GBEP SUSTAINABILITY INDICATORS FOR BIOENERGY:
LESSONS LEARNT AND RECOMMENDATIONS EMERGING FROM TESTING/IMPLEMENTATION

CROSS-CUTTING

INTEGRATION OF DEFINITIONS AND METHODOLOGIES

- A **more clear definition and demarcation of traditional versus modern bioenergy** should be developed and illustrated with concrete, detailed examples.

- Further **guidance** would be needed on the complex and crucial issue of the **attribution of impacts to bioenergy production and use**. 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.

- When indicators cannot be measured due to lack of data, skills and/or resources, and when appropriate as a complement to the measurement of the current quantitative indicators, the **implementation of relevant good practices** in bioenergy production and use could be assessed, including regarding their coverage and (if possible) their quality.

ENSURING AN EFFECTIVE IMPLEMENTATION OF THE INDICATORS

- 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 implement the GBEP indicators and analyse the results.

- A proactive **engagement of all relevant stakeholders** including government agencies, private sector organizations and civil society organizations is key to the effective implementation of the indicators and to a proper interpretation and use of the results.

- Where possible, **empirical information** is preferred to model estimates. In any cases, **assumptions** about the data and underlying conditions need to be made clear.

- Because there is much spatial variability in the indicator values, the **spatial extent of the assessment** needs to be carefully defined, and care needs to be taken in extrapolating site-level information to national-level indicators.

ENHANCING THE PRACTICALITY OF THE INDICATORS

- An **implementation guide** would be needed in order to complement the indicator methodology sheets with detailed guidance on both methodological and practical issues related to the measurement of the indicators.

- An **Excel and/or web interface based on a computerized model** could be developed, in order to significantly reduce the time, skills and cost required to measure the GBEP indicators. 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.

- **Mechanisms to facilitate the systematic flow of data and information from the private sector** to the organizations/agencies measuring the GBEP indicators could be identified and exploited.

- Last, but not least, given the global nature of the GBEP indicators, the report containing the methodology sheets could be **translated into other official languages of the UN** beside English (a Spanish translation is currently being prepared as well). This would greatly facilitate the dissemination and implementation of the indicators in developing countries around the world.

ENVIRONMENTAL PILLAR

INDICATOR NAME	1) Which are the major challenges when measuring this indicator?	2) Data availability? Data appropriateness?	3) How relevant is capacity building?	4) Any other fundamental obstacle?	5) Comments.
1. Lifecycle GHG emissions	1. Selection of attributional LCA (ALCA) vs consequential LCA approaches (CLCA) depending on whether direct and indirect land use changes are being accounted for. 2. The Common Methodological Framework does not offer sufficient guidance on the definition of LCA boundaries and the selection of the relevant timeframe and cut-off criteria. 3. The need to define an average national figure for GHG emissions related to the production of bioenergy is another methodological challenge, as site-specific or operator-specific assessments may vary greatly within the same country. The intrinsic diversity and variability of bioenergy production pathways that exist in some countries requires the formulation of assumptions and the production of scenarios in order to come up with nationally representative results.	1. Primary data should be used when available (this is generally the case). It would be important to specify when it is appropriate to use default values. 2. Biograce, GREET, GHGenius and other models are useful tools to be used, because methodologies and background data are already included. 3. Relevant data (GHG as well as other data) are collected or will be collected by countries as part of the UNFCCC inventory process. That UNFCCC process provides an opportunity for coupling with GBEP data collection. Coupling those efforts as much as possible should be explored.	1. Relevant: a. For training on methodology; and b. For generation of country specific data.	1. The issue of imported/exported biomass for energy has to be solved. IPCC GHG accounting good practice guidance could be used. 2. Accounting for potential climate feedbacks. 3. Inclusion of potential soil organic carbon (SOC) storage - is this temporary storage? To what soil depth should SOC storage be evaluated? How does this affect timeframe allocation and future land use?	1. Need to distinguish between the attributional and consequential LCAs. Most indirect land use change effects are really part of consequential LCAs and should not be used in attributional LCAs for individual farms/industrial facilities etc. 2. When this indicator is measured, it is recommended to take into account relevant national policies/programmes/standards and international processes (e.g. UNFCCC) and methodologies (e.g. IPCC).
2. Soil quality	1. More guidance needed on the type of measurement, e.g. soil depth. 2. Data availability might be an issue in some developing	1. In some countries there might be a lack of adequate data. Data on soil organic carbon is particularly limited and primary data campaigns tend to be complex and both time and	1. Relevant, for field assessments and processing of soil samples.	1. Sampling and having the capacity to process samples are the main limiting factors.	1. When this indicator is measured, it is crucial to define reference conditions in order to compare results at different scales (local vs.

countries.	resource intensive. 2. Where data bases exist, data are often under privacy protection. In these cases, confidentiality agreements may be necessary.			national vs. global). 2. The real key is to objectively evaluate soil biological, chemical, and physical properties and processes in a timely and routine manner. Soil quality assessments are not needed every year but only every 5 years or so to measure the direction and magnitude of the trend lines. Is the soil aggrading, degrading, or at least remaining stable? 3. Techniques for measuring soil quality need to be consistent across different systems (including soil type, soil depth and feedstock type). For example, the appropriate depth of measurement for soil indicators depends on depth of soil layers and cultivation practices on a given site and should remain constant over time. Soil organic carbon, pH, electrical conductivity, bulk density, N, P, K, and selected soil enzymes are frequently considered to be important components for a minimum data set. 4. The question of whether the GBEP indicator or its methodological approach might be adapted to take account of the impacts on

					soil quality of the application of vinasse, biocompost and perhaps residues from the bioenergy production process arose in one of the pilot countries. 5. Soil quality could be mapped, in order to identify - and focus on - hot spots. 6. A proxy that could be considered is the level of uptake of nationally/locally defined good soil management practices.
3. Harvest levels of wood resources	1. Data availability might be an issue in some developing countries. 2. In some cases it might be challenging to determine the share of woodfuel coming from forests.	1. Lack of forest inventories. 2. Possible lack of data on net growth or sustained yield. 3. Usually woodfuel is informally harvested and thus official data might not be available. 4. The quality of data on woodfuel consumption could be improved by conducting surveys to determine household and commercial woodfuel consumption and production at district level and transportation of woodfuel outside the district.	1. Relevant.		1. Connecting with REDD reports. 2. The counterfactual reality needs to be considered in analyses that attempt to evaluate forest harvest rates. For example, the alternative of leaving large debris piles in the woods or of burning those piles needs to be considered. 3. Among the natural phenomena affecting forest productivity and causing fluctuations in annual harvest levels, fires should be considered as well in addition to adverse weather and outbreaks of pests. 4. Harvest of wood and its use for bioenergy under programmes aimed at eradicating invasive alien plants (e.g. the 'Working for

					Water' programme in South Africa) should be accounted for separately.
					5. In the lack of information about net growth or sustained yield, a possible alternative would be to undertake surveys (which, however, could be costly) and a literature review regarding the state of a country's managed forests to determine if over-harvesting is considered to have occurred and, if so, where. This information could then be overlaid with the information on sources of wood for modern energy purposes.
					6. In order to understand the way in which woodfuel use affects the sustainability of wood harvesting, it would be useful to gather information on the end use and, in particular, the use efficiency.
					7. The indicator could be improved by developing a methodology to determine the impact of bioenergy production on the traditional uses of biomass.

4. Emissions of non-GHG air pollutants, including air toxics	1. Overall, the measurement of this indicator is quite burdensome. 2. This indicator is very skill intensive and requires the involvement of a team of expert chemists and engineers.	1. Datasets and default values are available, but there is a need to improve data quality. Moreover, emission factors may be missing for some activity levels and practices. 2. With regard to air toxics, there is a lack of data and default values tend to be pretty rough.		1. Distinguishing between particulates derived within a locality vs those that have migrated in from elsewhere.	1. In the methodological approach it is suggested that, where feasible, a full lifecycle analysis should be conducted. This approach might not be ideal, in light of the fact that the impacts of non-GHG air pollutants are mainly local and that large differences exist in terms of emissions and exposure to air toxics throughout bioenergy supply chains. 2. When this indicator is measured, it is recommended to take into account relevant national policies/programmes/standards and international processes (e.g. Gothenburg Protocol) and methodologies (e.g. IPCC).
5. Water use and efficiency	1. Data availability might be an issue in some developing countries.	1. Maps about water availability are there → hot spots detectable → need ground truthing. 2. It is suggested to use watershed level data as opposed to average national-level data and to present results at the same scale/level. 3. Possible lack of data on the share of renewable vs. non-renewable water sources, especially for feedstock production. 4. Watershed boundaries may not coincide with those of the			1. When this indicator is measured, it is crucial to define reference conditions in order to compare results at different scales (local vs. national vs. global). 2. When this indicator is measured, it is crucial to take into account environmental, social and economic parameters that may affect the levels of water use and efficiency. 3. In addition to withdrawals, evapotranspiration could

		administrative units for which data on production of bioenergy feedstocks and products are available, making it difficult to determine the amount of water withdrawn in a specific watershed for bioenergy production.			be considered as well. 4. It would be useful to measure this indicator for both average years and dry years, as the TARWR and thus the share of it used for bioenergy production might change significantly in a watershed. 5. This indicator has already been measured in several countries, however it would be interesting to see the results of the measurement of this indicator in more vulnerable countries from a water use and efficiency point of view.
6. Water quality	1. The indicator requires the measurement of nutrients/pesticides that reach a water body. This measurement may be pretty complicated and burdensome.	1. While data on the application of fertilizers and pesticides in bioenergy feedstock production is generally available, there might be less data about pollution of water bodies. Finally, data on the runoff of chemical inputs to water bodies is very rare. However, hot spots are detectable. 2. There are some models that can be used to trace water pollution back to the land use but they require a lot of entry data that oftentimes is not available. 3. Environmental data is needed to define and simulate reference conditions.			1. When this indicator is measured, it is crucial to define reference conditions in order to compare results at different scales (local vs. national vs. global). 2. When this indicator is measured, it is crucial to take into account relevant environmental, social and economic parameters. 3. Lesson could be learned from areas where within a watershed only one type of crop/feedstock is grown.

7. Biological diversity in the landscape	1. An official definition and map of areas of high biodiversity value or critical ecosystems might not exist in some countries.	1. When the areas concerned are either protected by law or tracked by national programmes, data should be available. 2. The concept of "nationally recognized areas" is not enough. Areas of high biodiversity value or critical ecosystems are not always nationally recognized. This reflects on data appropriateness.	1. Need to strengthen capacity at local level.		1. When this indicator is measured, it is recommended to consider as well the areas of high biodiversity value or critical ecosystems that are not officially recognized and protected in the country. 2. The importance of habitat corridors between areas of high biodiversity value or critical ecosystems should be considered when measuring this indicator. 3. A potential proxy for the impact on biodiversity is the change in the number of endangered and vulnerable species in key bioenergy production areas, especially in the lack of an official definition and map of nationally recognized areas of high biodiversity value or critical ecosystems.
8. Land use and land-use change related to bioenergy feedstock production	1. It may be difficult to measure the conversion between land-use types caused by bioenergy feedstock production. 3) A consistent time frame is important. 4) Consistency in the categorization of land types and management practices is critical.	1. Most land use is now categorized through remote sensing/satellite inventory. This may be complemented with ground truthing, also in order to capture land management practices.	1. Relevant.		1. Mapping technologies may help with this indicator. 2. Data to be used as a 'baseline' would be very useful.

SOCIAL PILLAR

INDICATOR NAME	1) Which are the major challenges when measuring this indicator?	2) Data availability? Data appropriateness?	3) How relevant is capacity building?	4) Any other fundamental obstacle?	5) Comments.
9. Allocation and tenure of land for new bioenergy production	1. Concept of "new" bioenergy production is complex to define because in many cases bioenergy is produced from feedstocks that are not dedicated solely to energy purposes (e.g. sugarcane, oil palm, soybean, etc.). 2. Data availability might be an issue in some developing countries.	1. Lack of data, especially in the case of areas recently converted to the production of bioenergy feedstocks.	1. Relevant, given the complexity of tenure-related issues.		1. If the required data is not available, a pragmatic approach that may be used is to analyse key variables closely related to land allocation and tenure, such as the structure of land ownership, the size and distribution of farms, and the various types of business models found along the bioenergy supply chain.
10. Price and supply of a national food basket	1. For some countries the measurement of this indicator might be quite burdensome and external support might be needed. In particular, the 'Causal descriptive assessment' (i.e. Step 2, tier II) requires the active engagement of a broad range of experts and stakeholders, while the 'Quantitative assessment' (i.e. Step 2, tier III) entails sophisticated modelling and analysis.	1. This indicator is very data intensive. However, in most cases data is available (e.g. from FAOSTAT, National Statistics Office and Ministry of Agriculture).	1. Given the complexity of this indicator and of the issues addressed by it, specific training at both policy and technical level is fundamental, e.g. on the Causal Descriptive Assessment, on the AGLINK COSIMO model, and on the analysis and interpretation of the results of both.		
11. Change in income	1. It may be difficult to attribute changes in income to bioenergy production. 2. Data availability might be an issue in some developing	1. Availability of - and access to - detailed data related to wages and prices might be an issue in a number of countries, due among other things to the commercially sensitive nature of part of this			1. Household income of those employed in the bioenergy industry is a useful indicator of well-being and is measured as

countries.		information. Cooperatives and associations of workers and producers may represent good sources of data. 2. Disaggregated data for bioenergy specifically is often not available. Data on wages, in particular, tend to be available by broader sectors, e.g. agriculture and industry. 3. In some cases, the compensation received by wage workers includes goods (e.g. food, sugar, etc.) and services. The available data might not always properly account for this.			financial compensation received by workers for their labour. As with other indicators, the income should be attributable to biofuels and distinct from other non-bioenergy-related income. 2. When this indicator is measured, inflation-adjusted figures should be used and the effect of feed-in tariffs (if any) should be considered.
12. Jobs in the bioenergy sector	1. It may be difficult to determine the exact number of jobs created and lost/displaced as a result of bioenergy production and use. 2. Data availability might be an issue in some developing countries.	1. Given the relative novelty of the bioenergy sector, data may be scarce. In particular, disaggregated data for bioenergy production specifically is often not available, neither on the feedstock side nor on the processing side. Bioenergy-specific data disaggregated into skilled/unskilled and temporary/indefinite jobs is even more rare.	1. Relevant.	1. Markets are changing dynamically → changes situation of jobs.	1. Further guidance would be useful on the measurement and estimation of jobs lost/displaced as a result of bioenergy production and use (to give net job creation figure).
13. Change in unpaid time spent by women and children collecting biomass	1. This indicator relies heavily on surveys and thus may be resource intensive. 2. Data availability might be an issue in some developing countries.	1. Data was not available in the pilot countries, due mainly to the fact that woodfuel is often collected/traded in the informal market; need for representative surveys (large sample over several months where seasonality exists).			1. In some countries, men (as opposed to women and children) are responsible for collecting biomass. Where this is the case, this should be reflected in the indicator measurement. 2. Apparently UNDP is carrying out surveys in Africa on this matter. It is

					advisable that GBEP liaises with UNDP in order to find out whether the survey could help measuring this indicator.
14. Bioenergy used to expand access to modern energy services	1. Excluding the case of decentralized energy production from biomass sources, in all other cases attributing an increase in access to modern energy services to bioenergy poses challenges both in terms of data requirements and methodology. 2. The issue of a more clear definition and demarcation of traditional vs. modern bioenergy is particularly important in the case of this indicator.		1. Relevant.		1. In the few countries where this indicator has been implemented so far, the focus is on other types of bioenergy technologies. Therefore, additional evidence is needed from other countries on the relevance and practicality of the indicator.
15. Change in mortality and burden of disease attributable to indoor smoke	1. The limited statistics available are the result of the aggregation of DALYs lost due to upper respiratory disease, thus including multiple possible causes such as cigarette smoke, etc. 2. In order to measure a change, reliable statistics based on sound epidemiological studies and covering an adequate period of time are needed.	1. Limited data available.			1. Statistics or surveys that cover a time window sufficient to describe the development of chronic diseases caused by indoor pollution from cooking (thus targeting the family members more exposed) may lead to the identification of the role of traditional bioenergy use.
16. Incidence of occupational injury, illness and fatalities	1. Data owned mainly by the private sector, having no incentive for reporting/sharing such data.	1. Lack of availability of adequate data with the level of disaggregation required in order to conduct a specific analysis for the bioenergy sector. 2. In general, agro-industries have data on occupational injury, illness and fatalities (e.g. in	1. It is fundamental, as in the case of any other indicator on which information is held primarily by the private sector, to partner with relevant organizations and strengthen the capacity to produce relevant statistics in order to monitor this indicator. It is also important to develop the capacity		1. In addition to baseline conditions, if possible conditions under a bioeconomy should be assessed as well.

		Brazil). Insurance companies have these data as well, but only for insured workers, which generally represent a relatively small share of total workers, especially in the agricultural sector of developing countries. The data owned by agro-industries and insurance companies, however, may not be publicly available.	of national policymakers to design policies that discourage informal jobs in bioenergy and require mandatory insurance regimes.		

ECONOMIC PILLAR

INDICATOR NAME	1) Which are the major challenges when measuring this indicator?	2) Data availability? Data appropriateness?	3) How relevant is capacity building?	4) Any other fundamental obstacle?	5) Comments.
17. Productivity	1. In the countries where the GBEP indicators have been implemented so far, the measurement of this indicator has been relatively straightforward. 2. Availability of part of the required data might be an issue in some developing countries.	1. Most of the data required under this indicator is generally available in national statistics. However, getting hold of the information required for indicator component 17.4 might be challenging, in light of the commercially sensitive nature of production cost data.			1. Further guidance on how to account for co-products and by-products under the various components of this indicator would be useful.
18. Net energy balance		1. Limited data available.	1. Relevant.		1. Energy balance should be evaluated on LCA basis, using data similar to those used for indicator 1.
19. Gross value added	1. Data availability might be an issue in some developing countries.	1. The availability of sufficiently detailed and up to date information (e.g. with regard to the value of intermediate inputs) might be an issue in some developing countries.			1. In the lack of information regarding the gross value added generated by the production of a certain biofuel, the estimated gross profit per unit of energy of a representative plant producing such biofuel could be used as a proxy
20. Change in the consumption of fossil fuels and traditional use of biomass	1. Data availability might be an issue in some developing countries.	1. In some countries, most of the required data is likely to come from one-off reports. Data may be particularly scarce with regard to the replacement of traditional biomass use with modern bioenergy.	1. Relevant, in order to support data collection and analysis.		1. The wording of indicator component 20.1b appears to be tailored mainly to oil importing countries. In the case of oil exporting countries, it is more appropriate to assess the increase in oil exports rather than the import

					savings associated with the substitution of fossil fuels with biofuels.
21. Training and re-qualification of the workforce	1. Data availability might be an issue in some developing countries.	1. Data on the skill level of workers (i.e. indicator component 21.1) might be limited in some developing countries, especially with regard to feedstock production, where high rates of informal labour are found.			1. Indicator component 21.2 appears to have a pretty narrow scope, as it seems to be applicable mainly (if not exclusively) to requalification programmes for sugarcane cutters who lost their jobs as a result of a switch to mechanical harvest.
22. Energy diversity					1. No particular issues arose in the implementation of this indicator so far.
23. Infrastructure and logistics for distribution of bioenergy	1. Data availability might be an issue in some developing countries.	1. Sufficiently detailed data for a quantitative assessment of this indicator might not be available in some developing countries.	1. Relevant.		1. Further guidance would be useful on how to measure the actual capacity of critical distribution systems for bioenergy and above all on how to attribute to bioenergy its share and disaggregate the results by commodities transported along the same routes and distributed by the same multi-purposes infrastructures.
24. Capacity and flexibility of use of bioenergy					1. In the example described in the scientific basis section of this indicator in the report, the numerators and denominators for the calculation of the capacity ratios of countries A and B were mistakenly inverted. This might confuse users.