Training on the use of the Global Bioenergy Partnership (GBEP) Sustainability Indicators for Bioenergy: a practical exercise based on the analyses of the wood energy pathway in Ghana.

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## The three pillars of sustainability

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**Strengthening Capacity on Global Bioenergy Partnership (GBEP) Sustainability Indicators for Bioenergy**

11-12 December, Accra (Ghana)
A tool to Measure, Notify and Verify (MNV)
the achievement of:

• Nationally Determined Contributions (NDCs) :
  e.g. to evaluate the effectiveness of adopted P&M and/or the efficient use of funds to achieve reduced GHGs emissions;
• Sustainable Development Goals (SDGs)

Not all countries include actions to reduce emissions from energy in their NDCs.

FAO can support countries to define what energy related emissions can be mitigated or need to be adapted in the agriculture sector.
The implementation of GSIs for Bioenergy

1. Requires:
   - a deep knowledge of the local context and national dynamics (that’s why it is key to engage national experts to carry out the activities!);
   - to be adapted to national context (for each indicator);
   - the definition of a tailor made data collection strategy also with a view to overcome main lack of data;

2. Offers opportunities:
   - for an integrated assessment of the sustainability of each specific bioenergy pathway in a given spatial and time context;
   - to define a baseline that could be used for comparison:
     • among alternatives (at the current time):
       - e.g. modern and traditional bioenergy forms;
       - e.g. bioenergy and conventional (e.g. fossil fuels) energy forms;
     • among different temporal scenarios:
       - e.g. to trace temporal changes and progress.
Use of an integrated approach: Life Cycle Assessment

An integrated approach should be used by taking into account each individual step of the value chain:

• Biomass production
• Biomass harvest
• Biomass Transformation
• Biomass and energy transports
• Bioenergy production
• Bioenergy use
What are the ‘traditional energy’ forms

According to the International Energy Agency (IEA), ‘traditional bioenergy’ forms include the use of fuelwood, charcoal, animal dung and agricultural residues burned for heat and cooking purposes at household level. It is commonly characterized by a very low efficiency (around 10% - 20 %) and an unsustainable provision".

Examples of traditional bioenergy forms:
1. charcoal production in traditional kilns;
2. use of fuelwood and charcoal in open fire;
3. use of fuelwood, charcoal, animal dung and agricultural residues in traditional stoves with a low efficiency.
If we limit our analysis to woody biomass used as feedstock for energy production, modern bioenergy systems include the following options:

- **alternative technologies**, such as industrial combustion, gasification, combined Heat and Power (CHP) plants;
- **improved cooking stoves** characterized by high efficiency and low emissions; and
- **use of improved feedstock**: e.g. chips, pellets, briquettes, charcoal (when efficiently produced);

If we take into account also the **use of alternative feedstocks**, modern bioenergy systems includes also other opportunities, such as:

- **Biogas** including *anaerobic digestion* and *gasification* of agricultural, livestock and agro-industrial residues/waste; and
- **Liquid biofuels** for transport or power production or blended with fossil fuels.
# Moving a first step into WP 2

**Strengthening Capacity on GBEP Sustainability Indicators (GSIs) for Bioenergy in the ECOWAS countries**

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Moving a first step into working package 2

Summary

1. Analysis of the bioenergy value chains currently set up in Ghana to define those that may be considered as the most relevant at the national level ................................................................. 2

2. Analysis of the GBEP Sustainability Indicators for Bioenergy to identify which are the most appropriate to use for monitoring the sustainability of the wood energy sector in Ghana ....................... 3

Specific objectives:

• to analyze the aspects approached by each GBEP Indicator:
  - A short description of each indicator;
  - The main purposes that each indicator aims to achieve.

• to identify which are the most appropriate GSI to assess and monitor the sustainability of the wood energy value chain in Ghana
The questionnaire aims to collect information on the following issues:

1. **Relevance** of each indicator in reference to the specific value chain (i.e. wood energy) and in the specific context (Ghana);

2. **Data sources: availability and accessibility**;

3. Existence at country level of **policies and measures** aiming to improve:
   - **the sustainability of the bioenergy sector** with a focus on the aspect addressed by each indicator;
   - **the availability and accessibility of data** in order to facilitate the monitoring of each indicator, also in the long term.
...for each of the GBEP indicator

### 1- INDICATOR RELEVANCE

Please give us your opinion on the relevance of this indicator in reference to the wood energy sector in Ghana

- [ ] the indicator has a role of primary importance
- [ ] very relevant
- [ ] relevant
- [ ] little relevance
- [ ] not at all relevant
2. DATA AVAILABILITY AND ACCESSIBILITY

Do you know some of the data sources already available for measuring this indicator?

☐ Yes  
☐ No

If your answer is affirmative, please give us the following information:

1. Name of the source (e.g. bibliography):

   _________________________________
   _________________________________
   _________________________________
   _________________________________

2. Name of the institution/ministry that produced the source:

   _________________________________
   _________________________________
   _________________________________
   _________________________________

3. Where it is possible to consult the source (e.g. online link, website name, articles, etc.):

   _________________________________
   _________________________________
   _________________________________
   _________________________________

Would you be available to be contacted by FAO in the future to give us additional information to analyze the indicator in question?

☐ Yes  ☐ No
3- POLICIES AND MEASURES already formulated or put in place at the national level:

Concerning only the wood energy sector in Ghana and the indicator analyzed:

Do you know of any existing policies and/or legislation at the national level to create/improve/promote the following:

- Data availability:
  - Yes
  - No

- The sustainability of the sector which concerns the aspect addressed by this indicator:
  - Yes
  - No
The questionnaire
Indicator 1 : Lifecycle GHG Emissions

**Description:** Lifecycle greenhouse gas emissions (GHGs) – from raw material production to bioenergy use), as per the methodology chosen nationally or at community level, and reported using the GBEP Common Methodological Framework for GHG Lifecycle Analysis of Bioenergy 'Version One‘.

**Measurement unit(s):** Grams of CO\textsubscript{2} equivalent per megajoule of bioenergy produced (gCO\textsubscript{2}eq/MJ).

**Objectives and expected outcomes:**
1. pinpoint what are the most **critical steps** of the value chain, the ones primarily responsible of GHG emissions. Identify which are the component/variables of the process and/or that need to be monitored/improved, to enhance the sustainability of the value chain in the future;
2. identify the main **data lack** which concern sensitive data and promote measures that entails regular monitoring systems of them; and
3. **compare GHG emissions from different energy sources at the national level** (e. g. traditional energy sources, fossil fuels) ;
Environmental pillar

Indicator 2 : Soil quality

**Description:** Percentage of land for which soil quality, in particular in terms of soil organic carbon (SOC), is maintained or improved out of total land on which bioenergy feedstock is cultivated or harvested.

**Measurement unit(s):** percentage

**Objectives and expected outcomes:**

1. **Assess the impacts of bioenergy production and use on soil quality**, in the long term period, by considering all the steps of the value chain and, overall, the biomass production (use of fertilizer, amendment, crop and soil tillage management practices) and the management of waste and residues;

2. Compare the uses of **various raw materials for bioenergy production** to guide towards the choice of sustainable species: highly productive and with a limited impact on soil ecosystem;

3. Pinpoint **the most critical aspects of the value chain** which could affect soil quality and that need to be carefully monitored in the future. Provide recommendation of PEMs to protect /improve soil quality concerning the bioenergy sector.
Indicator 3 : Harvest levels of wood resources

**Description:** Annual harvest of wood resources by volume and as a percentage of net growth or sustained yield, and the percentage of the annual harvest used for bioenergy.

**Measurement unit(s):** m³/ha/y, m³/y ou tons/y; percentage.

**Objectives and expected outcomes:**
1. Establish what is the total harvest of woody biomass at national level (timberwood + woodfuel), including forest residues and in particular for the production of bioenergy;
2. Describe the wood value chain at national level: e.g. inventory of forest resources and types of species; forest management practices; established forest plantations; (pre)processing technologies and related efficiency; use of by-products;
3. Define a balance of wood resources: demand and sustainable offer.
Indicator 4: Emissions of non-GHG air pollutants, including air toxics

Description:
Emissions of non-GHG air pollutants, including air toxics (e.g. PM$_{2.5}$, PM$_{10}$, NO$_x$, SO$_2$) and other air pollutants from:
(4.1) bioenergy feedstock production,
(4.2) processing,
(4.3) transport of feedstocks, intermediate products and end products, and
(4.4) use;
and in comparison with other energy sources.

Objectives and expected outcomes:
1. pinpoint what are the most critical steps of the value chain, the ones primarily responsible of non-GHG emissions. Identify which are the component/variables of the process that need to be monitored/improved, to increase the sustainability of the value chain in the future;

2. compare emissions of non-GHG and other pollutants from different energy sources used at the national level (e.g. traditional energy sources, fossil fuels).
Indicator 5: Water use and efficiency

Description:
(5.1) Water withdrawn from nationally determined watershed(s) for the production and processing of bioenergy feedstocks, expressed as
   (5.1a) the percentage of Total Actual Renewable Water Resources (TARWR) and
   (5.1b) the percentage of Total Annual Water Withdrawals (TAWW), disaggregated into renewable and non-renewable water sources;
(5.2) Volume of water withdrawn from nationally determined watershed(s) used for the production and processing of bioenergy feedstocks per unit of bioenergy output, disaggregated into renewable and non-renewable water sources.

Objectives and expected outcomes:
• Assess the impact of the bioenergy value chain on water resource, renewable and non-renewable, at the national level;
• pinpoint what are the most critical steps of the value chain in terms of amount and efficiency of use of water resources. Identify which are the component/variables of the process that need to be monitored/improved, to enhance the sustainability of the value chain;
• compare the impacts of the specific value chain with other energy value chains set at national level (e.g. use of other type of raw material/species, use of traditional energy sources, fossil fuels).
Indicator 6: Water quality

Description:

6.1 Pollutant loadings to waterways and bodies of water attributable to fertilizer and pesticide application for bioenergy feedstock production, and expressed as a percentage of pollutant loadings from total agricultural production in the watershed;

6.2 Pollutant loadings to waterways and bodies of water attributable to bioenergy processing effluents, and expressed as a percentage of pollutant loadings from total agricultural processing effluents in the watershed.

Objectives and expected outcomes:

• Monitor quality and quantity of pollutants used in the various steps of the bioenergy value chain and on their impact on water resources;

• pinpoint what are the most critical steps of the value chain in terms of impacts on water resources;

• This indicator is quite critical and oftentimes affected by data gaps. Thus, it is important to raise awareness and sensitize policy and decision makers on the need to introduce regular and standardized monitoring practices.
Indicator 7: Biological diversity in the landscape

**Description:**

7.1 Area and percentage of nationally recognized areas of high biodiversity value or critical ecosystems converted to bioenergy production;

7.2 Area and percentage of the land used for bioenergy production where nationally recognized invasive species, by risk category, are cultivated; and

7.3 Area and percentage of the land used for bioenergy production where nationally recognized conservation methods are used.

**Objectives and expected outcomes:**

- Measure the impacts of the bioenergy value chain and especially of the expansion of cultivated area for raw material/biomass production on biodiversity;
- Measure the impacts of the bioenergy value chain on biodiversity and especially the ones due to an increased pressure on forest resources or due to the introduction of invasive species (e.g. fast growing species) for biomass production.
Indicator 8: Land use and land-use change related to bioenergy feedstock production

Description:

8.1 Total area of land for bioenergy feedstock production and as compared to total national surface and (8.2) agricultural land and managed forest area;

8.3 Percentages of bioenergy from:
   (8.3a) yield increases,
   (8.3b) residues,
   (8.3c) wastes,
   (8.3d) degraded or contaminated land.

8.4 Net annual rates of conversion between land-use types caused directly by bioenergy feedstock production, including the following (amongst others):
   • arable land and permanent crops, permanent meadows and pastures, and managed forests
   • natural forests and grasslands (including savannah, excluding natural permanent meadows and pastures), peatlands, and wetlands
Objectives and expected outcomes:

• Monitor the Land Use and the Land Use Change of forests, cultivated areas at the level national;

• Provide data for a long term monitoring;

• Promote an intensification of biomass production and the cultivation of marginal, degraded and/or contaminated lands; and

• Promote bioenergy production based on the use of waste and residues coming from agriculture and food-processing industry, livestock raising.
Indicator 9: Allocation and tenure of land for new bioenergy production

**Description:**
Percentage of land – total and by land-use type – used for new bioenergy production where:

9.1 a legal instrument or domestic authority establishes title and procedures for change of title; and

9.2 the current domestic legal system and/or socially accepted practices provide due process and the established procedures are followed for determining legal title

**Objectives and expected outcomes:**
- Describe the legal framework and the regulatory mechanisms in place concerning land tenure;
- Describe access to land which is a consequence of land tenure;
- Define which are the mechanisms used to allocate land to different uses (e.g. various agricultural crops, forest production, food vs energy crops).
Indicator 10: Price and supply of a national food basket

Description:
Effects of bioenergy use and domestic production on the price and supply of a food basket, which is a nationally defined collection of representative foodstuffs, including main staple crops, measured at the national, regional, and/or household level, taking into consideration:

• changes in demand for foodstuffs for food, feed, and fibre;
• changes in the import and export of foodstuffs;
• changes in agricultural production due to weather conditions;
• changes in agricultural costs from petroleum and other energy prices; and
• the impact of price volatility and price inflation of foodstuffs on the national, regional,
• and/or household welfare level, as nationally determined.
Indicator 10: Price and supply of a national food basket

Objectives and expected outcomes:

• Supply information to estimate the competition:
  – for production resources:
    » Land;
    » Nutrients;
    » Water;
    » Workforce.
  – among various end uses:
    » food/feed/fibers/bioenergy production purposes (e.g. corn, cassava, soybean, sorghum);

• Modelling and projection of the market of agricultural products to forecast product costs and risks in the long terms, with the aim to avoid social and economic impacts on population well-being.
Indicator 11 : Change in income

Description:
Contribution of the following to change in income due to bioenergy production:

11.1 wages paid for employment in the bioenergy sector in relation to comparable sectors

11.2 net income from the sale, barter and/or own-consumption of bioenergy products, including feedstocks, by self-employed households/individuals

Objectives and expected outcomes:
• Define the contribution of the bioenergy value chain to economic and social development, in terms of income;
• estimate if the setting of the bioenergy value chain has produced economic benefits (e.g. increased purchasing power, increased livelihoods diversity and enterprise development) and improved, in general, households and private individuals well-being; and
• inform about changes in income distribution.
Description:
Net job creation as a result of bioenergy production and use, total (12.1) and disaggregated (if possible) as follows:
12.2 skilled/unskilled;
12.3 indefinite/temporary.
12.4 Total number of jobs in the bioenergy sector; and percentage adhering to nationally recognized labour standards consistent with the principles enumerated in the ILO Declaration on Fundamental Principles and Rights at Work, in relation to comparable sectors (12.5)

Objectives and expected outcomes:
• Assess the contribution of the bioenergy value chain to rural and social development by considering the number and the quality of new (direct and indirect) jobs created;
• Avoid child and hard labor.
Indicator 13: Change in unpaid time spent by women and children collecting biomass

Description:
Change in average unpaid time spent by women and children collecting biomass as a result of switching from traditional use of biomass to modern bioenergy services.

Measurement unit(s): Hours per week per household, percentage

Objectives and expected outcomes:
• Assess the contribution of bioenergy to rural and social development;
• Measure the impact/benefits of bioenergy production and use on women and children well-being, in terms of changes in time availability to dedicate to income generating activities, schooling and education.
**Indicator 14: Bioenergy used to expand access to modern energy services**

**Description:**

14.1 Total amount and percentage of increased access to modern energy services gained through modern bioenergy (disaggregated by bioenergy type), measured in terms of (14.1a) energy and (14.1b) numbers of households and businesses;

14.2 Total number and percentage of households and businesses using bioenergy, disaggregated into modern bioenergy and traditional use of biomass.

**Objectives and expected outcomes:**

Assess changes in access to energy and to modern energy services, such as:

- **Electricity** for lighting, communication and use of modern devices, other productive uses;
- **Fuels** and modern technologies to cook and heat; and
- **Mechanical energy** for productive use (e.g. irrigation, processing of farm produces).
Indicator 15: Change in mortality and burden of disease attributable to indoor smoke

**Description:**

15.1 Change in mortality and burden of disease attributable to indoor smoke from the use of solid fuels;

15.2 Changes in these as a result of the increased deployment of modern bioenergy services, including improved biomass-based cookstoves.

**Objectives and expected outcomes:**

- Evaluate the contribution of modern bioenergy to reduce smoke impacts on human health (e.g. blindness, pulmonary chronic diseases, lung cancer), at household level;
- The implementation of this indicator is usually affected by lack of data. Thus, it is key to inform and sensitize policy and decision-makers on the need to conduct monitoring campaign. The use of proxies is recommended to **define a baseline**:
  - Describe current conditions and types of technologies used for cooking and heating purposes (e.g. lack of chimney);
  - Risk Assessment Analysis: evaluate the exposition to risks for the various components of the family.
Indicator 16: Incidence of occupational injury, illness and fatalities

**Description:**
Incidences of occupational injury, illness and fatalities in the production of bioenergy in relation to comparable sectors.

**Objectives and expected outcomes:**
- Pinpoint the most critical steps of the value chain which are characterized by high level of health risks for the workers; inform the decision-makers; reduce the incidences of injury, diseases and fatal accidents in the value chain;
- Inform and sensitize decision-makers on the importance to collect these types of data that, oftentimes, are not available;
- Lack of data could be overcome through the use of proxies in order to define a baseline through:
  - describing the potential risks characterizing the various steps of the value chain;
  - Carrying out a Risk Assessment Analysis: evaluate the exposition to risks for the various workers in the value chain.
Description: Indicator 17: Productivity

17.1 Productivity of bioenergy feedstocks by feedstock or by farm/plantation (tons/ha/y);
17.2 Processing efficiencies by technology and feedstock (MJ/ton of feedstock);
17.3 Amount of bioenergy end product by mass, volume or energy content per hectare per year (MJ/ha/y, calculation is based on the results of the previous sub-indicators);
17.4 Production cost per unit of bioenergy (USD/MJ – approaches used: LCA or black box approach: with direct information from producers).

Objectives and expected outcomes:

- Pinpoint the most critical steps of the value chain in terms of productivity: identify the one which negatively impact on the final bioenergy production cost;
- Assess the productivity of the value chain as a result of the use of specific raw materials and technologies;
- Inform decision-makers to revise and/or define new policies and operational strategies to foster best practices.
Indicator 18: Net energy balance

Description:
Energy ratio of the bioenergy value chain with comparison with other energy sources, including energy ratios of:
18.1 feedstock production,
18.2 processing of feedstock into bioenergy,
18.3 bioenergy use; and/or
18.4 lifecycle analysis.

Objectives and expected outcomes:
• Identify the most critical steps of the value chains in terms of energy efficiency, which negatively impact on the final efficiency of the value chain (LCA);
• describe the efficiency of bioenergy production process as referred to the type of raw material and technologies used, thus allowing for comparison among various raw material and/or available technologies;
• Inform decision-makers to revise and/or define new policies and operational strategies to foster best practices.
Indicator 19: Gross value added

**Description:**
Gross value added per unit of bioenergy produced and as a percentage of gross domestic product.

**Objectives and expected outcomes:**
- Assess the added value created in the value chain and evaluate its contribution to country Gross Domestic Product (GDP);
- Measure the contribution of the bioenergy to the economic development of the country;
- GVA = Difference between the value of outputs (bioenergy products) and inputs in the value chain.
Indicator 20 : Change in consumption of fossil fuels and traditional use of biomass

Description :

20.1 Substitution of fossil fuels with domestic bioenergy measured by energy content (20.1a) and in annual savings of convertible currency from reduced purchases of fossil fuels (20.1b).

20.2 Substitution of traditional use of biomass with modern domestic bioenergy measured by energy content.

Objectives and expected outcomes:

• Assess the contribution of bioenergy in replacing fossil fuels and to reduce their import;
• Reducing fossil fuels import can enrich the country and contribute to its economic independence;
• Assess the contribution of bioenergy in replacing the use of traditional energy;
• This Indicator is strictly linked to Ind. 18 as it is calculated by taking into account the efficiency of domestic bioenergy production (i.e. Net Energy Ratio - NER)
Indicator 21: Training and re-qualification of the workforce

Description:
21.1 Share of trained workers in the bioenergy sector out of total bioenergy workforce; and
21.2 share of re-qualified workers out of the total number of jobs lost in the bioenergy sector.

Objectives and expected outcomes:
• Analyze the quality of the work in the bioenergy value chain by emphasizing the training and requalification of the workers who were previously employed into other energy value chains, then replaced by the use of bioenergy domestic products.
Indicator 22: Energy diversity

Description:
Change in diversity of total primary energy supply due to bioenergy.

Objectives and expected outcomes:
• Inform on energy diversity at national level and, indirectly, on country energy security;
• A diverse set of energy can ensure an higher resilience to energy crises, which may occur in case of: fossil fuels/electricity supply interruption or increased cost of them.
• the more diverse the supply, the higher the level of energy security, all other things being equal;
• Higher energy diversity could guarantee higher independence in terms of energy imports (e.g. fossil fuels).
Indicator 23: Infrastructure and logistics for distribution of bioenergy

Description:
(23.1) Number and (23.2) capacity of routes for critical distribution systems, along with (23.3) an assessment of the proportion of the bioenergy associated with each.

Objectives and expected outcomes:
• Assess the suitability of infrastructures for raw materials and bioenergy distribution and storage, including:
  • Harvest and transport of raw materials for bioenergy to processing industries;
  • Bioenergy transport to local markets or to final distribution points;
  • Bioenergy distribution to final users.
• Evaluate the impacts of raw material and bioenergy transport and storage on the final efficiency of the value chain and, especially, on its economic and environmental balance (e.g. final cost of bioenergy unit and bioenergy sustainability).
Indicator 24: Capacity and flexibility of use of bioenergy

Description:
24.1 Ratio of actual use of bioenergy compared with total capacity for using bioenergy, for each significant utilization route;
24.2 Ratio of flexible capacity (which can use either bioenergy or other fuel sources) to total capacity for bioenergy use, for each significant utilization route.

Objectives and expected outcomes:
- Evaluate the **flexibility of use** of bioenergy on the basis of existing technologies for its use in the country;
- This indicator was initially developed by keeping in mind the use of biofuels (ethanol) in Flex Fuel Vehicles (FFV) and considering the ‘blending wall’ for traditional fleets. Then, it has been also applied to the use of the bio-methane, syngas and biogas (used in electricity generators and/or improved cook-stoves).
Thank you for your attention and for your contribution!

Contact-us: GBEP-Secretariat@fao.org