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"

Template for the Compilation of GBEP Indicators Experiences

OVERVIEW

- Country: Argentina
- Scale at which the GBEP indicators were measured: National
- Year(s) during which the GBEP indicators were measured: The implementation of the project was from 2013-2015
- Organization(s) commissioning/overseeing the measurement of the GBEP indicators: The project was executed by the Directorate of Bioenergy of the Ministry of Agriculture, Livestock and Fisheries (currently Ministry of Agroindustry).
- Organization(s) carrying out the measurement of the GBEP indicators: The measurement of the indicators was entrusted to Centro IDeAS of Universidad Nacional de San Martín (National University of San Martin) and a team of experts retained by IDeAS for the project.
- Source(s) of funding: The project was financed by the Inter American Development Bank (IADB) and received administrative support from the Rural Change Unit (UCAR) of the Ministry of Agriculture, Livestock and Fisheries.
- Funding size: < 500k USD
- Existing bioenergy pathways (e.g. feedstocks, processing technologies, fuels and end-uses) in the country: Today, biomass represents 5% of domestic primary energy supply, involving wood (0,75%), bagasse (1%), oil (2,7%) and other primary sources - sunflower and rice husks, black liquor, maize cobs, and livestock waste - (0,9%). Main fuels and end-uses are: Soybean oil based-biodiesel, corn based-ethanol & sugarcane-based ethanol for transport fuel; bagasse and forest-industry based thermal energy and cogeneration of heat and electricity. Feedstocks are principally from the forestry-based industry sector, followed by sugarcane industry waste, and to a lesser extent poultry waste, and grains. There are a limited number of cases of generation of biogas from manure and slaughterhouse waste. Generation of electricity from biomass, mainly consisting of self-generation from operations' own residues and waste (black liquor, bagasse, peanut husk, etc.), represents 8.3% of the 1.3% of final demand of the Wholesale Electricity Market sourced by non-conventional renewable energy (2013).
- Bioenergy feedstocks assessed through the GBEP indicators: Sugarcane (including molasses and bagasse) and soybeans.
- Liquid, solid and gaseous fuels assessed through the GBEP indicators and respective end-uses (e.g. heating and cooking, power generation and transport) and end-use sectors (e.g. residential, commercial, industry): Sugarcane-based ethanol used for local transport fuel and soybean oil-based biodiesel for local transport fuel and export. These biofuels are used to very limited extent for power generation.

- GBEP indicators measured (disaggregated by bioenergy feedstock, fuel, end-use and end-use sector considered, as necessary): Indicator 1, GHG Emissions (for soybean based biodiesel only), 17 Productivity (both for soybean based biodiesel and cane-sugar based bioethanol), 18 Net Energy Balance (for soybean based biodiesel only), 19 Value Added (both biofuels), 20 Change in Fossil Fuel consumption (both), 22 Energy Supply Diversity (for soybean based biodiesel only). Indicators measured partially or qualitatively were: 1 GHG Emissions (cane-sugar based bioethanol), 2 Soil Quality (for soybean based biodiesel), 4 Non-GHG Air Emissions, 6 Water Quality, 7 Biodiversity (both), 8 Direct Land Use Change (both), 9 Land Allocation and Tenure (both), 10 Effects on Food Availability and Price (both), 11 Income (for soybean based biodiesel), Employment (for soybean based biodiesel), 18 Net Energy Balance (for sugar-cane based bioethanol), and 22 Energy Supply Diversity (for sugar-cane based bioethanol). The remaining indicators where not measured due to lack of data or deemed not relevant.

- Approach/methodology used for attribution of impacts to bioenergy: GBEP methodologies and recommendations were prioritized. Attribution to bioenergy was done where sector specific data (that is, on soybean or cane-sugar based biofuels) were available. Otherwise, partial or qualitative evaluations were made where possible, and if this was not possible, the indicator was considered un-measurable.

- Year when the next measurement of the GBEP indicators is planned: 2017

KEY RESULTS

- Overview (max. 1 page):

Argentina's participation in the GBEP and in the working group that established the 24 indicators and the methodologies for their measurement resulted in the country's interest in measuring the indicators locally in order to evaluate the effectiveness of the policies put into place to promote the production and sustainable use of bioenergy. Thus, the current project "Sustainability Indicators in the production and use of bioenergy" was carried out by Bioenergy Sector of the Ministry of Agriculture, Livestock and Fisheries, with financing from the IADB and the administrative support of the UCAR. Argentina has recognized that growing demand for agro-products results from efforts to diversify energy supply sources and the country has attempted to take advantage of this opportunity. Currently, biomass represents approximately 5% of primary internal supply of energy, but this does not reflect the great potential for bioenergy supply and large availability of biomass as an energy source. With the objective of diversifying the energy matrix and taking advantage of the opportunity to export biofuels, add value to agricultural activities, promote local development and resolve environmental issues related to conventional energy sources, as well as make a contribution to the mitigation of climate change, Argentina has taken steps to promote bioenergy, and biofuels in particular.

Starting in 2000, after some previous trials, Argentina has begun seriously exploring the option of promoting alternative energy sources for vehicles. Laws 26.093 (2006) and 26.334 (2007) establish the production regime and the sustainable use of biofuels. Since then, Argentina has substantially incremented its production of liquid biofuels, in particular soybean based biodiesel and, to a lesser extent, ethanol from sugarcane.

The biodiesel sector was the first to take-off and has been one of the better performing areas of the economy in recent years. Besides the regulatory framework, other factors contributed to its dynamism, including important investments from local and foreign sources, growing

international demand driven by foreign policies requiring a fuel mix, and tax benefits favouring this new component of the value chain of the soybean industrial complex. The expansion of the productive capacity of the oil industry, mainly tailored for export, during the 1990s and 2000s was an important prerequisite for this.

In the case of bioethanol, its production in Argentina is based on molasses, a sub product of sugar production, sugarcane juices and corn. Corn was introduced after sugarcane as a substrate. Today there are 14 plants, 9 of which produce bioethanol from sugarcane, and the rest from corn. The incorporation of two new corn ethanol plants in 2014 resulted in 60% of ethanol production being corn based since then. It must be noted that, stimulated by Laws 26.093 and 26.334, productive capacity in Argentina was expanded and modernized. One of the main challenges of bioethanol production relate to the high costs of investments needed in order to expand capacity and specially to treat effluents like vinasse, resulting from cane ethanol production. In 2016, the fuel mix for gas was raised from 10% to 12% blend with bioethanol. The official blend of biodiesel in diesel fuel is 10%.

An important sized scale of production capacity for biofuels resulted from the above-mentioned factors and policies. It has focused in the local market, as well as export markets in the case of biodiesel, but based on recent investments it can be foreseen that bioethanol will also eventually flow to international markets. The creation of a new productive sector is seen as a very positive example of the possibilities for taking advantage of the country's natural resources. Biofuels have contributed to increasing value added, and employment opportunities, diversification of production, export potential and energy security.

The application of the GBEP indicators to the Argentine case has helped highlight several issues, some involving the agricultural sector beyond the specifics of the biofuels value chain. It has helped identify positive impacts on sustainability, as well neutral impacts, and detect those indicators that may not be pertinent to the Argentine case or where measurement was not possible due to lack of data or bench-line and where further efforts need to be made to improve data availability.

- Environmental pillar (max. 1 page):

In the case of the Environmental Pillar, the only indicator that it was possible to measure following GPEB methodologies was GHG emissions from biodiesel. Partial or qualitative approaches were used in the cases of the indicators GHG emissions from bioethanol, soil quality (biodiesel), land use change, and biodiversity. It was not possible to measure soil quality (bioethanol), non-GHG air emissions (bioethanol) and water use and efficiency, due to lack of data. Wood resource use was not found to be relevant to the case of Argentina. Non-GHG air emissions from biodiesel and water quality were found to be highly relevant and related issues were identified.

We list the results of the indicators analysed:

1. GHG emissions: The results show a positive contribution to the reduction of emissions in the cases of both biofuels.
2. Soil quality: The reviewed data on organic matter did not show the evolution of soil quality in the time period considered, covering the period since the introduction of biofuel production. However, taking into account information relative to the widespread use of no-till agriculture it may be indirectly deduced that there is a general tendency to the improvement in physical and chemical soil fertility.
3. Wood resource use: This indicator was not evaluated, nor is it its periodic monitoring

recommended given its limited relevance to the Argentine case.

4. Air emissions (non GHG): Due to limited information, it was only possible to evaluate this indicator qualitatively, and in doing so, only partially: in the consumption phase of biodiesel, in the case of bioethanol, based on the emissions from primary agricultural production. In the case of biodiesel, measurements reported show variability in results, which depend on the technology and the fuel used. In 5 to 10% blends, biodiesel has contributed to reducing total particulate emissions, sulphur dioxide emissions and total hydrocarbon emissions, even if local data does not allow for a quantification of the reduction. Emissions of oxides of nitrogen are thought by experts to have increased. Information obtained in the case of sugarcane production suggests that the main emissions are related to the burning of residues after harvest. Progress is being made through increasing controls and enforcement of laws banning this practice, although it cannot be said that the problem is yet under control.
5. Water use and efficiency: It has only been possible to obtain preliminary values on water use in the industrial phase of biodiesel and ethanol production. Water consumption for industrial biodiesel production was estimated to be between 1,028 and1,800 m^3/ton. In the case of ethanol, the minimum estimate is de 17.5 m^3 per ton of ethanol, but this can increase considerably if cooling-water recycling technology is not used. According to experts, there is great variability in water use depending on the location, the productive process and technology used. In primary production, both soybeans and sugarcane production is mostly rain fed.
6. Water quality: Available information highlights two main problems associated with water pollution that pose risks to human populations and water bodies: runoff of glyphosate in the case of soybean production and vinasse effluents in the case of alcohol from sugarcane. Unfortunately there is no data to quantify the scale of these problems. It must be noted that the problems associated with glyphosate are not directly related to the production of the biofuels, but to raw material production, no matter what its end use is. In the case of vinasse the problem is related to industrial transformation phase and results from the production of ethanol.
7. Biodiversity: It has not been possible to calculate this indicator directly, but qualitative information has been obtained. Argentina is subject to an important rate of deforestation (310.000 hectares/year in the period 2006-2014, although there are indications that it has been recently reduced to 94.000 Ha/yr.) associated with the expansion of the agricultural frontier. Several regulatory measures have been put into place in the last decade to help solve this problem. As in the previous case, it is not possible to directly link deforestation to a specific product or sector, such as biofuel production from soybeans or cane-sugar.
8. Land use change (direct): In the period analysed, production of soybeans for biodiesel and sugarcane for ethanol represented 1,83% and 0,01% of the total surface area of the country respectively, and 12.95% and 0.08% of the total agricultural area. Increases in agricultural productivity in sugarcane production made possible the reduction of pressure on natural areas. To the contrary, soybean productivity decreased 11% between 2007 and 2011. The rate of land use conversion estimated for this study indicates that the larger part of land use change for soybean cultivation happened on lands already under production (78%), in particular pasturelands (38%) and extensive types of cultivation (37%), yet 22% of the expansion in soybean production occurred on natural lands, in particular Chaco Woodlands (Bosque Chaqueño). In general, it is considered that soybean production expanded by: replacing pastures and other crops, replacing natural forests and woodlands, particularly in the northwest of the country, and displacing cattle rearing to new areas not traditionally used for this purpose.

Social pillar (max. 1 page):

It was not possible to measure the social indicators by the strict use of GBEP methodology, but some were measured partially or qualitatively: land allocation-tenure, effect on food availability and price, income (biodiesel) and employment (biodiesel). Further, it was not possible to evaluate the following indicators due to lack of data: occupational health, income (bioethanol) and employment (bioethanol). The following indicators were deemed not relevant to the case of Argentina: change in time used for biomass collection, bioenergy to expand access to modern energy services, change in illness due to indoor pollution. The main reasons were considered not relevant because traditional use of biomass is limited in Argentina, access to electricity is widespread and biofuels are essentially used to replace transport fuels, and to a much lesser extent for power generation. A summary of results by indicator follows:

9. Land allocation/tenure: There is not sufficient information available to evaluate cultivated area with or without proper ownership titles. In addition, as in the case of other indicators, both soybeans and sugarcane are cultivated for multiple uses, so it is not possible to link primary production directly with biofuels (attribution issue).
10. Effects on food availability and price: No change of this nature was observed in the study nor detected in the literature review. The changes observed seem to be associated with agricultural change processes that occurred in longer terms than the introduction of biofuel production or their crop inputs. Biofuels contributed to the diversification of the production mix and to added value, but do not seem to be a significant factor in agricultural expansion.
11. Changes in income: The addition of biofuels has not had a significant impact on income/wages. Similar relatively higher salaries are found in the biofuels sector in comparison with three of the four other reference sectors considered. No information was obtained regarding wages in ethanol plants. It was not possible to estimate the income gap of employees in biodiesel production for self-consumption.
12. Effects on employment: It was only possible to make this evaluation on the basis of the isolated data available. It was impossible to aggregate results, as the information is not comparable. On the qualifications within the biodiesel production chain (excluding transport), information provided by some companies allows for the following estimate: tertiary level 59%, secondary level technicians 21%, un-qualified labour 20%. In the case of bioethanol, according to experts, it is very difficult to separate employment in the production of ethanol from total employment in sugar and alcohol plants.
13. Change in time used for biomass collection: deemed not relevant.
14. Bioenergy to expand access to modern energy services: deemed not relevant.
15. Changes in illness due to indoor pollution: deemed not relevant.
16. Occupational health: It was not possible to estimate these indicators, nor their relevance in the Argentine case, due to lack of health statistics that permit this type of evaluation.

<u>Economic pillar</u> (max. 1 page):

Several of the economic indicators were measured using GBEP methodology: productivity, net energy balance (biodiesel), value added, change in fossil fuel consumption, and energy supply diversity (biodiesel). Net energy balance in the case of bioethanol was measured partially. It was not possible to measure the following indicators due to lack of data: educational effects on workplace, infrastructure and logistics, and capacity and flexibility for bioenergy use. A summary of results by indicator follows:

17. Productivity: Soybean oil productivity for biodiesel is high in such cases where the

coefficient between biodiesel production and oil production stays within the range of 95 to 97%. The low productivity of the main input, soybean oil, in terms of the milling phase (19%) results from the fact that oil is a derivative of the processing of soybeans, being the main by-product of flour and pellets. The productivity of bioethanol grew strongly in recent years, to nearly 80 litres per ton, according to data of the last season coinciding with the time of the study.

18. Net energy balance: Estimates made within the project indicate that the net energy balance of biodiesel from soybeans, in the case of no-till systems for crop production, are within the range of 2.02 to 2.62 units of energy obtained per unit of energy consumed. The available estimates for ethanol from sugarcane are within 3 to 8 units of energy obtained per unit of energy consumed. These latter numbers are the result of specific studies with no continuity in time, and for this reason it is difficult to evaluate them as a function of productive or technological improvements. The indicators obtained require further fieldwork to systematize information, particularly with regard to the regions where the crops are produced. In the industrial stage, data can be standardized more easily, as they depend on technology and supplier information, independently of the region where the plants are located.
19. Value Added: In the case of biodiesel strong volatility in the calculation of value added is observed, varying between 10 to 20%, and 17% on average. This may in part be due to the difficulty in separating the effect derived from the changes in use of installed capacity in the sector year to year. In the case of bioethanol, value added varies between 4% and 7%.
20. Change in Fossil fuel consumption: Continued growth is observed in biofuel sales to the local fossil fuel market. The participation of biodiesel in sales to local diesel oil market in 2014 was 6.2% and contributed to avoiding 25% of diesel oil imports. In the case of bioethanol, its penetration in local markets was 2.6% in 2013 and its contribution to import-substitution reached 49.7% of gasoline imports.
21. Educational effects on the workforce: It was not possible to measure this indicator.
22. Energy supply diversity: The penetration of oil and biofuels in total primary energy supply and total final energy supply has displayed a growing trend, with the exception of a slight decrease in 2012 and 2013. Bioethanol specifically has displayed continued growth since 2010, and reached 0.3% of total final energy supply in 2013.
23. Infrastructure and logistics: It was not possible to measure this indicator.
24. Capacity and flexibility for bioenergy use: It was not possible to measure this indicator. No technical limitations have been identified for achieving the required legal blend of 10%; however, it is not easy to reach it for multiple economic and social coordination reasons.

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

- Overview / cross-cutting, e.g. stakeholder engagement (max. 1 page):

The experience of the study demonstrates that GBEP indicators show great potential usefulness for sustainability assessment, even though their full application to the Argentine case was not possible. Despite the fact that the indicators could be further fine-tuned in order better adapt to diverse realities and to varying information availability, in general, they provide valuable information for evaluating the sustainability of biofuel production in multiple dimensions. In addition, they are a valuable tool for governments in their effort to revise and strengthen planning policies and strategies for the promotion of bioenergy, and avoiding negative impacts.

Difficulties in applying the indicators in the case of Argentina seem to be due to two main factors: firstly, the existence of gaps between what is needed for the measurement of the indicators and what is available and, secondly, difficulties in the application of the indicators to the Argentine case.

Regarding the first factor, Argentina needs to generate regular statistics on the biofuel sector, and separate data on the different phases of the production chain (for example, production of raw materials, oil, flour, alcohol, transport, etc.) in order for all the indicators to be measurable. The country also needs to strengthen local follow-up and specific methodologies. In many cases, it was difficult to carry out a quantitative evaluation because there were not enough data or information available for the estimation, nor were there reference data needed to make comparisons, be it for benchmarking or for follow up/monitoring. This was the case in areas such as water use and efficiency, land use allocation, capacity and flexibility for bioenergy use, occupational health, including some indicators that were found to be highly relevant, like water quality or non-GHG air emissions.

Regarding the second factor, some basic hypotheses underlying the definitions of some of the indicators themselves do not seem to apply to the Argentine case. Significant impacts have not been found in cases across environmental-social-economic dimensions where the expectation underlying the indicators seems to be the opposite. The following are cases where the GBEP methodologies expect a direct and extensive link with biofuel production, and such a relation was not found: food availability and price, productivity, management decisions that impact on soil quality, land use decisions and efficiency in the use of water. A hypothesis underlying several indicators is that biofuel production modifies and promotes the advance in production in bio-energy raw materials. In the Argentine case under consideration (production of soybeans and sugarcane) the effect found is almost imperceptible for the wide spectrum of raw material producers of the country. As a consequence, its technological impact is also relatively moderate, given that agricultural production was expanding and modernizing earlier than the introduction of biofuels as part of a more general and longer-term phenomenon. Similarly, annual fertilization decisions have to do with short term cost variables and not with structural factors or the end products resulting from primary agricultural production.

Also related to the second factor of inapplicability to the Argentine case, it was found that one environmental and three social indicators were not relevant to Argentina. These were wood resource use, change in time used for biomass collection, bioenergy to expand access to modern energy services, and changes in illness due to indoor pollution.

In general, many effects in the case of all three pillars were not found to be directly related to the production of biofuels themselves or raw materials for biofuels specifically, but to the soybean and sugarcane agro-industrial production chains, which in both cases has multiple and interrelated purposes (flour, oil, sugar, alcohol, etc.). In many cases, it is not possible to differentiate the impact on the indicator (for example, water quality) of the production of soybeans/sugarcane *for biofuels specifically*, even though it is evidenced that soybean/sugarcane production has a negative effect on the indicator. Thus, attribution of impacts to biofuels becomes an issue to be resolved in terms of the indicators, and in terms of policy, sustainability policies and decisions in many cases may need to be targeted to the sector (agricultural and agro-industrial production chains of soybeans and sugarcane, or, in some cases, agricultural and agro-industrial production in general), rather than focused on biofuels themselves.

A last point to be noted is that, in some cases, indicator results seem to be highly sensitive to methodologies (e.g. GHG balance) and therefore explicit consideration of this sensitivity needs to be incorporated.

- Environmental pillar (max. 1 page):

Results obtained show a variety of effects (positive, neutral, negative, not-relevant) of biofuel production on the sustainability of the agro-industrial and energy value chain and this manifests itself particularly in the Environmental Pillar: a positive impact was found in the case of reductions in greenhouse gas emissions; a neutral effect on soils quality; wood resource use was found to be not relevant, and negative effects requiring further attention were found in the cases of the conversion of natural systems to agriculture, biodiversity loss, water pollution and inadequate water treatment.
Most of these effects are not directly related to biofuel production but mainly to raw material production for multiple uses (attribution issue mentioned above), except for the case of vinasse effluent and the widespread problem of inadequate treatment in ethanol plants. A key lesson is the need to develop tools for proper attribution and/or consider if, in some cases, the relevant indicator, may not be one encompassing the soybean/sugarcane value chain, or the entire agro-industrial value chain, rather than an indicator for each biofuel specifically. As was noted for the entire study, sector specific data would be necessary to be able to measure biofuel specific indicators where relevant.

- Social pillar (max. 1 page):

The Social Pillar was the dimension of sustainability where more indicators were found not to be relevant to the Argentine case, possibly manifesting the need to consider whether the Social Pillar may be the dimension where more diversity and specificity is found country by county, and where the indicators may need more adjustment or flexibility. Change in the time used for biomass collection, bioenergy to expand access to modern energy services (97% of the population has access to electricity, and biofuels are used to a very limited extent for power generation in Argentina), and changes in illness due to indoor pollution were found to be not relevant.
Absence or inadequacy of data made it impossible to measure effects on occupational health and land allocation and tenure in the case of both biofuels, and effects on income and on employment in the case of bioethanol. As was noted for the Environmental Pillar, a key lesson is the need to develop biofuel-sector specific data, and in other cases consider whether the impact of production for biofuel use can be or should be separated from the global impact of the value chain where production is for multiple and interrelated purposes (attribution issue).

- Economic pillar (max. 1 page):

Within the Economic Pillar there were no indicators found to be not relevant to the Argentine case, which may indicate, if found in other country cases also, that the methodology has achieved a better standardization for global application where economic aspects are concerned. Further evidence of this may be the fact that it was the Pillar where it was possible to measure more indicators using GBEP methodology.
However, the problem of lack of data also manifested itself within this pillar, as it was not possible to measure three indicators for this reason (energy supply diversity, infrastructure and logistics, and capacity and flexibility for biofuel use).
It is worth noting that it is the only pillar where no negative effects were found (though, as was said, it was not possible to measure all indicators).