GBEP Working Group on Capacity Building for Sustainable Bioenergy

ACTIVITY GROUP 2

"Raising awareness and sharing of data and experiences from the implementation of the GBEP indicators"

<u>Compilation of GBEP Indicator Experiences</u>

OVERVIEW

- <u>Country</u>: Colombia.
- <u>Scale at which the GBEP indicators were measured</u>: National.
- <u>Year(s) during which the GBEP indicators were measured</u>: 2011-2014.
- <u>Organization(s) commissioning/overseeing the measurement of the GBEP indicators</u>: The project was implemented by the Food and Agriculture Organization of the UN (FAO). The Colombian Government charged the Ministry of Agriculture and Rural Development with the lead responsibility for the project.
- <u>Organization(s) carrying out the measurement of the GBEP indicators</u>: The measurement of the indicators was entrusted to a team of researchers from the *Universidad Nacional de Colombia, sede Manizales*, supported by researchers from the International Center for Tropical Agriculture (CIAT) based in Cali.
- <u>Source(s) of funding</u>: International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety.
- <u>Funding size</u>: ☐ < 500k USD; ☑ 500k - 1,000k USD; ☐ > 1,000k USD
- <u>Existing bioenergy pathways (e.g. feedstocks, processing technologies, fuels and end-uses) in the country</u>: Sugarcane-based ethanol; palm oil-based biodiesel; bagasse-based cogeneration; traditional biomass; and manure biogas
- <u>Bioenergy feedstocks considered</u>: Sugarcane (including molasses and bagasse) and palm oil were the main bioenergy feedstocks considered.
- <u>Liquid, solid and gaseous fuels considered and respective end-uses (e.g. heating and cooking, power generation and transport) and end-use sectors (e.g. residential, commercial, industry)</u>: The main fuels, end-use and end-sectors considered were: Sugarcane-based ethanol (mainly from molasses) and palm oil-based biodiesel, both for transport; and bagasse-based heat and electricity generation, either for own consumption (in mills) or supplied to the grid.
- <u>GBEP indicators measured (disaggregated by bioenergy feedstock, fuel, end-use and end-use sector considered, as necessary)</u>: A few indicators were not deemed relevant, namely indicator 3 (Harvest levels of wood resources), 13 (Change in unpaid time spent by women and children collecting biomass), 14 (Bioenergy used to expand access to modern energy services) and 15 (Change in mortality and burden of disease attributable to indoor smoke), due to the focus of the assessment on liquid biofuels for transport. Each of the other 21 indicators was measured, at least partly.
- <u>Approach/methodology used for attribution of impacts to bioenergy</u>: mass balance; for selected economic indicators economic value allocation was chosen.

- Year when the next measurement of the GBEP indicators is planned: unknown

KEY RESULTS[1]

- Overview:

Production of sugarcane-based ethanol and especially of palm oil-based biodiesel has increased significantly in recent years in Colombia, following the introduction of biofuel blending mandates and of related support policies. Regarding heating and cooking and off-grid electricity generation, as of 2014 there was no significant use of modern bioenergy in Colombia. On the other hand, bioenergy produced from cogeneration in sugar mills (from bagasse) represented a noteworthy share of total primary energy supply in the country.

The increase in the demand for ethanol and biodiesel in Colombia has triggered different responses in the sugarcane and oil palm sectors, giving rise to different environmental, social and economic sustainability issues and trade-offs.

Most of the ethanol produced in Colombia is obtained from sugarcane molasses, even though ethanol plants have the flexibility to use different types of sugarcane-based products, e.g. different types of molasses or sugar juice directly, depending on market conditions. The increase in the production of ethanol from 2005 onwards was accompanied by a decrease in sugar exports, while the domestic supply of sugar for food remained substantially stable. The expansion in the harvested area of sugarcane was relatively minor and yields, which were already among the highest in the world, remained relatively unchanged. Therefore so far ethanol has had a minimal impact on employment, since the agricultural phase, which accounts for the vast majority of jobs in the ethanol supply chain, did not see much expansion in production and therefore workforce, while only a few dozen jobs were created in ethanol plants. Furthermore, in the recent dedicated sugarcane-based ethanol investments in Colombia (e.g. Bioenergy in the *Meta* Department), feedstock production is mechanized, creating eight times less jobs than manual sugarcane production and harvesting. On the other hand, mechanization can have positive environmental and health effects, by avoiding pre-harvest cane burning, which causes GHG emissions and has detrimental effects on air quality and on the health of local communities.

The oil palm sector, on the other hand, responded very differently to the increase in the demand for biodiesel. While exports of palm oil decreased and the domestic supply of it for food remained substantially stable as in the case of sugar, the planted area of oil palm expanded significantly in recent years in Colombia, partly in response to the growing demand for CPO for biodiesel production. Data on the land-use change associated with oil palm expansion is sparse. With regard to the Northern, Central and Eastern zones, a few studies reported that the majority of land converted to oil palm was previously occupied by pastures and crops (e.g. rice) and only a negligible share by forest. On the other hand, in the grey literature there is a great deal of reference to oil palm expansion in the Western zone (*Nariño* department and *Tumaco* municipality in particular) being a cause of deforestation.

A better understanding of the land-use change associated with oil palm expansion is essential, as this has important implications for a range of environmental, social and economic sustainability issues. If oil palm displaces extensive livestock grazing, it can increase carbon sequestration (both above- and below-ground), enhancing the GHG emission mitigation potential of palm oil-based biodiesel, and lead to net job creation. On the other hand, if crops are displaced, the domestic supply and price of these crops may be affected and indirect land-use change may be triggered. Finally, if oil palm expansion contributes to the conversion of

[1] The results summarized in this section and the related recommendations should be treated as preliminary and indicative, as during the testing of the GBEP indicators in Colombia only partial analyses could be conducted due to the limited data available.

natural ecosystems and lands with high carbon stocks, it may lead to the release of significant amounts of GHG emissions and to a loss of biodiversity.
Therefore, in order to properly monitor the GBEP indicators and conduct a meaningful assessment of the sustainability of bioenergy production in Colombia, it is crucial to conduct further research on the land-use changes associated with the expansion of bioenergy feedstocks and in particular oil palm, especially in the areas where this expansion has been more significant, e.g. the Western zone. Remote sensing, field visits and stakeholder consultation are complementary tools that should be used in order to study and analyze the land-use changes associated with this expansion.

- Environmental pillar:

In addition to the above, on the environmental side, along the sugarcane-based ethanol supply chain, pre-harvest cane burning was found to be an importance source of both GHG and non-GHG emissions. This procedure could be avoided by mechanization of the harvesting process, which in turn is understood to necessitate a (feasible) change in sugarcane varieties. Such a change could result in significant GHG emission mitigation as well as improvement in local air quality, but would be accompanied by increased energy (diesel) consumption in the machinery used to harvest the cane. Another, more significant, trade-off would be with the reduction in employment opportunities for manual labourers. A means to finance the creation of substitute job opportunities would be required for this shift towards a cleaner practice to be undertaken. Fertilizer and pesticide applications were identified as key sources of GHG emissions and water pollution along both the sugarcane-based ethanol and palm oil-based biodiesel supply chains. Few data could be found on this, due to the limited extent of ongoing monitoring and analysis of water quality in Colombia. Therefore, despite the limited interest in this issue expressed by Colombian stakeholders during the testing of the GBEP indicators, further data collection and analysis would be needed on the impacts of bioenergy feedstock production and processing on water quality. In parallel, good practices that reduce fertiliser and pesticide application while improving efficiency and profitability, such as Integrated Plant Nutrient Management and Integrated Pest Management, should be promoted. Wastewater is another source of GHG emissions and water pollution along the sugarcane-based ethanol and palm oil-based biodiesel supply chains. In this case, methane capture and use should be promoted, including through carbon offset programmes, as is already being done in the palm oil industry in Colombia. In addition to water quality, issues related to water availability and use in bioenergy feedstock production were identified. In particular, water withdrawals for sugarcane production (including for ethanol) in the *Cauca* watershed might trigger medium-high water stress in dry years. Therefore, irrigation efficiency should be closely monitored and improved technologies and management practices promoted. Finally, with regard to soil quality, both the *Valle del Cauca* (the main sugarcane production area of Colombia) and the Northern region of the *Caribe*, where oil palm is cultivated, show high susceptibility to salinization.

- Social pillar:

On the social side, in addition to the aspects already discussed above, other issues were explored, for instance with regard to the quality of the jobs associated with biofuel feedstock production and processing. Overall, compared to the average agricultural worker, sugarcane and oil palm workers seem to benefit from a higher level of formalization of employment, better wages and benefits and better protection against occupational risks. Another interesting aspect relates to the business models and the level of smallholder inclusion along the biofuel supply chain. During the last decade, there was an important transformation in the palm oil supply chain in Colombia, with the emergence of the so-called *Alianzas Productivas Estratégicas*. The *Alianzas* are strategic business partnerships formed by small-scale producers, which organize themselves in order to improve their access to credit, strengthen their bargaining power with the mills, and ensure a secure market for their produce thanks to contracts with the latter. As of 2010, around 16 percent of the planted area of oil palm was under an *Alianza*, up from less than 1 percent in 1999. In addition to having contributed to the growth of the palm oil sector, these strategic business partnerships have been quite effective in strengthening the inclusion of smallholders in the palm oil supply chain and in increasing their profitability. The *Alianzas* should be further researched and analyzed and the potential for their future expansion in the palm oil supply chain and eventually in the sugarcane supply chain should be explored.

- Economic pillar:

With regard to the economic aspects, the Colombian biofuel sector can count on a high level of productivity in feedstock production, especially with regard to sugarcane, with an average annual yield among the highest in the world (i.e. 120 t/ha). From an energy balance perspective, Colombian sugarcane-based ethanol and palm oil-based biodiesel supply chains are rather efficient compared to the production of other first generation liquid biofuels. This is true especially for sugarcane-based ethanol systems, which use the energy content of the biomass rather efficiently, through co-generation of electricity and steam from bagasse, in addition to the sugar and ethanol output. While the gross value added generated by the biofuel industry in Colombia is relatively small compared to the GDP (e.g. 0.031 percent in the case of ethanol in 2010), the demand for goods and services associated with this industry was found to trigger multiple indirect and induced effects on the economy, including in terms of employment.

Furthermore, even though in 2009 ethanol and biodiesel accounted for only 1.05 percent and 0.7 percent respectively of the total primary energy supply (TPES) in Colombia, these biofuels substituted fossil fuels worth 103 million USD (ethanol) and 215 million USD (biodiesel) in 2012. However, the contribution of these biofuels to energy security was limited by their lack of diversity in terms of feedstock and geographic location, exposing their production to risks related to pest outbreaks and adverse weather conditions, especially in the case of sugarcane-based ethanol.

Bagasse, which is a co-product of sugarcane processing used for cogeneration, contributed 3.49 percent to TPES in 2009. On other hand, in Colombia, where woodfuel was still accounting for 8.7 percent of TPES in 2009, modern bioenergy technologies have not played a significant role yet in displacing traditional uses of biomass and in providing access to modern energy services.

KEY LESSONS LEARNT AND RECOMMENDATIONS ON THE RELEVANCE, PRACTICALITY AND SCIENTIFIC BASIS OF THE INDICATORS

- Overview / cross-cutting:

Overall, the testing confirmed the usefulness of the GBEP indicators as a tool to inform policymakers about the environmental, social and economic sustainability aspects of the bioenergy sector in their country. Periodic monitoring of the GBEP indicators would certainly enhance the knowledge and understanding of this sector among Colombian policymakers and stakeholders more in general. Furthermore, the GBEP indicators address all the main risks and opportunities associated with biofuel development identified in the main document setting out the Colombian biofuel policy, i.e. CONPES 3510.

With regard to the practicality, as confirmed by the testing in Colombia, the GBEP indicators are rather data and skills intensive. For the testing, it was not possible to get hold of a number of data related to various indicators, especially within the Social basket. Part of this data was not available (an issue that might be in common with other developing countries as well) while in other cases it was not possible to get access to them due to a number of reasons, including the commercial sensitiveness of some of the information. This shows the importance of involving all relevant stakeholders in the process, ranging from relevant government departments/ministries (e.g. those dealing with agriculture, energy, environment, rural development, food security, infrastructure, etc.) to producer associations, universities and NGOs. Stakeholder engagement and ownership of the process is key in order to get access to the necessary data and information, receive inputs and feedback, discuss and interpret the results, and ultimately inform policy discussions and decisions.

In the planning phase of the testing in Colombia, the engagement of national consultants, ministries and other stakeholders was considered fundamental to obtaining a national perspective on the practicality of the GBEP indicators, to assessing the national capacity to measure the indicators in real-life conditions and to making use of the project to strengthen and diversify national discussions on the sustainability of their country's bioenergy sector. For this reason, FAO established an effective institutional coordination mechanism, involving all relevant stakeholders under the lead responsibility of the Ministry of Agriculture and Rural Development. As shown by this project, a proactive engagement of all relevant stakeholders including government agencies, private sector organizations and civil society organizations is key to the effective measurement of the indicators and to a proper interpretation and use of the results. A network of focal points within each relevant organization could be considered in the future as a means to strengthen institutional coordination and stakeholder engagement.

As mentioned above, the GBEP indicators cover a broad range of complex environmental, social and economic issues and some of the indicator methodologies are rather sophisticated. A multidisciplinary team of experts with an in-depth knowledge of the national context and of the domestic bioenergy sector is needed in order to measure these indicators. In Colombia, this task was entrusted to a team of researchers from the *Universidad Nacional de Colombia, sede Manizales*, supported by researchers from the International Center for Tropical Agriculture (CIAT) based in *Cali*, which are two centres of excellence in the country on issues related to agriculture and bioenergy. The quality of the work delivered by the experts from these institutes confirms that Colombia is well equipped to measure the GBEP indicators in the future and possesses the necessary skills and competences. However, in some cases and for some indicators, it might still be useful to integrate the local expertise with international expertise, as was done during the testing.

As realized during the testing in Colombia, in order to enhance the practicality of the GBEP indicators, more clarity and guidance would be needed regarding both methodological and practical issues related to the implementation of certain indicator methodologies. An implementation guide would be needed in order to complement the GBEP report on the sustainability indicators.

Further guidance would be necessary, in particular, on the complex and crucial issue of the attribution of impacts to bioenergy production and use. For instance, if data is available on the impacts on a certain environmental, social and economic variable for the production of a crop part of which is used for bioenergy, should the attribution of the impacts to the latter be done on the basis of the mass balance, of the energy content or of the economic value? Depending on the indicator considered and on the concerns and priorities of the user(s), the answer to this question might change. Therefore, for each indicator a range of suitable approaches for attribution could be identified and illustrated in detail providing specific examples, and the pros and cons of using one approach versus another should be discussed.

Furthermore, in order to significantly reduce the time, skills and cost required to measure the GBEP indicators, an Excel and/or web-based application should be developed. This would allow users to easily enter all data required for the 24 indicators into one single data entry sheet and to get a set of results for each indicator based on the related methodologies. In addition to the aforementioned benefits, this process would also simplify considerably the data collection process, and it would allow to easily save and share the results and to re-run the tool over time with up-to-date information.

Last, but not least, given the global nature of the GBEP indicators, the report containing the methodology sheets should be translated into other official languages of the UN beside

English, e.g. French and Spanish. This would greatly facilitate the dissemination and implementation of the indicators in developing countries around the world.