

A Compilation of Tools and Methodologies to Assess the Sustainability of Modern Bioenergy

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Elizabeth Beall, Paola Cadoni, and Andrea Rossi



Bioenergy and Food Security Criteria
and Indicators project
Food and Agriculture Organization of the United Nations (FAO)



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FOREWORD

The global demand for modern bioenergy, and especially liquid biofuels, is rapidly growing, driven mainly by climate change mitigation policies and increasing oil prices. This creates both opportunities and risks for developing countries.

On one hand, modern bioenergy development can boost both agricultural and rural development, by raising agricultural productivity, creating new employment and income-generating opportunities, and improving access to modern energy services in rural areas. On the other hand, if not properly managed, modern bioenergy development can trigger a number of negative environmental and socio-economic impacts, for instance by putting pressure on key resources such as land and water.

The environmental and socio-economic sustainability of modern bioenergy has been highly debated over the past few years. One of the most controversial issues that has dominated this debate is the relationship between bioenergy and food security.

In order to shed light on this complex issue and help policy-makers understand and manage the risks and opportunities for food security associated with various bioenergy development pathways, the FAO's Bioenergy and Food Security (BEFS) project developed an Analytical Framework and a toolbox, which are being implemented in several countries.

Building on this work, the FAO's Bioenergy and Food Security Criteria and Indicators (BEFSCI) project has developed a set of criteria, indicators, good practices and policy options on sustainable bioenergy development that foster rural development and food security. BEFSCI aims to inform the development of national frameworks aimed at preventing the risk of negative impacts - and increasing the opportunities - of bioenergy development on food security; and help developing countries monitor and respond to the impacts of bioenergy development on food security.

In order to ensure that modern bioenergy is sustainable and that it fosters rural development and food security, both the sector as a whole and individual operations need to be developed in a way that minimizes the risk of future negative impacts and increases the opportunities. Once the sector or a specific operation have been established, the resulting environmental and socio-economic impacts need to be monitored.

The BEFSCI project has compiled a set of thirty relevant tools and methodologies that can be used to inform the development of sustainable bioenergy policies, strategies and operations, and to assess, both ex-ante and ex-post, the main environmental and socio-economic impacts arising from individual operations or from the bioenergy sector as a whole.



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INTRODUCTION

The FAO's Bioenergy and Food Security Criteria and Indicators (BEFSCI) project (see box 1) has compiled a set of thirty relevant tools and methodologies that can be used to inform the development of a sustainable bioenergy sector and of sustainable operations, and to assess, both *ex-ante* and *ex-post*, the main environmental and socio-economic impacts arising from individual operations or from the bioenergy sector as a whole.

Modern bioenergy development, through its environmental and socio-economic impacts, may have positive or negative effects (both direct and indirect) on the four dimensions of food security: availability, access, utilization and stability (see box 2).

For instance, bioenergy may create new employment and income-generating opportunities, with positive effects on people's access to food. At the same time, if good practices are not implemented, bioenergy production may lead to negative impacts on the productive capacity of land or on water availability and quality, with negative repercussions on food security.

Both the nature and magnitude of the impacts of modern bioenergy development on food security will depend on a number of factors, related mainly to the type of feedstock and bioenergy technology considered, the way production is managed, and the environmental, socio-economic and policy context in which such development takes place.

BOX 1. FAO'S BIOENERGY AND FOOD SECURITY CRITERIA AND INDICATORS (BEFSCI) PROJECT

Building on the Bioenergy and Food Security (BEFS) Analytical Framework, the BEFSCI project has developed a set of criteria, indicators, good practices and policy options on sustainable bioenergy production that foster rural development and food security, in order to:

- inform the development of national frameworks aimed at preventing the risk of negative impacts - and increasing the opportunities - of bioenergy developments on food security; and
- help developing countries monitor and respond to the impacts of bioenergy developments on food security and its various dimensions and sub-dimensions.

Some of the impacts (both positive and negative) of bioenergy production on food security may arise from - and be attributed to - specific bioenergy projects and operations. Most of these impacts will be localized in and around bioenergy production areas. Examples of these are the impacts on soil quality in bioenergy feedstock production areas.

Other impacts of bioenergy production on food security will be the result of the cumulative effects of the domestic bioenergy sector. These impacts, which may not be attributed to specific bioenergy projects and operations, will have macro-level implications, some of which will have repercussions on local food security as well. Examples of these are the impacts of bioenergy production on the prices of staple crops.

A third category entails the local-level impacts attributable to specific bioenergy projects and operations, which may also trigger impacts at larger scales. For instance, each individual bioenergy project or operation may affect local water availability. In addition, the overall use of - and pressure on - water resources by all bioenergy projects and operations combined may compete with other water uses and affect water availability at larger scales (e.g. basin/watershed level), even if each individual bioenergy project and operation uses water efficiently.

In order to ensure that modern bioenergy development is environmentally and socially sustainable and that it fosters rural development and food security, the aforementioned impacts need to be assessed at both national and operator levels by the relevant stakeholders, during both planning and monitoring phases.

The thirty tools and methodologies that BEFSCI has compiled can be used to conduct these impact assessments, as well as to inform the development of sustainable bioenergy policies, strategies and investments.

These science-based tools and methodologies, which can be used by governments, operators and any other interested stakeholders, were selected based on their relevance (especially in terms of applicability to bioenergy), practicality and replicability.

The thirty tools that BEFSCI compiled are listed below, under the environmental and socio-economic dimensions they address. The intended “primary users” (i.e. governments and/or operators) and the “type” (i.e. planning and/or monitoring) are indicated in brackets.

BOX 2. FOOD SECURITY AND ITS FOUR DIMENSIONS: QUICK DEFINITIONS¹

FOOD SECURITY: “Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (World Food Summit, 1996).

- Food security comprises four dimensions: availability, access, utilization and stability.
- Food availability: “The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports [...]” (FAO, 2006).
- Food access: “Access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet [...]” (FAO, 2006).
- Food utilization: “Utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met [...]” (FAO, 2006).
- Food stability: “To be food secure, a population, household or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity) [...]” (FAO, 2006).

¹ The full definitions can be found here: www.fao.org/bioenergy/foodsecurity/befsci/definitions

TOOLS AND METHODOLOGIES

ENVIRONMENTAL		Primary Users		Type	
		Governments	Operators	Planning	Monitoring
BIODIVERSITY (INCLUDING AGROBIODIVERSITY)					
Integrated Biodiversity Assessment Tool (IBAT)	✓	✓	✓	✓	✓
Rapid Agrobiodiversity Appraisal (RABA) in the Context of Environmental Services Rewards	✓	✓	✓	✓	✓
Rapid Assessment Program (RAP)	✓	✓	✓	✓	✓
SOIL QUALITY					
CQESTR Model		✓			✓
LADA: Manual for Local Level Assessment of Land Degradation and Sustainable Land Management		✓		✓	✓
Revised Universal Soil Loss Equation (RUSLE)	✓	✓	✓	✓	✓
WATER AVAILABILITY AND QUALITY					
AQUACROP	✓	✓	✓	✓	✓
CROPWAT	✓	✓	✓	✓	✓
Soil and Water Assessment Tool (SWAT)	✓	✓	✓	✓	✓
Water Evaluation and Planning (WEAP)	✓			✓	
WOODY BIOMASS AND RESIDUES					
Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM)	✓			✓	✓
GREENHOUSE GAS EMISSIONS					
EX-ACT (Ex Ante Carbon-Balance Tool)		✓		✓	
GHGenius	✓	✓	✓	✓	✓
Global Emissions Model for Integrated Systems (GEMIS)	✓			✓	✓
Resources and Energy Analysis Programme (REAP)	✓	✓	✓	✓	✓
SimaPro	✓	✓	✓	✓	✓
The Greenhouse Gases, Regulated Emissions, and Energy Use in Transport Model (GREET)	✓	✓	✓	✓	✓
CROSS-CUTTING					
Land Suitability Assessment	✓			✓	✓

SOCIO-ECONOMIC		Primary Users		Type	
		Governments	Operators	Planning	Monitoring
LOCAL FOOD SECURITY					
Household Welfare Impact Analysis	✓			✓	✓
Integrated Food Security Phase Classification (IPC)	✓			✓	✓
Operator Level Food Security Assessment Tool	✓	✓	✓	✓	✓
COMMUNITY DEVELOPMENT					
Human Development Index (HDI)	✓	✓	✓	✓	✓
ENERGY SECURITY AND LOCAL ACCESS TO ENERGY					
Energy Development Index (EDI)	✓			✓	✓
Herfindahl-Hirschman Index	✓			✓	✓
GENDER EQUITY					
Gender-Related Development Index (GDI)	✓	✓	✓	✓	✓
CROSS-CUTTING (including employment, wages, income and smallholders inclusion)					
BEFS - Computable General Equilibrium (CGE) Modelling of Economy-Wide Impacts of Bioenergy Development	✓			✓	✓
Biomass Socio-Economic Multiplier (BIOSEM)	✓	✓	✓	✓	✓
Global Trade Analysis Project (GTAP) Model and Database	✓			✓	✓
Partial Equilibrium (PE) Models: AGLINK-COSIMO and OECD/FAO Agricultural Outlook	✓			✓	✓
Process Engineering for Environmental and Techno-economic Analysis (PENTA); Bioenergy Techno-economic Analysis for Africa (BIOTA)	✓	✓	✓	✓	✓

For each of the aforementioned environmental and socio-economic dimensions, an introductory text about its relevance for food security and how it may be impacted by modern bioenergy development is included.

For each tool and methodology listed under these dimensions, a description is provided, followed by an example of its application. In the selection of these examples, priority was given to applications in the context of bioenergy and, secondarily, in the agricultural and energy sectors.