GLOBAL SOCIO-ECONOMIC IMPACT ASSESSMENT OF BIOFUEL AND BIOPRODUCT CHAINS

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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. Biomass raw materials and biofuels offer the opportunity to replace petrochemical resources for a large variety of bioproducts (chemicals, bioplastics, etc.) and fossil fuels. 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 a detailed assessment of the socio-economic impacts of raw material production and a variety of biomass conversion chains. This paper presents an overview of the Global-Bio-Pact project as well as an introduction to socio-economic sustainability issues of biofuels and bioproducts worldwide.
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 desire 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.

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)). Several initiatives are currently working on this topic, including:

- Renewable Energy Directive (RED) of the European Union
- Cramer Report from the Netherlands
- Renewable Transport Fuel Obligation (RTFO) of the United Kingdom
- German Biomass Sustainability Regulation (Biokraft-NachV)
- Brazilian National Institute of Metrology (INMETRO)
- “Green Fuel” certification system of the State of São Paulo, Brazil, related to the regulation to avoid the burning of sugar cane during the harvest season
- Low Carbon Fuel Standard (LCFS) in California
- Biofuels certification working group United Nations

Environment Programme (UNEP)
- Global Bioenergy Energy Partnership (GBEP)
- Roundtable on Sustainable Biofuels (RSB)
- Roundtable for Sustainable Palm Oil (RSPO)
- Round Table on Responsible Soy (RTRS)

One of the most important governmental initiatives was the introduction of the "Directive on the promotion of the use of energy from renewable sources" (Renewable Energy Directive - RED) of the European Union [1], which also includes sustainability aspects of biofuel production.

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. Based on the results of these Commission 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.

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 OVERVIEW ON SOCIO-ECONOMIC IMPACTS

Generally, socio-economic issues are covered by many local, national, and international legislation and agreements.

On international level, the most important declarations include the Declaration of Human Rights adopted by the General Assembly of the United Nations in 1948 and the United Nations Millennium Development Goals adopted in 2000. Furthermore, also the international labour standards of the International Labour Organisation (ILO) are an important agreement focussing on worker rights. These agreements include various aspects which are also relevant to the value chain of bioproducts and biofuels, especially if they are internationally traded.

Since Global-Bio-Pact has just recently started, the following chapters shall provide an introduction on several socio-economic impacts of biofuel and bioproduct value chains.

3.1 Gender aspects

Gender aspects in the bioenergy field in developed countries are important, but usually more related to the general gender situation in a country and not specifically related to bioenergy.

In developing and emerging countries the general situation of women in rural areas are often weak. For instance, in many developing countries, most of the land is owned by men and not by women, and health conditions are also disadvantageous for women. The general situation depends upon the cultural framework, social status, and the rights of women in a specific country. In the bioenergy/bioproducts field, gender issues are much more important for developing and emerging countries than for developed countries due to several reasons which are explained below.

Traditional use of bioenergy (firewood) is still one of

the most important energy sources for households in developing countries. Women are primarily responsible for activities such as preparing food, gathering firewood, collecting water, and growing crops. The use of firewood for cooking is harmful to the women's health due to in-house air pollution.

Modern bioenergy may create several advantages for women and improve the overall situation of women in developing countries. Thus, on the one hand, the substitution of traditional fuel, such as firewood by modern bioenergy carriers (e.g. ethanol) reduces in-house respiratory intoxication, avoids the destruction of valuable trees and shrubs, and decreases the time spent for collecting firewood. On the other hand, the initial investment and operation costs for modern bioenergy stoves may be higher.

However, there is also the risk of harming women, especially if bioenergy/bioproducts are not produced for local use, but on industrial scale for external markets. This is especially relevant if bioenergy production competes, either directly or indirectly, with water and firewood supplies. The establishment of energy crop plantations on "marginal" lands might negatively affect women's ability to meet household obligations, including traditional food provision and food security. The establishment of such plantations might also lead to a loss of wild edible plant species, which women are usually responsible for collecting and preparing and which play a key role in the food security of rural households. At the same time, biofuels production might also affect men's contribution to household food security, due to its potential negative impact on ruminant production (cattle, sheep and goats), which men are often responsible for. The combination of these processes would have a negative impact on the food security of rural households [2].

Women, in particular, tend to have specialized knowledge about the patterns and uses of local agro-biodiversity [2]. The potential depletion of natural resources may place an additional burden on rural farmers' work and health, in particular on female farmers.

Women working on plantations for industrial bioenergy/bioproducts generally tend to be disadvantaged, compared to men, also in terms of employment benefits and exposure to occupational safety and health risks. A significant (and growing) number of agricultural workers in developing countries are employed on a seasonal and often on a casual or temporary basis with limited, if any, social security, including medical assistance. An increasing share of these workers is women [2]. Reliable data on the share of women waged agricultural workers are difficult to obtain, given the prevalence of informal labor arrangements. There is evidence, however, that this share has been rising worldwide and women now account for 20-30% of total waged agricultural workers [2].

There is evidence that women tend to receive on average less training and instruction than men, they often do repetitive work that can result in health problems, and face reproductive hazards as a result of exposure to agrochemicals. In Malaysia, for instance, women, who represent about half the workforce on plantations, are often recruited as sprayers of chemical pesticides and herbicides, without proper training and safety equipment. This may have serious implications for the long-term health of these women workers [2].

3.2 Employment opportunities and risks

The growing global demand for bioenergy and bioproducts is regarded as a way to create new employment opportunities in rural areas, thus leading to increased income generation and rural development. Employment increase is generally related to all steps of the value chain, from agricultural feedstock production, to the conversion process, and to the end use. For instance, in comparison to fossil fuels, the employment rate of biofuel production is much higher.

However, the positive or negative impacts on employment largely depend on the scale of the production systems. With the increasing mechanization of agricultural production in many countries, and the substitution of traditional agricultural systems, the number of agricultural jobs associated with the production of liquid biofuels is likely to decrease over time.

3.3 Working conditions

Generally, working conditions are regulated by national and international legislation (e.g. ILO). However, it is argued that in some cases, legislation is not enforced. A large share of the agricultural jobs in the biofuel industry would be of poor quality and targeted mainly to low-skilled seasonal agricultural workers (often migrants), who tend to be particularly vulnerable. Nevertheless, this is not a problem specifically addressed to the production of bioenergy/bioproducts but rather to the general legislative enforcement in a country. Thus, working conditions shall be ensured, independently if in the fields of bioenergy, bioproducts, other agricultural commodities, or even in the crude oil sector. In any case, specific studies and data on the working conditions on dedicated energy crop plantations are still scarce and have to be investigated in more depth.

3.4 Food security

Currently, the world food production is large enough to produce food to feed all people worldwide. Generally, the reasons for *food insecurity* are of national/local nature and manifold. The principal problem is that many people in the world do not have sufficient income to purchase enough food. Poverty is the principal cause of hunger. Furthermore, availability of suitable land to grow food at dedicated sites, instable economic systems, conflicts, agricultural commodity speculation and climate change are principle causes of food insecurity.

Bioenergy and bioproducts are currently not contributing to global *food scarcity*. However, this may change in the long-term as fossil resources become scarcer and land competition increases among the different sectors. Furthermore, several studies have shown that bioenergy and bioproducts are currently contributing only marginally to the increase of food prices and thus to reduced availability for the poor.

Increasing *food prices* may have large impacts on poor people in developing countries who spend a high portion of their income on food. On the other hand, increased commodity prices could contribute to rural development and poverty reduction since small-scale farmers gain more money from their products.

A number of developing countries that produce, or have the potential to produce, biofuels (or simply biofuel feedstock) are also food insecure. For this reason, it is important to assess the potential impacts of biofuels production on the food security of people living in these

countries. The establishment of energy crop plantations and the impacts of the increasing demand for liquid biofuels on food prices might affect at least two key dimensions of food security – availability and access [2].

A strategic objective would be to develop integrated agricultural systems for the simultaneous sustainable production of food, fuel and bioproducts.

3.5 Land use change

One of the most controversial subjects in developing countries is the issue of land occupation. Especially in Africa, land ownership systems are associated with uncertainties, since land property is often not officially secured, and cadastral registries are often non-existent. Land is often leased from the state or held communally and is not based on private property. Therefore, land rights are often in dispute. This uncertainty is crucial, since it does not allow for a calculation of how much land is actually available, how it is distributed across the country and how it is prevalently used. Against this background, potential development of the bioenergy sector could lead to increased demand for land and competition among actors, thus possibly exacerbating the aforementioned problems. This applies to both first- and second-generation bioenergy production from dedicated energy crops.

Previous to any land use change activity for bioenergy and bioproducts, it is important to investigate whether there is enough arable land available for food and feedstock production at the dedicated site. Furthermore, it needs to be investigated if land cultivation is possible in terms of soil conservation and efficient water use. Expansion of current bioenergy/bioproduct production is criticized especially in countries where food security is precarious since it is believed that bioenergy production aggravates competition about limited land resources [3].

In some areas (e.g. in Argentina, Brazil) the livestock sector may be affected by the production of liquid biofuels. This is due to the conversion of grazing lands to energy crop plantations, and to increased livestock feed prices caused by the growing demand for agricultural commodities for the production of biofuels. This rising demand might also give rise to a potential competition for land between food and feedstock production [2].

Due to economies of scale, generally the production of energy crops is more cost efficient on large scale. This may lead to an agricultural transition from small to large-scale agriculture with extensive monocultures. Insight is needed on the effects of this transition, especially on social impacts [4].

Large-scale production of current generation feedstock is often criticized for depriving small farmers of their properties. Unclear land rights and poorly regulated land acquisition – conditions which often prevail in developing countries – lead to displacement of local farmers to non-arable regions or urban centers. These concerns are basically the same if dedicated energy crops are grown for first or second-generation bioenergy production [3].

According to [5], the early adapters in the biofuel market will be the larger farmers in areas with well-functioning markets. These farmers can afford the start-up costs of converting land to another crop, expanding land under production, or changing the technological or labour inputs.

Large-scale plantations for the production of liquid biofuels require intensive use of resources and inputs to which smallholder farmers (particularly female farmers) traditionally have limited access. These resources include land, water and especially modern agricultural inputs (fertilizer, pesticide, seeds) [2]. If smallholders use these inputs, they may become highly dependent and risk severe problems due to potential market shocks such as rapid increases in the prices of agricultural inputs [2].

Furthermore, the early adapters are likely to do very well in the market. Later adapters, most likely the small farmers who take a longer period to e.g. accumulate start up costs, will enter a more crowded field of producers, leading to lower profits (or even losses). The expansion of production of biofuel feedstock will accelerate the transformation of the rural economic landscape through favouring large scale producers.

With careful planning, this displacement of small producers might be avoided through mandates or encouragement of arrangements that integrate small farmers with processing plants [5].

3.6 Change in traditional use and knowledge

The resilience of rural livelihoods might be reduced by the decline of traditional local knowledge linked to the loss of agro-biodiversity. The replacement of local crops with energy crop plantations would threaten especially the extensive knowledge and the traditional set of skills of smallholder farmers in the management of local crops. It would also threaten the knowledge related to the selection and storage of seeds and crops, all activities traditionally performed mainly by women [2].

The potential reduction in the number and the variety of animals (particularly ruminants) raised by smallholder farmers, due to biofuels production, would contribute to the decline of traditional local knowledge. This process would threaten, in particular, the knowledge related to the use of different animals and animal-derived products [2].

4 Global-Bio-Pact CASE STUDIES

In order to generate data on the ground, five 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 and Costa Rica
- Jatropha oil and biodiesel in Tanzania and Mali
- 2nd generation biofuels and products from lignocellulosic material in Europe and North-America

In order to work towards sustainable biomass production, concrete on-site examples showing main areas of concern are good measures 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- and macro-level are currently assessed for all Global-Bio-Pact Case Studies.

The Case Studies 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, oil refinery, 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.

4.1 Case Study 1: Soy in Argentina

The first Global-Bio-Pact case study is on biodiesel from soy and its related co-products.

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. According to the Argentine Biofuels Chamber, Argentina produced in 2009 about 10% of world biodiesel and still has a very large market growth. Currently, biofuel production in Argentina is mainly based on soy as feedstock and most biodiesel is exported.

In Argentina and other countries (e.g. Paraguay, Brazil), the main land use changes include deforestation, conversion of grasslands and pasture to crop fields and generally intensification of the agriculture. Its socio-economic impacts on local people as well as the damage to the human health of local and indigenous communities have been a constant paradigm of the soy expansion.

Figure 2: Biodiesel plant (Argentina) [A]

The traditional soybean production areas are located in Las Pampas containing parts of Buenos Aires, Cordoba, Santa Fe and Entre Ríos. In recent years, however, agriculture (primarily soybean production) has extended to less fertile and more remote areas in the northeast and west of Argentina [6]. The recent land use changes in La Pampa province (Argentina) are mainly caused by economic incentives for the farmer, receiving high prices for annual crops, and the possibility to extend the production of profitable crops to other areas within the region. Livestock production is traditionally characterized by low productivity, income and profit. The need for large areas and the low profit per area makes livestock production only viable in areas where land prices are low. Thus, when infrastructure improves and more intensive land types such as soybean production starts to predominate, cattle production will be displaced, intensified or decreased [7].

The extension of new agricultural land for soy cultivation has often led to conflicts with local people or indigenous communities [8]. Tenants and communities have often problems to enforce their rights when large land owners or speculators claim land for soy cultivation.

Another controversial topic in relation to soy production in Argentina is the use of genetically modified (GMO) soy mainly for feed, but also for biofuels. GMO soy currently accounts for 99% of the soy production in Argentina. The social, economic and environmental impacts of GMO crops still need further analysis [4]. When genetically modified herbicide-tolerant soy was introduced in Argentina in 1998, it was rapidly adopted by Argentine farmers. The resistance of GMO soy to the herbicide glyphosate facilitated weed control and no-till farming.

The widespread and often indiscriminate use of glyphosate has caused dozens of cases of intoxication. Weeds that have developed glyphosate resistance require cocktails of highly toxic herbicides such as atrazine to control. Intoxication of rural workers and neighbouring communities has been reported throughout the soy producing provinces [9]. The study from [10] mentions that the intensification of soy monoculture at a large scale, along with transgenic technology and the lack of rotation cycles generates an ecosystem that does not permit co-existence with other crops and farmers. It also results to indiscriminate crop spraying and dependency on input products [10].

The required labour input for large-scale and mechanized agricultural soybean production in Argentina, generates around one labour place for every 200 hectares [11]. In comparison, small traditional farms practicing rotation with two crops generate around one labour place for every eight hectares. The low labour input for intensive soybean production generates a process of rural out-migration compared to more traditional production systems, destabilization of livelihoods and scarcity of jobs in the agricultural sector.

Figure 3: Soy bean (Argentina) [A]

Due to high inflation rates, food prices in Argentina have increased in the last few years although the government announces yearly a maximum price to avoid strong increases for the principal food products. The price of products falling in the category ‘‘oils and fats’’ increased strongly between 2002 and 2007 due to a strong international demand and insufficient production. As the price increased by 218% in the period 2002–2006, the government agreed to provide a subsidy to keep local price increases within a bandwidth. This agreement was ratified in June 2007. Related to this development, there was a shortage of vegetable oils (especially sunflower oil followed by other oil types), caused by limited production capacity and increasing (international)

demand. This example shows that the dynamics of food and feed prices over time is influenced by a wide range of factors (demand for land, development of international markets, growth of economies, labour costs, etc.). [12]

Land prices increased strongly in the last few years in Argentina. Average increases of 10% in agricultural land rents in 2006/2007 compared to the previous year are mentioned and similar increases (10–15%) are mentioned for 2007/2008. This is caused by various factors [12]. Land rents are pushed by high outputs and price levels for annual crops as soybean or maize. This creates good income perspectives for farmers, especially with the expectation of further increasing yields. Consequently, there is a high demand for renting suitable land for annual crop production and a supply that does not catch up. Also, the agricultural sector is seen as a secure financial investment. The increase in land rents as well as other costs and investment costs forces producers to select a crop with sufficient income [12].

Land use rights are officially laid down and described in Argentina. Land property is largely regulated through private ownership or tenure of land. In case the land is rented there are basically two forms of contracts. The first form is a contract in which the owner charges a fixed amount per year or per harvest. The second form is that the owner receives a certain percentage of the production obtained by the tenant [12].

The working conditions for employees in the soy value chain in Argentina are influenced by the Tripartite Declaration of Principles. The Argentinean government itself has subscribed the OECD guidelines for multinational enterprises. The Ministry of Labour has established the ‘‘Network for Corporate Social Responsibility and Decent Work’’ to promote Corporate Social Responsibility. This network of companies signed a Commitment to Corporate Social Responsibility and Decent Work in 2007 [12].

Rural work conditions in Argentina are regulated by specific resolutions. The ‘Rural Worker License law’ aims at regulating different aspects of the hiring process of permanent, temporary and harvest workers in the agricultural sector. The National Record Office of Rural Employers and Workers is established in 2001 to combat informal employment and to increase protection of workers. Literature sources show variable estimations about the amount of informal workers (with no to limited access to insurance) and formal workers in agriculture in Argentina. Accurate statistical data are difficult to obtain. Unofficial estimations range from 17.5% to 50% of the workers in the agricultural sector engaged in formal employment [12].

Violations against human rights related to the working conditions of employees and child labour are not mentioned as an issue in Argentina [12].

4.2 Case Study 2: Oil palm 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 [13].

As palm oil is one of the major natural resources for bioproduct 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: Oil palm fruits [B]

Although palm oil generates a considerable amount of foreign currency for Indonesia, its production may have significant negative environmental (e.g. deforestation) 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.

According to [13], 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 neighboring plantation companies for inputs (e.g. seeds, fertilizer) and marketing [13]. 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.

4.3 Case Study 3: Jatropha in Tanzania/Mali

Mali and Tanzania are among the key countries in Jatropha research, development and promotion and the expansion of Jatropha cultivation is currently discussed at several levels.

Two-thirds of the population in the developing world,

where poverty is at its peak, derive their incomes from agriculture. Thus, the cultivation of Jatropha as feedstock for biofuels and bioproducts is considered as large opportunity to improve their economic situation. Traditionally, farmers cultivate the *Jatropha curcas* scrub to produce oil for lighting lamps and manufacturing medicinal soaps. Furthermore, Jatropha serves as insecticide, for medicinal applications, and as firewood.

Jatropha is also increasingly cultivated for biofuel production. At the community level farmers who produce dedicated energy crops can increase their incomes and grow their own supply of affordable and reliable energy for their internal needs. At the national level, cultivating biofuel crops may generate new industries, technologies, jobs and new markets. At the same time, producing more biofuels will reduce energy expenditures and allow developing countries to put more of their resources into health, education and other services for their neediest citizens.

Figure 5: Jatropha (Tanzania) [A]

On the other hand, the cultivation of large Jatropha monocultures for industrial use is envisaged by international large scale companies and investors. This may cause negative socio-economic impacts, especially on land tenure issues and national revenues. Many large-scale economic models discourage pro-development practices. In order to prevent negative social, economic, and environmental impacts, a sustainability scheme is needed.

Jatropha production has been seen as a tool for local empowerment and poverty alleviation. The benefits of a centralized model for communities are guaranteed markets for seeds and crop management support, which is expected to enhance rural development through job creation, income generation and capability support. However, in comparison a decentralized model is expected to increase the local availability of biodiesel and by-products [14].

Marginal lands are regarded as a potential production area for bioenergy production. Marginal lands are considered to provide little economic or ecological benefits although these lands represent an integral part of the livelihood of the rural poor, to which they supply essential commodities as food, fuel or fodder [2]. Marginal lands are particularly important for women. On marginal lands, women have traditionally grown crops for household consumption, medical uses, etc. The conversion of these lands to plantations might therefore cause the partial or total displacement of women's agricultural activities [9]. Though it is possible for Jatropha to grow on low-productivity land, larger yields on high-productivity lands may cause converting land currently under food production to Jatropha production fields [14].

The low level of agronomic information currently available for Jatropha means that it is difficult to gauge whether a plantation will be high yielding. Failure of a plantation to live up to expected yields may have a significant effect, as local communities may have been promised improved living conditions or farmers may have invested their livelihoods [14].

Because of the variable timing of the ripening, Jatropha seeds are currently harvested by hand. This translates into high labour costs and substantial job creation [14]. However, first attempts to mechanically harvest Jatropha are underway.

Land conflicts are common phenomena in Africa, especially when a large parcel of land is being earmarked for large scale commercial projects such as commercial plantations of Jatropha. This is because boundaries of many properties are not clearly demarcated and land title ownership is generally not well documented. It often only exists as common historical knowledge among elders of the community. It is therefore likely that one of the key constraints that large scale commercial plantations may face is land ownership conflicts [14].

Figure 6: Pressing of Jatropha (Tanzania) [A]

4.4 Case Study 4: Sugarcane in Costa Rica/Brazil

Due to the importance of ethanol production from sugarcane in Latin America and the large associated positive and negative socio-economic impacts, Brazil and Costa Rica were selected as Global-Bio-Pact Case Study.

Brazil is the world's second largest producer of ethanol and the world's largest exporter. Also Costa Rica has a considerable ethanol industry producing ethanol from sugarcane. Currently, ethanol is mainly used for biofuel production, but also increasingly for chemical applications such as for ethane/polyethylene production.

The agricultures of Brazil and Costa Rica are characteristically dynamic. Land and production resources have a skewed ownership distribution, and agricultural production is essential for smallholders of rural poor regions. Due to increasing demand of ethanol worldwide, Brazil is expected to expand its sugarcane based ethanol production.

Socio-economic impacts of sugarcane based ethanol production in Brazil and Costa Rica are mainly related to income distribution and land tenure, working conditions, worker rights, and child labour.

Figure 7: Sugar cane (Brazil) [A]

Considering increasing large-scale production, impacts on net employment effects may be very significant. For instance, mechanised sugarcane harvesting may have severe impacts on overall employment, but is currently being introduced in the State of São Paulo in order to erase manual cutting of sugarcane which is hard and harmful to health and pollutes the environment. It is estimated that by 2020 the manual cutting of sugar cane in São Paulo will be practically non-existent. It is also anticipated that between 2006 and 2020, the number of employees in the sugar cane industry in that state will be reduced from 260 thousand to 146 thousand workers, even with an increase of 20 thousand employees in manufacturing [15]. Furthermore, the seasonality of jobs in the sector has been decreasing as a consequence of extending harvests and higher levels of mechanization.

With the evolution of the technologies employed, less growth can be observed in labour demand, along with higher required qualifications and an increase in quality of the work performed [15]. Current trends towards increased efficiency and the replacement of laborers suggest that the employment benefits of sugarcane production for landless rural workers will disappear [5]. A sugar cane harvester (a machine), for instance, can replace up to eighty cutters (people).

Another example and area of concern is the income concentration of large scale sugarcane production. Sugarcane and bioethanol production shows significant economies of scale. Thus, there is a gradual transition towards larger capacity units. This trend is aggravated by the low attractiveness of a large number of farming activities and the economic deprivations of some regions where sugarcane production becomes one of the more viable alternatives, compared with traditional crops. In order to preserve small-scale agriculture and its agricultural production model, it has been suggested that biofuel production shall be stimulated in a decentralized manner which allows the market entry of small-scale farmers as biofuel producers [15].

The increasing demand for ethanol production is encouraging the sugar/alcohol industry to expand to other regions. Part of the land use competition is compensated by the intensification of cattle breeding which requires generally less land. However, an effect of the increase on land use competition is price increases.

Figure 8: Sugarcane bioethanol plant (Brazil) [A]

4.5 Case Study 5: Lignocellulosic biomass in Europe and North-America

Lignocellulose is a feedstock which can be used for various processes, including different biofuels and bioproducts. However, the current use of lignocellulose is still limited since the conversion processes requires large financial and technical efforts and improvements. Due to the large advantages of lignocellulosic feedstock, namely low prices, availability, and high productivity, its use for 2nd generation conversion chains of biofuels and bioproducts, is promoted. These conversion chains include Biomass-to-Liquid (BtL) and 2nd generation bioethanol conversion in the biofuel sector as well as the conversion of lignocellulose into bioproducts and bioplastics (biorefinery).

Due to the currently limited use of lignocellulose for the above mentioned technologies, socio-economic and environmental impacts are low at the moment, but are expected to significantly increase in future. Since 2nd generation conversion routes are currently mainly developed in industrialized countries (e.g. USA, Sweden, Germany, Austria), the Global-Bio-Pact Case Study assesses the current and future impacts of lignocellulose for 2nd generation biofuels and biorefineries in Europe and North-America. These impacts include mainly effects on employment and on macro- and microeconomics of agricultural markets.

Figure 9: Eucalyptus (Argentina) [A]

As the timing and scale of market of lignocellulosic conversion routes are difficult to foresee in developed countries, it is still not clear if and when 2nd generation conversion routes will be introduced in developing countries and under which framework conditions. One of the main obstacles will be the high investments for setting up conversion facilities. In addition poor infrastructure, lack of capacity and instable economic conditions present main challenges in developing countries.

Once expanded to developing countries, bioenergy and bio-products from lignocellulosic feedstock may have large impacts especially for local people, economies, and farmers due to competition between 1st and 2nd generation conversion technologies, between large-scale (industrial) and small-scale conversion concepts, as well as between centralised versus decentralised approaches.

An important issue which determines the overall sustainability of lignocellulosic conversion routes is the choice of the feedstock origin. Thus, the impacts will be largely influenced by whether the feedstock is specifically cultivated (e.g. short rotation woody crops) or if it is waste material, such as from forestry or from other conversion processes (e.g. bagasse from sugarcane).

Figure 10: Lignocellulosic bioethanol plant (Spain) [A]

5 CONCLUSION

The present paper gave an introduction to the activities of the Global-Bio-Pact project and provided an overview on different socio-economic impacts of biofuel and bioproduct value chains.

It can be concluded that these 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. 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.

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.

The Global-Bio-Pact project, which has just recently started, will contribute to improve the introduction of social aspects in biofuel and bioproduct certification schemes.

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7 PICTURES

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8 NOTES

(1) Forest Stewardship Council
(2) Crude Palm Oil