil has the largest share (57%) of the world's vegetable oil exports. The production continues to increase, particularly in Indonesia. Malaysia and Indonesia are the world's largest producers of palm oil, producing 86% of total global palm oil output in 2006. Other producing countries are Thailand, Nigeria, Colombia, Ecuador, Papua New Guinea, Ivory Coast, Costa Rica and Honduras. The primary mode of production is the large-scale monoculture production system. In addition, the sector counts more than a million of small scale producers with plots ranging from 1 to 50 hectares [5].

As palm oil is one of the major natural resources for bioproducts and biofuel production in Indonesia and as large impacts are expected, it was selected as Global-Bio-Pact Case Study.

Palm oil, which is extracted from the fruits of the oil palm, has many uses, for example in food products, cosmetics, animal feed, biofuels, and chemicals. Partly because the oil palm has the highest per-hectare yield of all edible oils and due to the steady increase of Indonesia's palm oil export, palm oil is foreseen to become one of the most important vegetable oils in the world. Thus, growers in Indonesia are increasing the production of palm oil to meet the global demand. The Indonesian Government promotes palm oil production to become the world's top producer of palm oil and at the same time it is regarded as a major tool of rural socio-economic development.

Figure 4: Meeting of Global-Bio-Pact members with smallholders (Indonesia) [A]

Although palm oil generates a considerable amount of foreign currency for Indonesia, its production may have significant negative environmental and socio-economic impacts resulting from large scale palm oil production. Examples are expropriation of community forest land, which deprives local communities of their livelihood resources. Large scale oil palm cultivation may also undermine local employment.

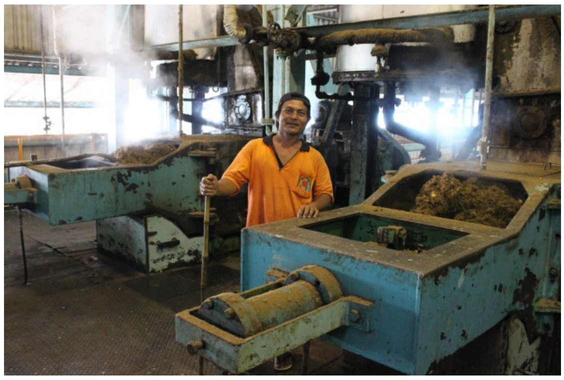

Figure 5: Worker in an oil palm mill (Indonesia) [A]

According to [5], land right conflicts are persistent in the oil palm plantation sector. Indonesia's forestlands provide livelihoods to some 100 million people, of which 40 million are indigenous people. Because these communities rarely have formal rights, licensed palm oil companies have taken over large tracts, which communities perceive as theirs by customary law.

Oil palm smallholders in Indonesia and Malaysia are usually fully dependent on neighbouring plantation companies for inputs (e.g. seeds, fertilizer) and marketing [5]. As oil palm fruits have to be processed within 24 hours, smallholders have no choice but to supply their fruits to the CPO[2] mill of the plantation company. This may lead to exploiting their bargaining power and offering very low prices to smallholders, especially when there are no strong collective bodies defending their interests.

Three main ownership models are investigated in the Global-Bio-Pact project:

- private plantations comprised of a nucleus estate and smallholder plasma areas
- state owned plantations
- and independent smallholders

Regional level

The main regional focus is North Sumatra. The region is a major producer of palm oil, contributing 18% of Indonesia's national production. The sector is a key contributor to the region's economy and is well established within the region, having originated here. North Sumatra is considered to have the most favourable soil and climatic conditions for plantation development and has well developed infrastructure. Although the full range of ownership models are represented in North Sumatra, the region is particularly notable for having the country's longest standing plantations and those exhibiting industry best practices. North Sumatra also allows for the study of the entire conversion chain, being home to refineries and downstream processing facilities.

An important feature of the palm oil industry in Indonesia is its regional diversity. Therefore, it was decided to investigate a second region, Jambi, in South Sumatra as a comparison to those in North Sumatra. Like North Sumatra, palm oil production is important to Jambi's regional economy. However, it represents a

[2] Crude Palm Oil

contrast in terms of average size of plantations, having smaller, independently owned plantations, and less established infrastructure. Drawing local case studies from two regions also allows understanding the impacts of the differing approaches of provincial governments on socio-economic and environmental impacts.

Local level

The first local Case Study of palm oil production in Indonesia is the independent smallholder system in Harapan Makmur Village, Jambi. The village is located in a relatively isolated part of Jambi province. Oil palm smallholders in this village have been cultivating the crop for a maximum of 6 years. They have adopted oil palm independently, purchasing planting materials from traders. The crop has been widely adopted amongst villages, with 70% of village land now used to cultivate oil palm. The socio-economic impacts of palm oil production in this village are mixed: farmers are earning a higher income than with previous crops, selling their fresh fruit bunches to traders, who subsequently sell them on to the nearest palm oil mill. However, the full income potential of palm oil is currently not yet being realized for farmers in this village. Remote from the nearest mill, lacking in extension services and market information, their yields are low and their bargaining position is weak: the price they receive for their crop is significantly lower than factory gate prices. Moreover, in converting large areas of land to oil palm from rice paddy, the village produces far less food than it previously did.

The other Case Studies are drawn from North Sumatra, with studies of a large private plantation associated mill, a contrasting group of independent smallholders, and a palm oil refinery with plans to begin biodiesel production about to be undertaken. These Case Studies have been selected to represent both the entire production and conversion chain of biodiesel from palm oil, but also to capture some of the diversity, particularly in the production stage, present in Indonesia.

3.4 Case Study: Jatropha in Tanzania

National level

Tanzania has considerable land resources for liquid biofuels production which could be used for export earnings as well as to reduce fossil oil imports, to increase employment, and to stimulate rural economic growth. In recent years, there has been a growing interest in liquid biofuels. Local and multinational investors are acquiring increasingly large farms, some in the range of up to 400,000 hectares in some parts of Tanzania. But also some smallholder farmers have developed interest in taking advantage of this opportunity through improving rural energy services, soap production and selling seeds and oil to large companies. Jatropha is being considered as one of the main crops for producing biofuels (biodiesel or straight vegetable oil - SVO) in Tanzania.

The growing interest in liquid biofuels production has also increased government commitment to the promotion of the biofuel sector. However, while the biofuels sector is growing, the country is facing several socio-economic challenges without a clear bioenergy policy. There are only statements within energy, agriculture, forest, land and environment policies aimed at enhancing production and use of solid biofuels. Liquid biofuel guidelines have recently been approved by the parliament. However, recent development in biofuel production in the country has led to calls on government to develop a comprehensive policy and strategies for biofuels development.

Figure 6: Jatropha (Tanzania) [A]

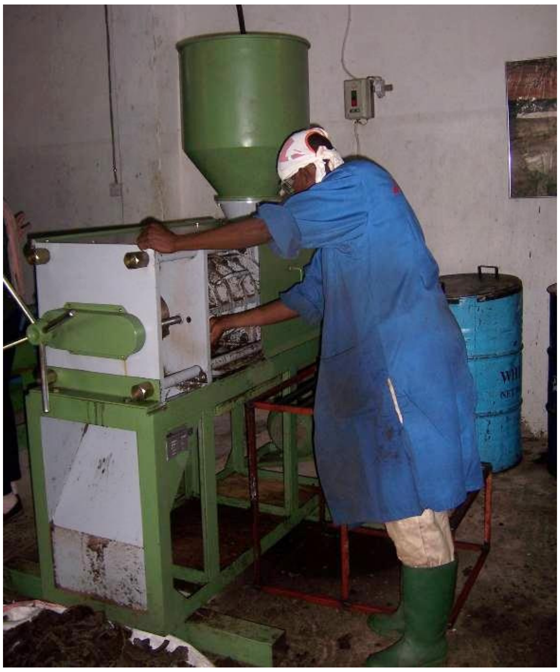

Figure 7: Small-scale pressing of Jatropha (Tanzania) [A]

Different business models are now emerging in Tanzania in relation to the production, processing and marketing of jatropha products. The cultivation of jatropha has socio-economic impacts on the livelihoods of smallholder farmers and indigenous communities. This is assessed by the Case Studies companies Sun-Biofuels (Coast Region) and Diligent (Arusha Region) as well as by local smallholder communities in the villages Leguruki and Selela.

Regional level

The first case study in Tanzania assesses the Sun-Biofuels company located in Kisarawe District, Coastal Region. The company is representing a stand-alone large scale plantation model. Sun-Biofuels (Tanzania) Ltd has invested in an 8,200 ha with a strategy to cover the whole biofuel value chain, from feedstock cultivation to processing and marketing of the end product. The company has directly and indirectly affected over 10,000 inhabitants in 12 villages from which the land was allocated for jatropha plantations.

The model has a number of positive and negative socio-economic impacts. The model of the large-scale jatropha plantation is a new source of revenues, creates employment and has developed plantations for piloting large scale jatropha farming. Contrary to those positive impacts, there were inadequacies in land transfer with either little or no compensation and limited access for local communities to: (1) forest resources for charcoal production, (2) firewood, (3) clay for pottery, (4) water, and (5) plants for food and medicine. The land allocated to Sun-Biofuels also includes a swamp where the local people used to get water during the dry season. The quality of life and food security in labourer households has changed as salaries paid are not sufficient. Farming activities in the nearby villages have been affected as people employed in the plantation have less time for their own farms. In addition, the area allocated for biofuel feedstock production affected biodiversity.

The second case study is the company Diligent in the Arusha region. It is representing a contractor business model for jatropha in which smallholder farmers are producing jatropha seeds on contractual arrangements with Diligent. The company has entered into contracts with local smallholder farmers, who grow jatropha and contractually supply seeds to the company. The company has no own plantation-based production, but it sources seeds solely from contracted local farmers and out-growers. The company is producing oil for domestic use and export. The by–products are used locally.

With regard to socio-economic impacts, the smallholder farmers are producing and selling jatropha seeds and seedlings. The economics of producing jatropha seedlings for sale by community could have high returns where fair terms are practiced. The centralised company in addition provides knowledge and skills to smallholders through trainings which enable them to produce more quality seeds. The by-products from jatropha processing can be used as fertiliser by smallholders and are used for producing briquettes by the company. The briquettes contribute to the initiatives of reducing deforestation while fertiliser is used to improve soil fertility.

Local level

At local level the independent small-scale farmer model plays an important role of producing, processing and marketing jatropha. Some small-scale farmers are organised in associations/cooperatives in order to locally produce, process and use jatropha oil and its by-products for meeting their different own needs.

The Case Study of independent smallholder communities for local level focuses on Leguruki and Selela Village Communities in Arusha Region. Jatropha is produced from small farms by intercropping with other crops or planting on their farm hedges. Jatropha oil and other by products are either used locally or sold to local processing centres (Energy Services Platform - ESPs) for rural electrification and provide motive power for milling, de-husking and oil pressing. Villagers bring their seeds for pressing to the ESPs in order to produce jatropha oil. Electricity is distributed to the villagers from ESPs through mini-grids constructed in the two villages. Villagers have been using electricity as an alternative energy source for the provision of light, powering various electrical appliances such as radio, TV sets, charging mobile phones and other services. The installed ESPs create income for village government through collection of taxes from entrepreneurs who own ESPs and individuals through selling jatropha oil and other by-products. Moreover, jatropha oil is used for soap making, insect repellents and seedcakes for biogas plants. On the other hand, slurry produced from the fermentation process can be used as fertilizer for improving productivity and soil fertility. Social impacts among others include improved education due increased light availability and thus increased study time for pupils.

Figure 9: Smallholder women opening jatropha fruits in Tanzania [C]

The model of independent small-scale farmers in cooperatives has been observed to be a potential promising business model for developing jatropha farming in Tanzania. This model has high positive socio-economic and environmental impacts since it enables people to produce, to process and to use jatropha oil locally for income and energy generation and has potential to sell extra oil or seeds to local biodiesel producing companies.

3.5 Case Study: Jatropha in Mali

National level

The potential for jatropha is of particular interest for Mali as the country is not an oil producing country and hard-earned resources are devoted for the importation of increasingly expensive fossil fuel products. Several initiatives, using jatropha oil as fuel are being implemented by various actors in Mali for rural electrification and by the transport sector. But this is at its infancy and the contribution to the national energy supply is very low.

Figure 9: Jatropha fruits and de-husked seeds, produced at MFC's test field in Garalo [D]

In 2007, the government of Mali has adopted the national strategy for the development of biofuel which is based on the energy policy and the renewable energy strategy. The objective of the national biofuel strategy is to replace 20% of diesel oil consumption with biofuel by 2022. Jatropha oil and ethanol have been identified as the most promising sources for biofuel production in Mali. The objective of the national biofuel target for jatropha oil production is to produce 39.2 Ml by 2012, Ml in 2017 and 84 Ml by 2022. This will require the production of 224,000 tons of seeds in 2012, 336,000 tons in 2017 and 448,000 tons in 2022. The total plantation surface necessary to produce these quantities are 71,680 hectares in 2012, 53,760 hectares in 2017 and 47,787 hectares in 2022.

In order to facilitate the implementation of this strategy and the elaboration of legislative rules, the National Agency for Biofuel Development (ANADEB) was established in 2009.

Regional & local level

The two selected Case Studies in Mali are MaliBiocarburant, a Dutch-Mali joint venture company, and the Garalo Bagani Yelen pilot project of the Mali-Folkecenter Nyetaa.

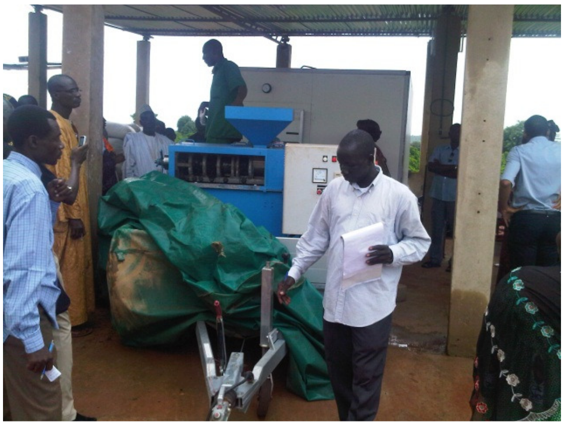

Figure 10: MaliBiocarburant's mobile press mounted on a trailer [D]

MaliBiocarburant is a Dutch-Mali joint venture company that works with rural populations to produce biodiesel from jatropha oil. It is currently the most centralised jatropha activity in Mali, as the biodiesel-processing technology is more high-tech and thus requires a more centralised approach. Mobile pressing units have been deployed to villages in an attempt to reduce transport costs by transporting oil instead of seed. Oil is processed in Koulikoro at the processing station with a capacity of 2,000 litres per day. MaliBiocarburant has been successful in obtaining carbon credits for its work. MaliBiocarburant seeks to supply jatropha biodiesel for the national market.

Biodiesel could thus create a sizable market for itself due to the fact that it can be used in most diesel engines with just some very minor engine changes. This means the potential market is very large. But there may also be an increased risk that the biodiesel is exported instead of being used for the local needs and the local development in Mali.

Mali-Folkecenter Nyetaa has a more low-tech grassroots approach based on the use of pure jatropha oil in converted diesel gensets to produce power for rural electrification. MFC is currently working in eleven villages to set up these systems. Garalo Bagani Yelen was the pilot project in which the organisational model was developed. This model has been expanded into the so 10-villages project called "Bagani Courant 10". The key to the approach is that in typical rural diesel electrification projects, 50-75% of operating costs are for fuel. This cash leaves the village and leaves the country to pay for diesel imports. In MFC's work the fuel costs are re-injected into the local community to pay for jatropha oil and jatropha seed and thus the electrification increases people's revenues. Combined with the support for new income generating activities it becomes an engine to kick-start local economic development.

An interesting approach for future projects is carbon financing as it could potentially help to reduce costs on such projects and make them more financially viable. However, there are currently still difficulties in certifying small projects. Joint and bundled applications of several small-scale initiatives may be an opportunity to solve the difficulties.

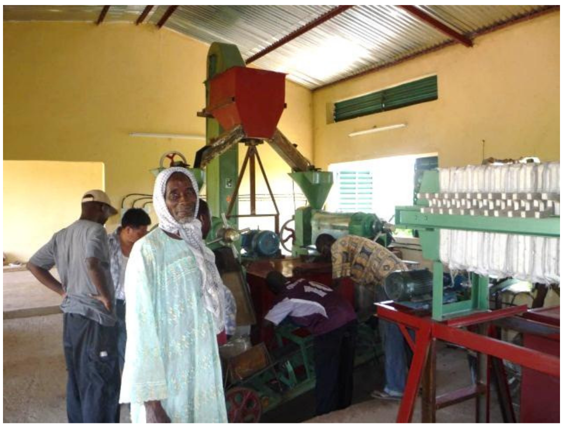

Figure 11: Jatropha pressing hardware installed in Garalo by MFC Nyetaa. The picture shows the village leader Mr Mamadou Kane, the initiator for the electrification of his village [D]

3.6 Case Study: Sugarcane in Costa Rica

National level

The smallest country of the Global-Bio-Pact Case Studies, Costa Rica has a long standing tradition of sugarcane production and ethanol production which started in 1918. The activity covers 9.3% of agricultural employment and 1.3% of total employment. Since 2004, Costa Rica dehydrates Brazilian ethanol to be further exported to the United States.

Nowadays, the sugarcane area is 53,000 hectares, producing 400,000 tons. From these volumes ethanol production is still very limited, given favourable conditions for sugar supply and the lack of incentives to invest securely in ethanol facilities.

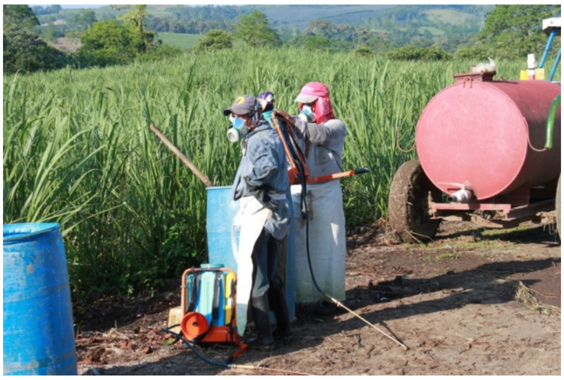

Figure 12: Employees spraying pesticide in sugarcane fields (Costa Rica) [A]

Local level

The local Case Study in Costa Rica is CATSA in Guanacaste representing a large modern plant in a flat area which is suitable for sugarcane monocultures. The plant produces ethanol for exportation (including to Germany) and has just passed successfully the auditing procedure of the International Sustainability & Carbon Certification (ISCC) Standard. In the 2008/09 harvesting season 13% of the national ethanol production (195,901 tons) was produced by CATSA. 800 farmers supply the plant with sugarcane (27% of cane ground in the mill).

Figure 13: Ethanol distillery of CATSA (Costa Rica) [E]

3.7 Case Study: Sugarcane in Brazil

National level

Brazil is worldwide the largest sugarcane producer and the second largest ethanol producer (the largest producer from sugarcane).

The sector represents 2% of the Brazilian GDP, generating U$ 28.15 billion in 2008, with 426 mills in 2009. The sector has over 1,280,000 direct employees and over 3.85 million indirect and induced jobs [6].

The most traditional area of sugarcane production in Brazil is in the Northeast, which currently contributes less than 10% of the total output. The Brazilian Northeast is one of the poorest areas in the country and has the worst socio-economic indicators (e.g. health, education, income, wealth distribution). On the other hand, the state of São Paulo is the richest region in Brazil, and concentrates a large amount of the sugarcane production.

Figure 14: Sugar cane (Brazil) [A]

Figure 15: Sugarcane bioethanol plant (Brazil) [A]

Regional level

The two regional Case Studies in Brazil are the states of Alagoas and São Paulo. São Paulo is the largest producer in Brazil with around 40% of all sugarcane employments of the country, and 60% of sugarcane production, representing one of the most important sugarcane production regions in the world.

Evaluating the socio-economic indicators, HDI, schooling, poverty, life expectancy, income and household infrastructure, and comparing the areas with considerable sugarcane production, one can see that the municipalities with sugarcane and ethanol production are better off than the ones without, in the several years studied by Oliveira (2011) [7].

In São Paulo, the sugarcane sectors indicators of income and schooling are higher than the Brazilian average for the sector, as reported in the 2006 National Survey by Household Sampling (PNAD) [8]. These averages are also among the highest averages in the agricultural sector, behind only two traditional crops (soy and citrus). In the near future, the labour requirements will decrease due to higher mechanization levels, and the schooling requirements will increase, since trucks and harvest machines require higher educational levels than sugarcane cutting [9].

Alagoas is a traditional sugarcane producer with 54% of Northeast's total sugarcane production, with most of it turned to sugar production (68%). In Alagoas, the analysis of the socio economic indicators showed that the state itself has worse conditions than other sugarcane producing states. But, inside Alagoas, the municipalities with sugarcane and ethanol are still better off than the municipalities without sugarcane and ethanol production, even if in smaller proportions. The study by Oliveira [7] also shows that there are no traces that the presence of sugarcane in an area interferes negatively.

Although the state represents only 5% of all national sugarcane production, it has 14% of all employments in the sector.

Local level

The two local Case Studies were selected because of their uniqueness. The São Francisco mill, situated north of São Paulo state is the largest organic sugarcane producer in the world, and the Pindorama mill is a cooperative in the Alagoas state. Social and technical issues of these two production systems differ from usual plants.

The São Francisco mill harvests 1,400,000 tons of sugarcane per harvest season, and employs over 400 people in the field. Because organic sugar is mainly exported, it demands a wide variety of certifications granting trustfulness to an organic product. The São Francisco mill was the first in Brazil to receive international certification in 1997 as an organic sugar producer. Today it is certified with eight seals that guarantee their organic origin as well as environmental and social standards. The seals are recognized in Europe, USA and Japan.

One of the certification systems is the eco-social seal of the IBD (Biodynamic Institute), a Brazilian certification institute that develops inspection and certification activities including the certification of organic and fair trade products. It establishes minimum social and environmental criteria and improvement programs to be completely accomplished and implemented.

The Pindorama mill is a small mill that harvested 610 thousand tonnes of sugarcane, and produced 35 million litre of ethanol in 2009/2010. Being a cooperative, it has better economic returns for small associated producers. However, in comparison with other mills in the region, it cannot be said that the benefits are transmitted to workers. The comparison done with two other mills in Alagoas, showed that Pindorama did not present any better or improved social economic, or environmental, indicator. On the other hand, there are several social projects done by Pindorama, including technical teaching such as reading and computer classes and new professions (like welders).

3.8 Case study: woody biomass in Canada

National level

Canada has the largest forest estates in the world with 397.3 million hectares of forest and is one of the leading exporters of forest products globally. In rural areas the forestry sector is dominant with entire towns depending on it. Biomass is currently not utilized in large quantities for energy production. With large parts of the country not suitable for agriculture, liquid biofuels will have to be produced from wood products. The Case Study in Canada focuses on British Columbia situated on the western coast of Canada bordering the United States. British Columbia is the most important forestry province in Canada in terms of resource base and forestry industry. The Global-Bio-Pact Case Study includes one study on a lignocellulosic ethanol refinery and one on a pyrolysis refinery.

Lignocellulosic ethanol refinery

Lignol is a company based in Vancouver, British Columbia, Canada. The company is currently developing a pilot plant with a daily dry biomass input of 200 tonnes. The plant is based on the Accell technology. The technology combines pre-treatment and lignin/ hemicellulose removal in one process and has lignin and ethanol as main products. Extraction of other products is currently under research.

Feedstock used for lignocellulosic biofuel production may come from different sources and have usually been co-products from various wood processing activities, like mill residues and logging residues. Lignol's pilot plant in Burnaby has been using pulping chips – with a moisture content of 50% - obtained from debarked whole log chippings and chips from lumber mill residues such as slabs and trim ends of logs. The costs of the chips range between 50 and 70 dollars per tonne. Generally, chips from sawmills tend to be lowest cost while chips from logs harvested from hillsides invariably tend to have the highest costs. A hypothetical commercial plant located in British Columbia would most likely have its own cutting rights or source feedstock from contractors on Crown lands provided under provincial cutting rights. Native Indian bands might provide cutting rights on their territory or supply the chips directly to the company.

The investment cost of the plant is unknown yet, but for the business case to be valid the lignin utilization is essential. The employment generation of the plant can be compared to a normal paper mill. The installation can employ around 45 workers in total. On management level 3 direct jobs are created and for every shift (4 shifts a day) 5 people can be employed. The remaining jobs are created in the harvesting and supply sector.

Pyrolysis refinery

The Global-Bio-Pact Case Study for pyrolysis in Canada is fictitious and based on the long experience BTG Biomass Technology Group in developing the flash pyrolysis technology. In BTG's pyrolysis process woody biomass is transformed by a rotating cone reactor to pyrolysis oil, coal and gas. Pyrolysis oil – which has a larger energy density than raw biomass – can, for example, be used in a boiler, furnace, gas turbine or diesel engine (under development) to replace domestic fuel oil. Current research focuses on the extraction/fractionation of chemicals and the use as automotive fuel. The plant is assumed to have an input of 120 tonnes of dry biomass a day.

The investment cost – including biomass pre-treatment, biomass & pyrolysis oil storage and utilization of the heat – lies between 10 and 15 million Euro. In Canada there are a lot of abandoned pulp and paper mills, which are perfect locations for a pyrolysis plant. Such pyrolysis plants can give a boost to the local and regional economy. Instead of exporting raw biomass, high-end biofuels are produced which have a higher added value for the region. The plant will also create around 45 jobs of which 17 jobs are direct. The other jobs are created in wood harvesting, transportation of pyrolysis oil and plant maintenance.

9 CONCLUSION

The present paper gave an overview about on-going assessments on different socio-economic impacts of biofuel and bioproduct value chains in the framework of the Global-Bio-Pact project. A core focus was thereby on the presentation of the Global-Bio-Pact Case Studies.

A large advantage of the Global-Bio-Pact Case Studies is the direct involvement of the local partners and stakeholders in the project. The involvement of local stakeholders ensures a solid and strong base for the inclusion of certain criteria in biofuel and bioproduct certification initiatives. This provides the opportunity for the European Union to develop their current and future policies on biofuels (e.g. RED [1]) and bioproducts with input from non EU countries.

It can be concluded that biofuel and bioproduct value chains are associated with both positive and negative impacts. Due to the limitation of fossil resources, there is no other option than to use biomass based products and fuels as substitute of fossil counterparts in the long term. In addition, also other innovations and solutions have to be found to fill the gap of decreasing fossil fuels. Thus the question is not *if* biofuels and bioproducts shall be used in the future, but rather *how* the negative impacts can be minimised and the positive impacts increased [2].

In order to ensure sustainable production of biofuels and bioproducts several tools exist. The most important measure would be to enforce national and international legislation, not only on biomass use, but also on associated laws (environment, energy, agriculture, labour, working conditions, safety measures, etc.). However, since this enforcement is not fulfilled in several countries, another tool would be certification of biofuels and bioproducts as initiated by several initiatives. Thereby the consideration of social criteria in comparison to environmental criteria is more difficult and challenging.

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PICTURES

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