Impacts of Bioenergy on Food Security

Guidance for Assessment and Response at National and Project Levels

52

ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER

ENVIRONMENT CLIMATE CHANGE [ENERGY] MONITORING AND ASSESSMENT

BEFSCI

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Impacts of Bioenergy on Food Security

Guidance for Assessment and Response at National and Project Levels

BEFSCI
Bioenergy and Food Security Criteria and Indicators

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, 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, 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 development is sustainable, the impacts (both positive and negative) of bioenergy on food security need to be assessed and properly managed.

The BEFSCI project has developed a set of indicators that can be used to assess the impacts of modern bioenergy production and use on food security at both national and project levels. In addition, BEFSCI has identified a range of possible responses to address these impacts at the relevant level.

Although the focus of this report is on bioenergy, the operator level tool described in the second chapter and the associated indicators could be used to assess potential benefits and risks to food security from agricultural operations in general.

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CHAPTER 1

INTRODUCTION

Modern bioenergy development, through its environmental and socio-economic impacts, may have positive or negative effects on the four dimensions of food security: availability; access; utilization, and stability.

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 bioenergy considered, the way production is managed, and the environmental, socio-economic and policy context in which such development takes place. In particular, these factors include:

- the environmental and socio-economic characteristics of the specific country, area or group considered;
- the regional, national and local policy environment;
- the types of bioenergy, feedstocks and processing technologies;
- the types of agricultural and forestry management approaches, systems and practices adopted in bioenergy feedstock production;
- the scale and ownership of production, and
- the types of business models found along the bioenergy supply chain.

When assessing the impacts of modern bioenergy development on food security, an important aspect to consider is the *time horizon of the assessment*, which may affect quite significantly its outcome and the analysis and interpretation of its results.

The importance of some of the factors listed above and of the time horizon of the assessment is clear when considering, for instance, the impacts of bioenergy development on the prices of staple crops. The contribution of bioenergy to potential changes in the prices of staple crops will depend, among other things, on: the crops that are used as bioenergy feedstocks; the local availability and affordability of land, water, labour and agricultural inputs, and the domestic agricultural, energy and trade policies[1]. Changes in

1 In addition to bioenergy, several other factors may affect the prices of main staple crops, including: demographic growth, income growth and associated dietary changes (demand side), adverse weather conditions (supply side), trade barriers and export restrictions, and speculation.

the prices of staple crops may affect different types of countries and households differently in the short run. For instance, an increase in the price of these crops tends to have, on average, a positive impact on net-exporting countries and net-producing households, and a negative impact on net-importing countries and net-consuming households, in the short run. Beyond these immediate effects, however, behavioural responses by consumers, who may switch to cheaper crops/foods, may mitigate the negative welfare impacts on net-consuming households. In addition, in the longer-run, an increase in the price of main staple crops may trigger a supply response, which may reduce or even neutralize the impact of bioenergy on the prices of main staple crops.

Another important aspect concerns the *scale(s) where the impacts of bioenergy production on food security may arise and/or be felt*.

Some of the impacts (both positive and negative) of bioenergy 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 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 for local food security as well. Examples of these are the impacts of bioenergy 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.

Last, but not least, there is an important *international dimension* to the links between bioenergy and food security and to the impacts of the former on the latter. More precisely, food security in a country may affect (or be affected by) bioenergy production and use in other countries, for instance through changes in imports or exports of staple crops, which may contribute to variations in the international prices of these crops. Part of these variations may be transmitted to domestic markets, with repercussions for national food security.

In order to capture the complex relationship between bioenergy and food security and determine how the former affects the latter, assessments of the impacts of bioenergy on food security need to be carried out at *both national and project levels, taking into account the international dimension* as well. If negative impacts are identified through these assessments, appropriate responses should be implemented.

This report provides a set of indicators that can be used to carry out such assessments.

In particular, the *second chapter* describes a methodology for assessing, through different steps and tiers, the *effects of bioenergy use and domestic production on the price and supply of a national food basket*. This indicator, which was developed based on technical inputs from FAO and the BEFSCI project (see box 1), was agreed by the Global Bioenergy Partnership (GBEP) as part of a set of 24 sustainability indicators for bioenergy.

The *third chapter* focuses on the *project level* and provides a tool that can be used to assess how an existing or planned agricultural operation with a bioenergy component may affect food security. The tool, which is also available online, comprises a number of indicators, which address key environmental and socio-economic aspects of agricultural operations that are directly linked to one or more dimensions of food security.

Lastly, the *fourth chapter* of the report discusses a range of *possible responses to address the impacts* identified through the aforementioned indicators at both national and project levels.

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 subdimensions.

CHAPTER 2

ASSESSMENT OF THE IMPACTS OF BIOENERGY ON FOOD SECURITY AT THE NATIONAL LEVEL

2.1 INTRODUCTION

As discussed in the introduction to this report, modern bioenergy development, through its environmental and socio-economic impacts, may have positive or negative effects on the four dimensions of food security: availability; access; utilization, and stability.

In order to ensure that modern bioenergy development is sustainable and that it fosters rural development and food security, countries need to prevent and manage the risks associated with this development.

In addition, once the modern bioenergy sector is in place, it is important to assess and respond to the impacts of bioenergy on food security at both national and project levels. With regard to the national level, BEFSCI has contributed, through its technical inputs, to the development of an internationally agreed indicator for assessing the effects of bioenergy use and domestic production on the price and supply of a national food basket.

This indicator, which is described below[2], is part of a set of twenty four sustainability indicators for bioenergy that were developed by the Task Force on Sustainability of the Global Bioenergy Partnership[3] (GBEP). This set of indicators provides a framework for assessing the relationship between production and use of modern bioenergy and sustainable development.

In its report on indicators, GBEP recognized that there is a complex, multifaceted relationship between bioenergy and food security, which was also acknowledged in the 2008 Hokkaido Toyako Summit Declaration on Global Food Security, where G8 leaders explicitly asked that countries "ensure the compatibility of policies for the sustainable production and use of biofuels and food security".

Food security is a broad, many-sided issue that has multiple economic, environmental, and social aspects. GBEP developed a number of indicators that address most of these key aspects and when measured in concert, will permit an evaluation of the impacts of bioenergy on food security at the national, regional and household levels.

In addition to the indicator described below, the core GBEP indicators relevant to food security are: Land use and land-use change related to bioenergy feedstock production;

2 The sections below were excerpted from the GBEP Report on Sustainability Indicators for Bioenergy: http://www globalbioenergy.org/fileadmin/user_upload/gbep/docs/Indicators/Report_21_December.pdf

3 GBEP was established to implement the commitments taken by the G8 in the 2005 Gleneagles Plan of Action to support "biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent." GBEP is a forum where voluntary cooperation works towards consensus amongst governments, intergovernmental organizations and other partners in the areas of the sustainability of bioenergy and its contribution to climate change mitigation.

Allocation and tenure of land for new bioenergy production; Change in income; Bioenergy used to expand access to modern energy services; and Infrastructure and logistics for distribution of bioenergy.

This core set of indicators relevant to food security is complemented by additional indicators that monitor the economic, environmental, and social factors that affect food security, including jobs in the bioenergy sector, biological diversity in the landscape, soil quality, water use and efficiency, and productivity.

2.2 INDICATOR: 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.

Measurement unit(s)

Tonnes; USD; national currencies; and percentage

2.2.1 RELEVANCE

Application of the indicator

This indicator applies to bioenergy production and use and to all bioenergy feedstocks, end-uses and pathways.

Relation to themes

In addition to bioenergy use and domestic production, numerous other factors may affect the price and supply of a food basket, including the demand for foodstuffs for food, feed and fiber; imports and exports of foodstuffs; weather conditions; energy prices; and inflation. This indicator aims to measure the impact of bioenergy use and domestic production on the price and supply of a food basket in the context of other relevant factors.

The food basket is defined on a regional and/or national level and includes staple crops, i.e. the crops that constitute the dominant part of the diet and supply a major proportion of the energy and nutrient needs of the individuals in a given country. In addition, the indicator aims to assess the impact of changes in the prices of the food basket components on the national, regional and household welfare levels.

This indicator is strongly inter-related with numerous issues of sustainability including land use, income and infrastructure. As such, this indicator is also related to the themes of *Land-use change, including indirect effects*, *Rural and social development* (and in particular the Indicator 12.1 *Net job creation* and Indicator 11 *Change in income*) and *Energy security/Infrastructure and logistics for distribution and use*.

How the indicator will help assess the sustainability of bioenergy at the national level

This indicator aims to measure, through the methodologies described in the Scientific Basis section, the impact of bioenergy production and use (in the context of other relevant factors) 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. In addition, this indicator aims to assess the welfare impacts of the measured price changes at the national, regional and household levels.

Bioenergy production may contribute to an increase in agricultural production (Diaz-Chavez, 2010), resulting in an increase in the domestic supply of staple crops for food depending on the share of them used for feed, fibre, fuel and/or export. On the other hand, bioenergy production could lead to a reduction in the domestic supply of staple crops available for food due to a reduction in the availability of these crops and/or to an increase in the share of them used for feed, fiber and/or fuel, unless the gap between domestic supply and demand is met through imports.

In addition, bioenergy feedstock production may alter demand for inputs, such as land, water and fertilizers that are used in the production of main staple crops. This can lead to a change in the demand for these inputs, which could influence their prices. Part of this price change can be transmitted to the final price of foodstuffs, including main staple crops.

Changes in the prices of main staple crops (due to bioenergy production) will have both an international and a national/local dimension. In the case of non-traded crops such as cassava in Africa, domestic prices would reflect, at least in part, changes in the domestic supply and demand (including for food and fuel) for these crops. In the case of internationally-traded commodities. However, it would be necessary to look at additional factors. Much of the variations in the domestic prices of these crops can be linked to international price variations due to external factors and thus domestic bioenergy production may have a limited impact (Minot, 2010, Robles, 2011).

Comparison with other energy options

A comparison can be made with any energy source that may compete for land or other inputs used in food production (e.g. other land-based renewables such as solar and wind). Similarly, a comparison can be made with fossil fuels, which are themselves an input for food production and whose demand-induced price changes will be transmitted to food prices. Note that certain elements of the methodological approach described below would have to be slightly adapted to permit comparison to other energy sources.

2.2.2 SCIENTIFIC BASIS

Methodological approach

Summary

The measurement of this indicator consists of two main steps, the second of which includes three tiers, which provide a range of increasingly complex approaches for the evaluation of the effects of bioenergy production and domestic use (in the context of other relevant factors) on the price and supply of nationally-determined food basket(s):

Step 1: Determine the relevant food basket(s) and its components; and

Step 2: Assessing the links between bioenergy use and domestic production and changes in the supply and/or prices of relevant components of food basket(s):

- **Tier I: "Preliminary indication"** of changes in the price and/or supply of the food basket(s) and/or of its components in the context of bioenergy developments resulting from collecting data on price and supply;
- **Tier II: "Causal descriptive assessment"** of the role of bioenergy (in the context of other factors) in the observed changes in price and/or supply, and
- **Tier III: "Quantitative assessment"** using approaches such as time-series techniques and Computable General Equilibrium (CGE) or Partial Equilibrium (PE) modeling.

Collecting and analyzing data on the price and supply of food provides the basis for understanding the impact of bioenergy on food and commodity markets, but does not provide information on the impact of price and supply changes on welfare at the national, regional and household level. In order to translate the data collection and analysis described in the aforementioned steps and tiers, additional methodologies for **assessing the welfare impacts** of food price inflation and volatility at national, regional and household levels are provided. Making the connection between the economic data and welfare impacts is of fundamental importance and users of the indicator are encouraged to use these welfare impact tools in conjunction with any of the tiers listed above and/or in a standalone way in response to food price inflation and volatility.

Step 1, "Determining the relevant food basket(s) and its components", is a prerequisite to evaluating the entire indicator. In this step the relevant food basket(s) and its components are identified.

Step 2, with its three tiers, provides a range of approaches – from the simplest to the most complex – to evaluate the effects of bioenergy use and domestic production. For each of them, different types of data are to be to be collected and analyzed.

Users of this indicator are encouraged to evaluate the indicator to the fullest extent that they can. Depending on their needs, as well as on data and resource availability; however, such users could decide to use any one (or more) of these tiers. If, in the context of increasing levels of bioenergy production and/or use, the "preliminary indication" (step two, tier I;) detects a decrease in the supply of the food basket(s) and/or of its components for food and/or an increase in the "real" prices of such basket(s) and/or components, a "causal descriptive assessment" (Step two, tier II of the role of bioenergy (in the context of other relevant factors) in the observed supply decreases and/or price increases can be conducted. If this assessment indicates that there is a high probability that the demand for modern bioenergy in a given country led to a downward pressure on supply – and to an upward pressure on prices – of the relevant food basket(s) and/or of its components, then the "quantitative assessment" (i.e. step 2, tier III), such as time-series techniques, Computable general equilibrium (CGE) and/or Partial equilibrium (PE) modeling, can be used to quantify these impacts of bioenergy in the context of other factors (step 2, tier III).

Welfare impacts at both national and household levels have to be assessed whichever tiers is chosen in step two. Specific methodologies to assess these impacts at the national and household levels (i.e. respectively the so-called "terms-of-trade-effect" and "net benefit ratio") are described below in the step 3 section.

Users of the indicator are encouraged to pay particular attention to local food basket price and supply variations in food insecure and vulnerable areas and the impacts that these variations have on household welfare. Mapping these areas and identifying the most vulnerable groups would be quite useful in this context, as it would help countries target the analysis of the domestic impacts of bioenergy, and increase cost-effectiveness of the analysis by starting with these most vulnerable groups and/or areas.

The data and analyses that compare the behavior of food basket price and supply across different locations and population groups create the opportunity for cross-cutting analyses and for connecting this indicator to themes such as Land-use change including indirect effects, Rural and social development, Economic development and Energy security/ Infrastructure and logistics for distribution and use.

Domestic production and use of bioenergy from agricultural commodities may influence prices at the international level. For countries and regions that are well connected to international markets, these international effects can loop back and impact the price and supply of food in their national food basket(s). This feedback effect will be limited to countries or regions that use major commodities as feedstocks for bioenergy and are major importers or exporters of those same feedstocks. In these cases, evaluating the indicator would entail assessing the effects of domestic production and use of bioenergy on international markets and how this feeds back on domestic prices of relevant components of the national food basket. This can be achieved through quantitative approaches of varying degrees of complexity such as time-series techniques and modelling; techniques which are described in Section 3. Measurements of impacts of domestic bioenergy use and production on international prices are not relevant for countries which do not play a significant role in the international market of those commodities used in the domestic bioenergy sector. On the other hand, in order to disaggregate the effects of domestic bioenergy production and use on the price and supply of the elements of the food basket in price-taking countries, some methodological approaches require analysis of those international factors that substantively affect domestic food prices and supply. Linked to the above, when relevant, one should consider not only the crop of interest but also all the elements of the national food baskets whose supply and prices might be influenced by that crop, in order to account for possible ripple effects (see for example CBO, 2009). In other words this should be considered when there is a possible displacement from a production (i.e. concerning land) or consumption (i.e. concerning food) point of view. The causal descriptive assessment – i.e. step 2, tier II – allows one to do this from a qualitative point of view; and step 2, tier III presents quantitative approaches to carry out this analysis.

Much of the data required to measure this indicator is available in international, national and/or local statistics. If deemed necessary by the relevant domestic authority, then market surveys can also be used to complement and integrate data for evaluating the indicator. Finally, in order to fill any remaining gaps in the data and analysis, the relevant domestic authority can seek inputs from experts with an in-depth understanding of the relevant national and/or local agricultural commodity market (including its links to the international market) and of the food, feed and fuel sectors. These experts could include, among others, economists, scientists and analysts drawn from different stakeholder groups, as deemed relevant and appropriate by the relevant domestic authority[4].

Detailed methodology

Step 1: Determination of the relevant food basket(s) and of its components

The first step in the measurement of this indicator is the identification of the "representative" food basket or baskets (Flores and Bent, 1980). These baskets, which reflect current food consumption patterns, may be determined, for instance, by ranking foodstuffs based on their contribution to the average per capita calorie in-take (either through direct consumption or via the foods that these crops are processed into), with the 'main staple crops' likely providing the highest share in developing countries. Certainly, the most significant food items in people's diets are to be included in the food basket.

It would be informative for countries to define a representative "low income food basket", which would include the main crops and foodstuffs consumed by households in the bottom household income quintile(s) that are particularly vulnerable to food insecurity (Meade and Rosen, 2002). Large countries with significant differences in diets across regions and/or segments of the population may consider specifying regional/local food baskets. In addition, if a country is interested in assessing the effects of its domestic bioenergy demand/use on the international market, it might also consider how its demand/use affect the price and supply of the main internationally-traded agricultural commodities and/or of the main regional staple crops (e.g. maize and cassava in Sub-Saharan Africa).

Generally, food consumption patterns are not subject to rapid variations, especially in developing countries. If such changes do occur, then the composition of the food basket can be adjusted accordingly. In the event that changes do occur, then it would be important to identify and analyze the main drivers of these changes, in order to assess the role (if any) played by bioenergy.

Evaluators of the indicator are encouraged to monitor the effects of bioenergy use and domestic production on the nutritional quality of the food basket over time. In order to do this, the "representative" food basket and its development over time would need to be compared with a "nutritious" food basket, which fulfills basic nutritional guidelines while reflecting the range

4 The definition of "experts" provided in this paragraph applies to the entire indicator.

of foods typically eaten in a country. This "nutritious" food basket should contain a sufficient amount of food per day and contain specific food and nutrient groups that are typical of a country's food consumption patterns. There are numerous sources of data for these food patterns, including a compilation of food-based dietary guidelines from different countries maintained by FAO[5] and standards from various US government agencies, such as USAID and USDA[6].

Step 2. Assessing the links between bioenergy use and domestic production and changes in the supply and/or prices of relevant components of food basket(s)

After defining the relevant food basket(s), the next step is to assess whether bioenergy production and/or use has increased significantly in the country (since the last time the indicator was measured[7]) and whether this has been accompanied by significant changes in the price and/or supply of the identified food basket(s) and/or of its components. Three ways to carry out this assessment, hereafter referred to as tiers, are proposed, from simple (tier I) to more complex (tier III).

Tier I: "Preliminary indication" of changes in the price and/or supply of the food basket(s) and/or of its components in the context of bioenergy developments

Data on the following factors are needed:

- Levels of bioenergy use and domestic production;
- Supply of the food basket(s) and its components disaggregated by end-use (food; feed, fibre; and fuel), and
- "Real" (i.e. inflation adjusted) prices of the food basket(s) and its components.

Domestic supply of a given crop is the sum of domestic production and imports minus exports. If a crop is stockpiled, then domestic stocks should be considered as well, as they might reduce – if part of the production is stocked – or increase – if stocks from a previous year are released into the market – the supply of a crop for a given period of time. Estimates of crop production are usually made at the district level and then combined to give the overall national picture, while data on imports, exports, stocks and use are generally available at the national level. In addition, FAOSTAT provides time-series and cross sectional data on production and trade of main staple crops for some 200 countries.

Once the domestic supply of a given crop has been determined, data should be gathered from national statistics on the share of this supply that is used for feed, fibre and fuel and

5 The compilation of food guidelines by country available here: http://www.fao.org/ag/humannutrition/nutritioneducation/fbdg/en/. The International Network of Food Data Systems maintains Food Composition Tables (http://www.fao.org/infoods/directory_en.stm) that could provide essential data to evaluating the nutritional composition of a food basket.

6 IOM (Institute of Medicine). 2002. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty, Acids, Cholesterol, Protein, and Amino Acids*. Washington, DC: National Academy Press, IOM (Institute of Medicine). 2004. *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate*. Washington, DC: National Academies Press, and http://www.choosemyplate.gov/.

7 The first time the indicator is measured, price changes occurred during the last year – if the indicator is measured on an annual basis – or the last x number of years – if the indicator is measured every x years – should be considered.

the share of it that is available for food. If deemed necessary, market surveys could be used in order to complement and integrate this data. Finally, in order to fill any remaining gaps in the data, input could be sought from the relevant experts convened by the relevant domestic authorities. This approach would provide a preliminary, qualitative indication of the potential role played by bioenergy production and use, should a decrease in the supply or an increase in the prices of food basket components be observed.

With regard to prices of the food basket(s) and its components, detailed data is available in official statistics in the majority of countries, both nationally and, in most cases, locally as well. USAID's Famine Early Warning Systems Network (FEWS NET) and FAO's Global Information and Early Warning System (GIEWS) can provide detailed, up-to-date data on food prices for countries for which market data are not readily available. Further, market surveys may be conducted to fill any additional gaps in the data.

If bioenergy production is distributed across the country in proportion to the production patterns of main staple crops, then a national focus should suffice. However, if bioenergy is produced in localised regions, then local price levels – and variations – should be considered as well. For instance, prices of the food basket(s) and its components might be distinguished between rural and urban areas. This split would also implicitly capture differences in the import-content of urban households' food baskets and transaction costs associated with moving foods from rural to urban areas. In the case of rural areas, it would be especially important to focus on those areas where food production is displaced. Finally, as already mentioned particular attention should be given to local food basket price and supply variations in food insecure and vulnerable areas.

If there is a significant increase in the price of the identified food basket(s) and/or of its components, it is important to also get an initial indication of the resulting welfare implications at both the national and the household levels. In order to do so and identify countries and population groups that are likely to benefit and those that are likely to be worse off, the net trading position of both the country as a whole (i.e. whether the country is a net exporter or importer) and of households (i.e. whether these households are net producers or consumers of food products) should be determined with respect to the food basket components that experienced a price increase. As explained in detail in the welfare impact section, an increase in the price of a certain commodity will have positive welfare effects on countries that are net exporters and households that are net producers of that commodity. On the other hand, countries that are net importers of food commodities and households that are net consumers will be negatively affected by this price increase. In line with the "quick and simple" character of this tier, the estimate of household and national welfare impacts should be based on inputs from experts convened by the relevant domestic authority. A more quantitative estimate of these features would require the use of methodologies such as terms of trade regarding the national level welfare and net benefit ratio for the household level welfare[8]. These are described in the welfare section below.

8 If a country already analyzes household level welfare implications of food price rises, e.g. through the net benefit ratio (see section 3 below), then these can be applied at this stage in light of the identified probable impact of bioenergy on food prices.

If, in the context of increasing levels of bioenergy production and/or use, the "Preliminary indication" detects a decrease in the supply of the food basket(s) and/or of its most relevant components for food and/or an increase in the "real" prices of such basket(s) and/or components, then a "Causal descriptive assessment" (step 2, tier II) of the role of bioenergy (in the context of other relevant factors) in the observed supply decreases and/or price increases can be conducted. This assessment would also be useful in case of significant variations in the composition of the food basket(s), especially when the diversity of the latter is reduced.

Tier II: "Causal descriptive assessment" of the role of bioenergy (in the context of other factors) in the observed price increases and/or supply decreases

The causal descriptive assessment described here aims to determine the share of the demand for modern bioenergy in a given country that is met through each of the five ways described below, as different combinations of them are associated with different levels of probability of a downward pressure on supply – and of an upward pressure on prices – of the relevant food basket(s) and/or of its components. This type of analysis may be carried out by a multidisciplinary team of experts convened by the relevant domestic authority based on data from national statistics or obtained through market surveys.

The causal descriptive assessment represented in the accompanying diagram (page 26) entitled "Causal descriptive assessment" and described below aims to provide an indication of the probability that the demand for modern bioenergy in a given country resulted in a downward pressure on supply – and to an upward pressure on prices – of the relevant food basket(s) and/or of its components. A number of relevant supply- and demand-side factors need to be considered when this assessment is conducted. These include: changing demands for food/feed; energy prices affecting bioenergy demand and prices of inputs/food; and weather conditions affecting supply (responses).

As explained in detail below, in order to assess whether or not this probability is low or high, the causal descriptive assessment aims to determine how the demand for modern bioenergy was met, including consideration of the sources of the bioenergy feedstock(s) (e.g. expansion of agricultural land vs. yield increases), as well as possible effects from the co-production of animal feed.

In the Diagram, the likelihood of a downward pressure on supply and an upward pressure on prices being low is indicated with a "check mark" symbol (✓). Scenarios for which it is possible that bioenergy production and use will lead to a downward pressure on food supplies and upward pressure on food prices are indicated by a "magnifying glass" symbol (🔍), which indicates the need for further analysis. The five different means discussed below for sourcing bioenergy feedstocks are each given a distinct colour in the Diagram. The colour scheme is intended only to improve the clarity of the presentation and to facilitate following the information flow within the Diagram. Methods of further analysis are described in Tier III and include the use of quantitative methods such as time series techniques, Computable general equilibrium (CGE) and/or Partial equilibrium (PE) models described in Tier III. The causal descriptive assessment alone may be sufficient to provide countries with an indication of possible corrective actions that would likely mitigate the identified risks.

Not only can the causal descriptive assessment be used to identify risks to food security created by the production and use of bioenergy, but it can be used to identify ways to compensate for increased demand created by bioenergy production. The demand for modern bioenergy in a given country can be met through any combination of the following:

A. Imports;

B. Non-agricultural Waste[9];

C. Residues from agriculture, fisheries and forestry;

D. Additional crop production, and

E. Diversion of crops.

A. Imports

If the demand for modern bioenergy in a given country is met through imports, then this demand is not likely to directly affect the domestic supply and prices of the relevant food basket(s) and/or of its components in the country considered. In this case, the probability of a downward pressure on domestic supply – and of an upward pressure on prices – of the relevant food basket(s) and/or of its components would normally be low.

Meeting the domestic demand for modern bioenergy in a given country through imports may impact the international market and the markets in countries from which modern bioenergy and/or feedstocks are imported. In order to determine the extent of these impacts, importing countries could assess the effects that their imports have on the international price and supply of such commodities using the quantitative approaches described in Tier III. Given the links between international and national markets, this analysis of the international effects would also provide relevant information on the potential changes in the price and supply of food basket items at the domestic level.

Although it is beyond the scope of this indicator, countries engaged in the trade of bioenergy and bioenergy feedstocks may decide, on a purely voluntary basis, to collaborate on data sharing and analysis of the impact of trade in bioenergy and bioenergy feedstocks on their respective national food basket(s).

B. Non-agricultural Waste

Modern bioenergy may be produced from non-agricultural waste. For instance, biogas may be obtained from the organic component of municipal solid waste or from sewage sludge. If the demand for modern bioenergy in a given country is met through bioenergy obtained from waste, the probability of a downward pressure on supply – and an upward pressure on prices – of the relevant food basket(s) and/or of its components is likely to be low. This positive scenario is indicated with a check mark.

9 This includes the organic component of the by-products of all sectors excluding agriculture and forestry – e.g. residential, commercial, industrial, public and tertiary.

C. Residues from agriculture, fisheries and forestry

Modern bioenergy may be produced from agricultural, fisheries and forestry residues. Biogas, for instance, may be obtained from livestock manure, while second-generation liquid biofuels may be obtained from ligno-cellulosic residues from both agriculture and forestry.

The change in availability of feed resulting from the use of residues for modern bioenergy production and from the associated co-product generation (C1) should be assessed, and then taken into account in the context of E (Diversion of crops from the food/feed market).

Agricultural and forestry residues are used for other purposes as well, such as animal feed, soil management – both to prevent erosion as soil cover and as a source of soil organic carbon and other nutrients. If agricultural and forestry residues are used to produce modern bioenergy, it is important to assess how soil quality is affected, as measured by GBEP indicator 2 ("Soil quality") If there is no significant decrease in soil quality, the probability of a downward pressure on supply – and of an upward pressure on prices – of the food basket(s) and/or of its relevant components is likely to be low (check mark) (C2). If such decrease occurs (C3), this probability could be high (magnifying glass).

In rural areas of developing countries, agricultural and forestry residues are an important source of fuel for cooking and heating (i.e. the traditional use of biomass energy). Modern bioenergy obtained from residues could replace – at least in part – the traditional uses of biomass (including residues), as captured by GBEP indicators 14 (*Bioenergy used to expand access to modern energy services*) and 20 (*Change in consumption of fossil fuels and traditional use of biomass*). This would lower the demand for residues for such traditional uses. GBEP Indicator 3 *(Harvest levels of wood resources)* could inform and be informed by this section as well, as it deals with the harvesting of wood resources, including forestry residues, for modern bioenergy production.

The use of agricultural and forestry residues for modern bioenergy production will generate a number of co-products. These co-products (which may be defined as "secondary" residues) may replace – at least in part – the use of ("primary") agricultural and forestry residues for feed, soil management and/or traditional use of biomass for energy. Bio-slurry, for instance, which is a co-product of biogas production from livestock manure, can be used as fertilizer and/or feed (Marchaim, 1992).

D. Additional crop production

The demand for modern bioenergy may be met through a supply response, in other words through additional production of a certain crop/feedstock induced by the additional demand for this crop[10]. The additional production of crop A may be obtained through an increase in the area under cultivation of this crop (D1) and/or through an increase in crop yields (D2).

10 A number of factors, such as weather conditions, may affect this supply response.

A number of co-products will be generated when this additional quantity of crop A is used to produce modern bioenergy. As shown in figure (see page 26), these co-products – minus those associated with the displaced production of food and feed from the same crop – is to be accounted for in the context of E (Diversion of crops from the food/feed market).

For this fourth option (i.e. "Additional production of crop A"), the assessment described in the sub-sections below is to be carried out for each crop used as modern bioenergy feedstock.

D.1. Increased land area

The increase in the area under cultivation of crop A (D1) may be achieved through agricultural expansion (D1a) and/or through the displacement (by crop A) of items included – or not included – in the food basket (D1b) and (D1c, respectively). If the increase in the area under cultivation of crop A is the result of agricultural expansion (D1a), it is important to consider which land-use changes took place, as measured by GBEP indicator 8 (*Land use and land-use change related to bioenergy feedstock production*), as land-use changes may affect a number of ecosystems goods and services that are important for food security.

In order to determine whether this agricultural expansion is associated with a high or low probability of a downward pressure on supply and/or an upward pressure on prices of the food basket(s) and/or of its relevant components, the efficiency of crop A production (measured in terms of yields/inputs) on this new land should be assessed. The efficiency of water use – as measured by GBEP Indicator 5 (*Water use and efficiency*) – can be considered as well. If the efficiency is the same as – or higher than – the average in the country for crop A (D1a1),then the probability of a downward pressure on supply – and of an upward pressure on prices is likely to be low (check mark). If this efficiency is lower than average (D1a2), then this probability could be high (magnifying glass). As in this case the increase in the area under cultivation of crop A will result in a decrease in the average productivity of this crop and will lead to an increase in the demand for inputs and water (including internationally) and thus to a potential decrease in their availability and/or to an increase in their price, which may be transmitted at least in part to the price of the food basket(s) and/or of its components.

Increasing the area used to cultivate of crop A may displace the production of agricultural items that are not included in the food basket (D1b). Examples of these non-food basket items include agricultural products used for fibre and other uses, such as cotton or tobacco. In this case, it is important to understand whether this displacement of non-food crops leads to the displacement of food basket items. If there is no displacement of food basket items (D1b1), then the probability of pressure on supply and/or prices of the food basket(s) and/or of its components is likely to be low (check mark). If there is displacement (D1b2) that results in a significant decrease in the domestic availability of the displaced food basket items, then the probability of pressure on supply and could be high at the domestic level and further study is warranted (magnifying glass). If this displacement of food basket items is compensated through trade and results in significant changes in imports/exports of the displaced food basket items (D1b3), then an analysis of the international effects can be undertaken through the quantitative approaches described in tier III (magnifying glass). It should be noted that here one assesses only the qualitative probability. While beyond the scope of this indicator, consideration of the extent to which the expansion of crop A displaces production items of relevance to nutrition that are not in the food basket can be undertaken with these data.

If the increase in the area under cultivation of crop A is the result of a displacement (by crop A) of food basket items (D1c) and this leads to a significant decrease in the domestic availability of the displaced food basket items (D1c1), then the probability of pressure on the supply and price of the food basket(s) and/or of its components could be high at the domestic level (magnifying glass). If the displacement (by crop A) of food basket items is compensated through trade and results in significant changes in imports/exports of the displaced food basket items (D1c2), then an analysis of the international effects can be undertaken through the quantitative approaches described in tier III (magnifying glass).

D.2. Increased crop yields

The additional production of crop A may also be achieved through increased yields of crop A (D2). Consistent with GBEP Indicator 8 (*Land use and land-use change related to bioenergy feedstock production*), users of the indicator are encouraged to determine the share of these yield increases that is "additional" (i.e. a result of the additional bioenergy use and domestic production being analyzed). If these increased yields are the result of improved technology or an increase in the efficiency (i.e. yields/inputs) in the production of crop A (D2a) – including in terms of water use (see GBEP indicator 5) – for instance through the introduction of improved agricultural management practices, the probability of price and supply pressure is likely to be low (check mark).

If the increased yields of crop A are simply the result of an increase in the use of inputs and/or water (D2b) – without any efficiency improvements – and this leads to a significant decrease in the domestic availability of these inputs then the probability of price and supply pressure could be high at the domestic level (D2b1, magnifying glass) . If this increase in the use of inputs is compensated through trade and results in significant changes in imports/exports of inputs and/or water (D2b2), then an analysis of the international effects can be undertaken through the quantitative approaches described in section step 3 (magnifying glass).

E. Diversion of crops from the food or feed

E.1. No decrease in available food or feed

The demand for modern bioenergy may be met through the diversion of crops/feedstocks A, B, C, etc. from the feed market. In this case, the co-products generated by modern bioenergy production (minus those associated with the displaced production of feed from the same crops) are to be considered. The co-products generated by the use of the additional production of crop A (situation D) for modern bioenergy, as well as those resulting from the diversion of crop A from the food market (E2), can be added to these. In addition, the change in availability of feed (before trade) resulting from the use of residues for modern bioenergy production (C) can be taken into account.

If, overall, the diversion of crop A from the feed market is sufficiently compensated by the aforementioned co-products of modern bioenergy production and thus there is no significant net decrease – before trade – in availability of feed (E1), then the probability supply and price pressure is likely to be low (check mark).

If the diversion of crop A from the feed market is more than compensated by suitable co-products of modern bioenergy (resulting from C, D and E), then the "extra" co-products can be considered in the context of the "additional production of crop A" (situation D), as they may reduce the demand for crop A and thus the additional production required in order to meet the demand for modern bioenergy. In the case of E1 the effects resulting from the diversion of each crop (i.e. A, B, C, etc.) used for bioenergy is expected to be additive. As such, there is a need to sum different types of animal feed and to determine the share of the "extra" co-products mentioned above that are to be considered as adding to the "Additional production of crop A" when individual crops are considered in situation D. This means that the extent to which one type of feed might substitute for another type of feed or for a food crop is to be determined, based on inputs from experts convened by the relevant domestic authority. If this compensation does not occur or is not sufficient there may be a significant net decrease – before trade – in the availability of crop A for feed (E2). In this case, it is important to determine whether or not this decrease is compensated through trade. If this compensation does not occur and there is a significant decrease in domestic availability of feed, then the probability of price and supply pressure is high (E2a) (magnifying glass). If this compensation occurs and results in significant changes in imports/exports of feed, then an analysis of the international effects can be undertaken through the quantitative approaches described in tier III (E2b) (magnifying glass).

E.2. Diversion of crops from the food or feed

The demand for modern bioenergy may also be met through the diversion of crop A from the food market. A number of co-products will be generated when a certain quantity of crop A is diverted from the food market in order to produce modern bioenergy. These co-products – minus those associated with the displaced production of food from the same crop – are to be taken into account in the context of E2.

If the diversion of crop A from the food market is not compensated through trade and results in a significant decrease in the domestic availability of crop A for food or feed (E2a), then the probability price and supply pressure is likely to be high at the domestic level, especially if crop A is a staple crop(magnifying glass)

If the diversion of crop A from the food or feed markets is compensated through trade and results in significant changes in imports/exports of the displaced food basket items (E2b), then this probability could be high at the international level, especially if crop A is a staple crop (among the main trading partners)(magnifying glass).

As stated above, if the causal descriptive assessment indicates that bioenergy production and/or use could significantly contribute to a downward pressure on the supply – and/or an upward pressure on the prices – of the food basket(s) and/or of its components, then it would be necessary to use the quantitative approaches described in tier III in order to quantify these effects. However, the causal descriptive assessment may provide countries with an indication of possible corrective actions/measures to be taken in order to mitigate the identified risks; thereby, lessening the need to carry out more quantitative analyses.

Tier III: "Quantitative approaches" – time-series techniques and computational modelling (e.g. CGE and PE)

The indicator on supply and price of relevant food basket elements is intrinsically multivariate. The variables to be considered will vary country-by-country. Using the data collected on the factors affecting the price and supply of a national food basket, countries can perform economic analyses to estimate the relative effects of these many factors, including bioenergy production, on the price of a national food basket. The multivariate nature of the problem invites time-series techniques and computational approaches (PE and CGE).

Assessment of market integration and price transmission often use time series techniques. Market integration refers to the extent to which different markets are linked, and price transmission refers to the effect of prices in one market on prices in another market (Rapsomanikis et al, 2006). Countries with sufficient data on existing biofuels programs can use standard econometric techniques to provide a historical assessment of bioenergy on the price of a national food basket. Econometric models have the advantage of being relatively straightforward to develop. They require time-series data to provide historical assessments. Via regression analysis the modeller can identify the factors that contribute to changes in the price of a national food basket.

Two different aspects should be considered:

- Links between domestic production/use and international prices. Time series methodologies such as error correction models (Hallam and Zanolli, 1993, CCP/FAO, 2010) can be used as simpler approaches to this assessment. While relatively simple they are rather static. On the other hand PE models would provide more dynamic information but these models require more assumptions, which are based on experts' judgments. As a general rule of thumb, such techniques require a minimum of thirty data points collected at thirty consecutive time points. Monthly data on supply, prices, etc., would clearly be preferable, though quarterly or yearly data could be sufficient provided that they were available over a sufficiently long time period.
- Links between international and domestic prices use price transmission approaches, which measure transmission elasticity, defined as the percentage change in the price in one market given a one percent change in the price in another market (Minot, 2010). Although the markets could be for related commodities (e.g. maize and soybeans) or for products at different points in the supply chain (e.g. wheat and bread), here we focus on the case of markets for the same commodity in two locations, in this case between international markets and domestic markets. This latter could form part of analysis for this indicator, for instance in the case of a major biofuel importer that wished to assess the impact of this domestic biofuel use

on international commodity prices and then assess how this impact fed back to the price and supply of their national food basket items. Another case could be for a small price-taker to work out to what extent their prices followed international ones rather than domestic factors.

The simplest way to assess price transmission is through simple correlation coefficients of contemporaneous prices (Rapsomanikis et al, 2006). A high correlation coefficient is evidence of co-movement[11] and is often interpreted as a sign of an efficient market. Another simple method is to use regression analysis on contemporaneous prices, with the regression coefficient being a measure of the co-movement of prices. Information on the different methods, their pros and cons and level of complexity can be found in Awudu (2006) and Rapsomanikis et al. (2006). Each of these methods is taken to present evidence about the components of transmission thus providing particular insights into its nature. Collectively, these techniques offer a framework for the assessment of price transmission and market integration.

Examples of assessment of price transmission of agricultural commodities can be found in Dawe (2008) and Minot (2010). Specific examples related to bioenergy can be found in Balcombe and Rapsominakis (2008) and Elam and Meyer (2010). Generally speaking, computable models (partial equilibrium/PE or general equilibrium/CGE) regarding the impacts of bioenergy and other relevant factors on agricultural markets "start with a baseline which describes the model's 'best estimate' description of the present or future state of the world's markets and agricultural policies" (Edwards et al, 2010). This baseline is then "shocked" with a change, such as an increase in the demand for modern bioenergy. The results then show changes in a number of important variables, including agricultural and food prices (Edwards et al., 2010).

Equilibrium models can be divided into general or partial equilibrium models. Computable General Equilibrium (CGE) models "calculate an equilibrium state for a system including all relevant economic markets" (Ecofys, 2010). These models, therefore, take into account all sectors of the economy[12].

CGE models provide effective means of economic analysis (Wing, 2004), and as such, have often been used in bioenergy, not without controversy though. As with many computational modeling approaches, the approach and assumptions underlying the modeling effort must be clearly understood and stated. The results of the modeling must be understood in the context of the caveats associated with the assumptions underlying the model. This standard tool can be used to analyze the impacts of economic changes, including the impacts of a nascent bioenergy sector. CGE models have been applied to areas as diverse as fiscal reform, development planning (Dixon and Rimmer, 2002), international

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11 Co-movement and completeness of adjustment implies that changes in prices in one market are fully transmitted to the other market at all points in time.

12 Due to this feature, CGE models tend to be more comprehensive than Partial Equilibrium (PE) models (which are described in the last paragraph of this section) and more suitable for calculating the indirect effects of a sector – such as modern bioenergy – on other sectors of the economy. However, as described in the section on anticipated limitations, CGE models tend to be particularly sensitive to the assumptions made and to the choice of input parameters as well.

trade (Taylor and Black, 1974, Hertel, 1997), environmental regulations and food policy. CGE models can be implemented using publicly available software such as the General Algebraic Modeling System (GAMS)[13] and the General Equilibrium Modeling PACKage (GEMPACK) on standard microcomputers (Lofgren, Harris and Robinson, 2002).

Countries with sufficient data on existing biofuels programs can use standard econometric techniques to provide a historical assessment of bioenergy on the price of a national food basket (Greene, 2008). Econometric models have the advantage of being straightforward to develop. They require time-series data to provide historical assessments. Via regression analysis the modeller can identify the factors that contribute to changes in the price of a national food basket.

Another option for exploring the impact of biofuels on the price of a national food basket is the use of advanced partial equilibrium forward-looking models. Partial Equilibrium (PE) models calculate an equilibrium state for one specific sector – i.e. the agricultural sector in this case – while all other sectors are exogenous, and as such time-dependent developments of key macroeconomic variables are determined independently of the model (Solberg et al., 2007)." They are based on linear relations between prices, demand and production described by linking elasticities. The elasticities are derived from statistical data of past market movements" (Edwards et al., 2010).

These models highlight challenges and opportunities that might materialize in some countries/commodity markets as they analyze key relationships and trends that could develop in agricultural markets. Forward-looking models are based on historical inputs, but require sets of assumptions and parameter estimation. As such, it is essential that they be utilized with appropriate caveats and clear expression of the underlying assumptions. Forward-looking projections are an established component of modern agricultural economics. They are resource intensive and require considerable support. USDA supports the Food and Agriculture Policy Research Institute (FAPRI), the EU supports the Common Agriculture Policy Regionalized Impact analysis (CAPRI), and the OECD and UN FAO support AGLINK – COmmodity SIMulation MOdels (AGLINK-COSIMO). Other institutions that model national, regional and world economic development include the World Bank, World Food Program and International Food Policy Research Institute. Partial equilibrium models facilitate policy and market analysis of agricultural markets by allowing the modeller to observe the impact of various changes in policies and/or market conditions, such as the development of a bioenergy sector.

As is discussed in more detail in the section on anticipated limitations, the results of both CGE and PE models are quite sensitive to the assumptions made, as well as to the choice of input parameters.

13 GAMS software is available from the GAMS home page (www.gams.com) and from the International Food Policy Research Institute (www.ifpri.org/publication/standard-computable-general-equilibrium-cge-model-gams-0). GEMPACK is available from the Centre of Policy Studies of Monash University (www.monash.edu.au/policy/gempack.htm).

Net impacts of food price changes on national, regional and household welfare levels

When there is a significant change in global, national and/or regional food prices, regardless of the possible influence of bioenergy and other relevant factors, then it is essential to assess the resulting welfare effects at national, regional and household levels. Users of the indicator are encouraged to assess welfare effects in parallel with the data collection and analysis of the rest of this indicator. Assessing welfare effects is critically important in the case of low income food deficit countries (LIFDCs) and for poor households and vulnerable groups. An increase in the prices of the food basket(s) and/or of its components will have different impacts on different types of countries, regions and households.

Price volatility and price changes of foodstuffs will affect welfare at the household, regional and national levels. In order to further their understanding of national level effects users of the indicator can consider measuring the "terms-of-trade effect". As explained in Benson et al. (2008), the "terms-of-trade effect" is the effect of a change in the international price of a commodity (or group of commodities) on the value of a country's exports and imports as a percent of GDP. In countries that are net exporters the "terms-of-trade effect" will likely reveal how commodity producers (i.e. farmers) benefit at the national level. Likewise for countries that are net importers of commodities, the "terms-of-trade effect" will provide national level information on the challenges posed by increased international commodity prices. In the context of this indicator, one way to measure the terms-of-trade effect would be to calculate the change in the value of net exports of the food basket(s) and/or of its components due to changes in international prices of such basket(s)/components as a proportion of the size of the economy as measured by GDP[14].

In countries that are particularly large and/or heterogeneous, it would be useful to measure this indicator at regional and local levels as well. This would be especially important in food insecure and vulnerable areas. This could be done by applying the same methodology described above to the outflows and inflows of food basket components respectively from and to the specific area considered.

In order to further understand how changes in the prices of the food basket(s) and/or of its components affect food security, it is important to assess the net welfare impacts of these changes at the household level, and especially on poor households[15]. In order to assess the net welfare impacts on poor households arising from bioenergy production and/or use, only the share of the price change that is due to bioenergy use and domestic production – as determined by the CGE or PE modelling – should be considered.

Households may be both producers and consumers of food basket components such as staple crops. The impact of a change in the price of staple crops on household welfare

14 For instance, the terms of trade effect of a 40 percent increase in the price of agricultural commodity *a* in a country with exports and imports of this commodity worth US$ 0.1 billion and US$ 1 billion respectively, and with a GDP of US$ 9 billion, would be (0.1 x 0.40 – 1 x 0.40)/9 = -0.36/9 = -4 percent.

15 Other measures could be used as well, such as the movement of households across the poverty line. This poverty line might be a food poverty line, based on the nationally-determined food basket (Appleton, 1999 and 2009; Duc Tung, 2004; Hoang & Glewwe, 2009; Rio Group, 2006).

can be decomposed into the impact on the household as a producer of these crops and the impact on the household as a consumer of them. In the short run, the net welfare impact will be the difference between the two – i.e. between the producer gains and the consumer losses[16]. More precisely, as described in FAO (2010a) – appendix 14.5, the short-run welfare impact on households (also referred to as "net benefit ratio") is calculated as:

$$\frac{\Delta w^1}{\chi_0} \%P_{p,i} * PR_i - \%P_{c,i} * CR_i$$

where $\Delta w^1/ x_0$ is the first order approximation (i.e. assuming no supply and demand responses in the short-run) of the net welfare impact on producer and consumer households deriving from a price change in crop i, relative to initial total income x_0 (in the analysis income is proxied by expenditure);

$P_{p,i}$ is the producer price of crop i;

$\%P_{p,i}$ is the change in producer price for crop i;

PR_i is the producer ratio for crop i and is defined as the ratio between the value of production of it to total income (or total expenditure)[17];

$P_{c,i}$ is the consumer price of crop i;

$\%P_{c,i}$ is the change in consumer price for crop i;

CR_i is the consumer ratio for crop i and is defined as the ratio between total expenditure on crop i and total income (or total expenditure)[18].

This type of analysis does not allow for household responses in production and consumption decisions[19]. In the very short run, however, the adjustments in crop production are limited, and on the consumption side the poorest households are likely to have only minimal substitution possibilities (FAO, 2008a).

By differentiating welfare impacts across quintiles, it is possible to target the poorest segments of the population and understand how they are affected by a change in the price of the food basket(s) and/or of it components. In addition, differentiating by location allows for comparisons between the net welfare impacts on households in urban vs. rural areas or in different regions.

Another important differentiation that may be introduced is by household-head gender. This would allow one to determine whether male- and female-headed households are affected differently – and how their welfare is impacted – by a change in the price of main staple crops[20]. Households may be further distinguished by land ownership, education level, age, and so on.

16 For a detailed description of the methodology to calculate the net welfare impacts of price changes at the household level, please refer to Deaton (1989) and Dawe & Maltsoglou (2009). For an example of the application of this methodology, please see FAO (2010b).

17 In other words, the proxy used for the production ratio (PR) is the share of the value of agricultural sales and own production in total household income.

18 In other words, the proxy used for consumption (CR) is the share of the value of food purchases and own consumption in total household expenditures.

19 Both supply and response elasticities, however, could be factored into the analysis of the household welfare impacts of price changes over the medium run (see, for instance, Benson et al., 2008).

20 It has been observed in different contexts that all other things being equal, female-headed households tend to spend a greater share of their income on food. In different rural contexts, female-headed households have also been found to have less access to land and to participate less in agricultural income generating activities. When this is the case, female-headed households are less likely than male-headed households to participate in the benefits of food price increases than male-headed households (FAO, 2008b).

In addition to the household-level analysis described above, it would be useful to analyze the welfare impacts of a change in the price of the food basket(s) and/or of it components at the intra-household level as well. As argued by Benson et al. (2008), "the welfare impact of a food crisis [e.g. of a significant food price increase] may differ across members of the same household" (p. 6). This is mainly due to the fact that generally resources are not distributed equally to all household members, with women and girls often being disadvantaged, with varying degrees across countries, regions and household characteristics (Quisumbing, 2003, cited in Benson et al., 2008). This individual level analysis could be carried if detailed individual-level data are collected through household surveys[21].

Anticipated limitations

With regard to the so-called "Preliminary indication" (i.e. step 2, tier I of the), it might be difficult to develop accurate estimates of crop production (as well as of stocks and trade) and of the share of main staple crops used for food, feed and fuel; and of prices of main staple crops in some areas, particularly those most dependent on local production.

With regard to step 2, tier II of the methodology, the Causal descriptive assessment may be carried out by a multidisciplinary team of experts convened by the relevant domestic authority, based on data from national statistics or obtained through market surveys. In some cases, these will need to be combined with expert judgment and educated guesses, which will be sensitive to the assumptions that the experts convened by the domestic authority will need to make (in a transparent way).

Numerous factors influence agricultural commodity markets and prices. These factors have very complex effects resulting from their nonlinear interactions with each other, making the identification and measurement of any one factor a difficult challenge. Disentangling these multi-faceted and complex interactions makes it difficult to precisely quantify the effects of any one factor. Evaluation of impacts across different factors may depend on the sequencing of the factors in the evaluation and thus can lead to non-unique results and misleading implications. Neither the CGE nor the econometric approach is immune to this potential limitation.

The results of both CGE and PE models are sensitive to the assumptions made and to the choice of input parameters, which should be fully disclosed when the results are presented. In particular, CGE models, which tend to be more comprehensive than PE models, can include more uncertainties in assumptions (Ecofys, 2010). Another important limitation of CGE models is "the need to limit sectoral and regional disaggregation and the level of institutional detail". For instance, in CGE models the number of agricultural products rarely exceeds ten (Gerdien Prins et al., 2010).

21 Both supply and response elasticities, however, could be factored into the analysis of the household welfare impacts of price changes over the medium run (see, for instance, Benson et al., 2008).

2.2.3 PRACTICALITY

Data requirements

- Calorie contribution by crop;
- Production of main staple crops (both nationally and regionally/locally);
- Changes in stocks of main staple crops;
- Exports and imports of main staple crops;
- Energy costs and their impact on agricultural production and distribution costs;
- Impacts of weather on crop production;
- Price inflation;
- Change in demand for foodstuffs;
- Shares of main staple crops used for food, feed, fibre and fuel;
- Prices of main staple crops;
- Household income and expenditure by crop, and
- Data required for the Causal descriptive assessment (see annexed table).

These data, collected at the national or regional level can be sourced from national or international statistical accounts. If necessary, these data can be gathered through interviews and surveys.

Data sources (international and national)

In the vast majority of countries, detailed data is available on domestic production, consumption and imports/exports of crops (especially staple crops). In most cases, data is available by region/area. In addition, USDA and FAO maintain global databases that provide data relating to food and agriculture, including production and trade of main staple crops, for some 200 countries. Further, USAID's FEWS and FAO's GIEWS can provide detailed, up-to-date data on food prices for countries for which market data are not readily available. Data on household income and expenditure by crop is available for the large majority of countries. Part of the data required for the Causal Descriptive Assessment may be obtained from national statistics.

Known data gaps

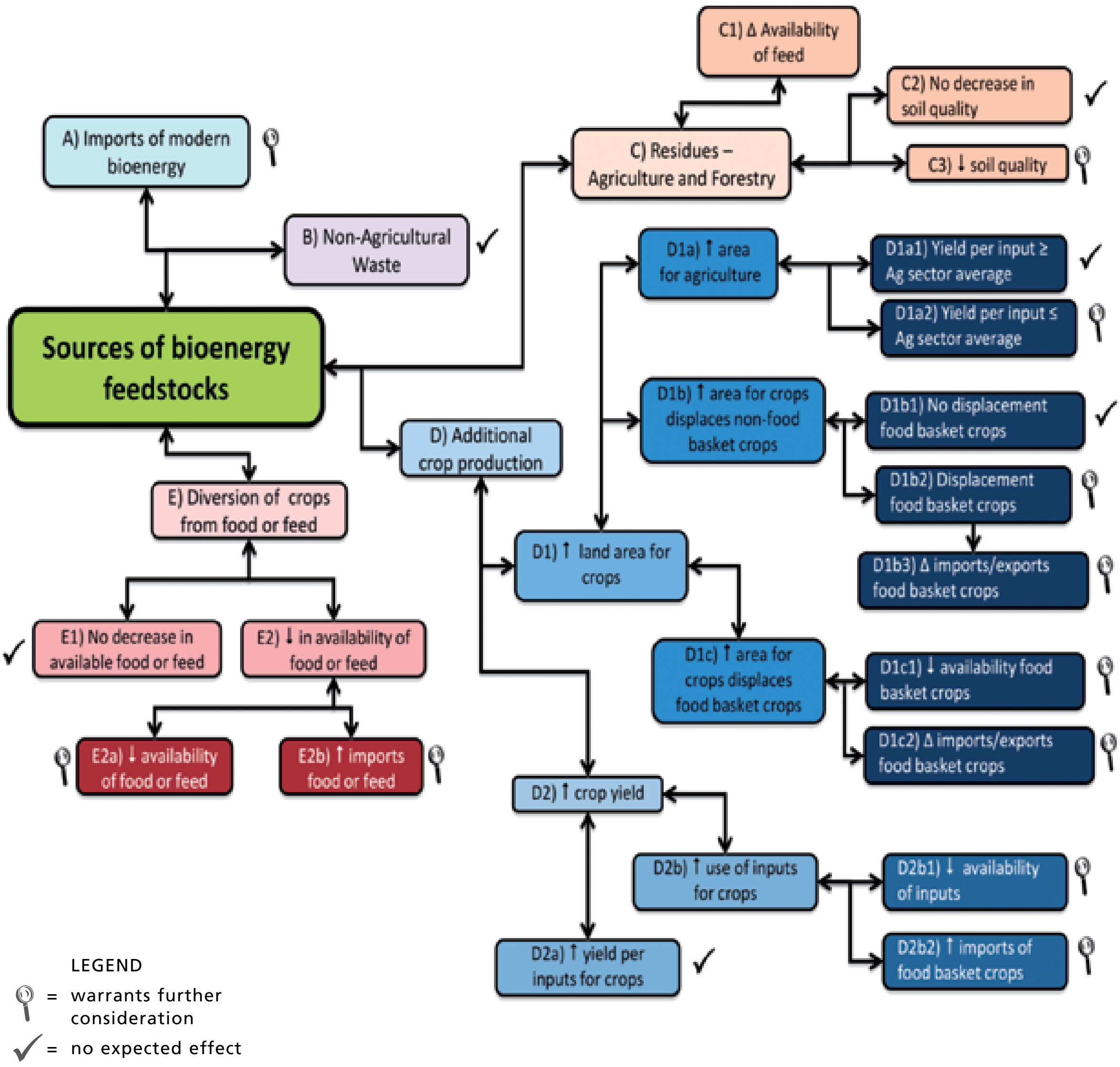
Through the above data, it should be possible to estimate the share of main staple crops used (both nationally and regionally/locally) for food, feed and fuel; and FAOSTAT provides up-to-date specific data for food and feed (combined). In order to disaggregate them and identify the share of main staple crops used for fuel production, it is necessary to consult with local stakeholders (including governments). Market and/or households surveys could be conducted to fill any gaps in the data, including those required for the Causal descriptive assessment.

Relevant international processes

Data on the production, supply and prices of a national food basket is used in a number of international processes and is widely available.

FIGURE 1

Causal descriptive assessment



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CHAPTER 3

BEFSCI OPERATOR LEVEL FOOD SECURITY ASSESSMENT TOOL

3.1 INTRODUCTION

Agricultural operations with a bioenergy component[22] can affect food security both positively and negatively. The BEFSCI Operator Level Food Security Assessment Tool aims to provide a preliminary indication of both the potential benefits and risks that such operations may pose to food security. This tool consists of three parts:

1. Change in the supply of food to the domestic market;
2. Resource availability and efficiency of use; and
3. Physical displacement, change in access to resources, compensation and income generation.

Each part includes a number of indicators, which address key environmental and socio-economic aspects of agricultural operations that are directly linked to one or more dimensions of food security (see box 2).

BOX 2

SHORT DEFINITIONS OF KEY FOOD SECURITY TERMS

"**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 is comprised of four dimensions (FAO, 2006):

Availability: The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports;

Access: Access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet;

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; and

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).

22 These can be defined as operations that produce agricultural products that can be used as bioenergy feedstocks, or that, in addition, process such feedstocks into biofuels (among other things).

For each indicator, specific thresholds and a scoring system are provided, based on the following three categories:

- Potential Benefit for Food Security;
- No Significant Influence on Food Security; and
- Potential Risk to Food Security.

Given the complex nature of food security and the multiple interlinkages and potential trade-offs[23] between the issues addressed by the three categories of this tool, each indicator and the associated scoring should be considered in an integrated way.

This tool has been developed for use by different parties, including relevant national and local authorities, development banks and operators themselves, interested in assessing how an existing or planned agricultural operation with a bioenergy component may affect food security.

For existing operations, measured data from the operation should be used. For planned operations, the assessment should be based on projected data, which can be extrapolated from the business plan of the operation considered and from any other relevant document available (e.g. Environmental/Social Impact Assessment, Environmental/Social Management Plan, etc.). When data are not available for the specific operation being assessed, a number of proxies are provided in the tool.

The three parts that comprise the Operator Level Food Security Assessment Tool (Version One) and the associated indicators are described in the sections below. The Excel file of this first version of the Tool is included in the annex at the end of the report. The numbers included in brackets in the text below refer to this Excel file. The Tool can be accessed on-line[24], and will be revised and updated based on comments and feedback from users.

It is important to note that the indicators, thresholds and scores included in this tool aim to provide a preliminary indication of potential risks and benefits for specific aspects of food security. A number of assumptions and approximations are embedded in the tool in order to ensure the practicality and applicability to a wide range of situations. The actual food security impacts of agricultural operations with a bioenergy component will also depend, among other things, on a number of environmental, socio-economic, policy and institutional factors that are not captured by this tool.

3.2 CHANGE IN THE SUPPLY OF FOOD TO THE DOMESTIC MARKET

The first part of the BEFSCI Operator Level Food Security Assessment Tool includes an assessment of the change in supply of food to the domestic market as a result of the operation, addressing the availability dimension of food security.

As a first step, under this part operators should provide information on how the land was used prior to the establishment of the operation (1.1), namely for subsistence agriculture, commercial agriculture, livestock grazing, or as fallow land.

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23 For instance, under the first part, an operation could lead to a reduction in the supply of food, thus posing a potential risk to food availability; at the same time, under the third part, it could lead to an increase in income generating opportunities for households, with benefits for food access.

24 www.fao.org/bioenergy/foodsecurity/befsci/operator-tool/en/

Operators should then enter the items supplied to the domestic market prior to the operation, and by the operation that are part of the "food basket" of the country where the operation is located.

The food basket reflects current food consumption patterns in the country where the operation is located. As described in chapter two, the composition of the food basket can be determined by ranking food items based on their contribution to the average per capita calorie in-take[25] (either through direct consumption or via the foods that these crops are processed into), with the 'main staple crops' likely providing the highest share in developing countries. The most significant food items in people's diets are to be included in the food basket.

Each food basket item supplied by the operation, and prior to it, should be considered within this part, under the food group to which it belongs:

CROPS:

- Cereals and tubers[26];
- Pulses[27];
- Sugar crops;
- Oilseeds;
- Vegetables;
- Fruit;

LIVESTOCK:

- Meat (small/large animals);
- Eggs; and
- Milk.

The total annual supply of food basket items from the same land prior to the operation should be determined (1.2). Items produced on temporarily fallow land[28] (i.e. over the last five years) or obtained from hunting and wild edible plant collection should be taken into account as well.

With regard to crops, in order to calculate the amount of food basket items supplied to the domestic market, the share of these items that is exported should be subtracted[29]. This can be done by multiplying production by the export ratio and then subtracting the result from production itself. To the extent possible, data on the export share for the specific area/

25 FAOStat provides data on food consumption (in Kcal/capita/day) by food item by country: http://faostat.fao.org/site/609/DesktopDefault.aspx?PageID=609#ancor

26 Under the heading of root and tuber crop (simply referred to as "tubers" in this tool), FAO classifies seven primary crops: potatoes (Irish potato); sweet potatoes; cassava (manioc, mandioca, yuca); yautia ("chou caraibes"); taro (cocoyam, old cocoyam, colocasse); yam; and other roots and tubers.

27 Pulses are the edible dry seeds of leguminous plants. They include dry beans, dry broad beans, dry peas, chick-peas, dry cow peas, pigeon peas, lentils, bambara beans, etc.

28 FAOSTAT defines "fallow land (temporary)" as the "cultivated land that is not seeded for one or more growing seasons. The maximum idle period is usually less than five years". The idle period should be taken into account when determining the average annual production..

29 In the case that this tool is used in conjunction with the national level indicator described in chapter two, the share of these items supplied to the domestic market for food (rather than for feed, fuel and fibre) could then be determined. These data can be estimated based on interviews with local market actors from different stages of the food supply chain. Also in this case, if data cannot be obtained for the specific area/production being considered, national averages could be used as proxies. As described in chapter two, generally these data are available from national statistics. If deemed necessary, market surveys can be used in order to complement and integrate these data.

production being assessed should be used[30]. Alternatively, the national average export ratio for each of the items considered can be used as a proxy[31].

With regard to meat, the total slaughtered small animals (e.g. poultry) and large animals (e.g. beef cattle) respectively should be determined[32]. If the number of slaughtered animals is not available, the average number of live animals kept in the area during the year prior to the establishment of the operation, used primarily for meat production, should be considered as 'slaughtered'[33]. The total slaughtered animals – or the aforementioned average – is then multiplied by the yield (i.e. the live weight at slaughter) and by the carcass percentage, in order to determine the annual meat production (in tons). If data on yield and carcass percentage for the specific area considered are not available, the country average should be used as a proxy[34].

With regard to eggs and milk, the type and number of live animals used primarily for the production of food basket items under each of these groups should be indicated[35]. The annual production of eggs and milk (expressed in grams and tons respectively) should then be determined, based on eggs/milk yields for each type of livestock animal for the specific area/production being assessed. These data can be obtained, for instance, through interviews with local producers. Alternatively, average yields for the country can be used as proxies[36].

In most cases, trade in livestock products, especially eggs and milk, tends to be relatively limited compared to certain crops. For this reason, and for simplicity, in the case of livestock, production is used as a proxy for the supply to the domestic market.

The supply of food basket items from the operation should then be determined (1.3).

With regard to crops, in order to calculate the amount of food basket items supplied by the operation to the domestic market per year, the share of these items that is exported should be subtracted[37]. To the extent possible, data from the specific operation being

30 If the operation is established in an area where subsistence farming is practiced, the export share can always be assumed to be equal to zero.

31 As described in chapter two, this average can be calculated based on data on domestic production and exports,. FAOSTAT (under Food Balance Sheets, and/or Production and Trade respectively), in particular, provides time-series and cross sectional data on production and trade of all the main food items for some 200 countries..

32 Information on livestock concepts, definitions, and classifications can be found on the following FAO web-page: www.fao.org/economic/ess/ess-trade/ess-prod-method/en/

33 In order to account for nomadic pastoralism, the annual average over a longer period of time could be considered if data are available.

34 FAOStat (under Production – Livestock primary) provides data on average meat yields for the main types of livestock animals for some 200 countries: http://faostat.fao.org/site/569/default.aspx#ancor. For small animals, these data are expressed in 0.1 grams, while for large animals hectograms are used. Conversion factors are included in the Excel spreadsheet in order to automatically convert to tons the figures provided by FAOStat.

35 For the determination of this average, the same rules described above for meat apply.

36 FAOStat (under Production – Livestock primary) provides data on average eggs and milk yields for the main types of livestock animals for some 200 countries: http://faostat.fao.org/site/569/default.aspx#ancor. A conversion factor is included in the Excel spreadsheet in order to automatically convert to tons the figures provided by FAOStat on average milk yields.

37 In the case that this tool is used in conjunction with the national level indicator described in chapter two, once the amount of food basket items supplied by the operation and exported has been calculated, the share of these items supplied to the domestic market for food (rather than for feed, fuel and fibre) could be determined. Also in this case, to the extent possible data from the operation being assessed could be used. For existing operations, these data can be obtained from an analysis of the sale contracts mentioned above and of the buyers of the food items supplied by the operation. If the operation is not yet in place, relevant information might be available in the business plan. Alternatively, as described under 1.2, data on the average share of these items used for food in the country where the operation is located could be used as a proxy.

assessed should be used. If the operation is already in place, these data can be obtained from the contracts stipulated by the operator for the sale of its products. If the operation has not been established yet, these data can usually be extrapolated from the business plan, which generally includes information regarding the marketing aspects. If these data are not available, the national average export ratio for each of the items considered should be used as a proxy, as already described under 1.2.

With regard to livestock, operators should enter the same information requested under 1.2. To the extent possible, data on yields and carcass percentage for the specific operation considered should be used. Alternatively, the country average should be used as a proxy.

The change in the supply of food basket items to the domestic market can then be determined (1.4).

With regard to crops, this can be done by subtracting, for each food group, the amounts of food basket items supplied prior to the operation to the domestic market (1.2), from those supplied by the operation to the same market[38] (1.3). As the supply change is calculated by food group, substitution between different food basket items within the same group is allowed (often these items are – or can be considered as – substitutes) and does not influence the result. A score is then assigned for each relevant food group, based on the measured changes in the supply to the domestic market. If this change is positive, there could be a potential benefit for food security, while if it is negative there could be a potential risk to food security; if supply has not changed, there may be no significant influence on food security.

Concerning livestock, the production of meat, eggs and milk prior to the operation (1.2) should be subtracted from that of the operation being assessed (1.3). The same scoring system used for crops and described above is then applied.

The indicators described above aim to provide a preliminary indication of the potential changes in the domestic food supply as a result of the establishment of an agricultural operation with a bioenergy component, and of the associated potential risks and benefits for food security. These indicators focus on the supply of food basket items, which are key for people's diets. The calorie content and nutritional characteristics of these items are not measured by the indicators. The supply of co-products from the operation, including feed from the processing of crops/feedstocks into biofuels, is not taken into account either.

38 If this tool is used in conjunction with the national level indicator described in chapter two, this subtraction could be made on the basis of the amounts supplied to the domestic market for food, if these amounts have been determined under 1.2 and 1.3.

3.3 RESOURCE AVAILABILITY AND EFFICIENCY OF USE

The second part of the BEFSCI Operator Level Food Security Assessment Tool addresses the availability of land and water in the area of the operation (2.1), the implementation of good agricultural practices to minimize negative impacts on natural resources (2.2), and the efficiency with which the operation uses key resources and inputs such as land (2.3), and fertilizers (2.4).

This section addresses three of the four dimensions of food security: availability, stability, and utilization. Both the availability and stability dimensions of food security are affected by the availability of land, water and fertilizers for food production; agricultural management is important as well for these dimensions, as it may affect both the current and future productive capacity of land. Additionally, the availability of water is important for the preparation of food, and thus for the utilization dimension of food security.

The first indicator under part two addresses the issue of land and water scarcity on the area of the operation (2.1). Rising demand for land and water from agriculture and other sectors is leading to increasing pressures on these resources and, in some cases, to land and/or water stress/scarcity. Locating an operation in an area with land and/or water scarcity could further exacerbate these issues, posing a risk to food security.

In order to determine the level of land and water scarcity, under indicator 2.1 operators should insert the GIS coordinates of the operation into the FAO's State of Land and Water (SOLAW) 2011 'Agricultural Systems at Risk' map[39]. This map shows to what extent rainfed and irrigated agricultural systems within the main river basins around the world suffer from land and/or water scarcity[40]. If an operation is located in an area with no land and water scarcity, there could be a potential benefit for food security; if the area is characterized by low land and water scarcity, there may be no significant influence on food security. If the operation is located in an area with moderate or high land and water scarcity, there could be a potential risk to food security.

Indicator 2.2 deals with the implementation of good agricultural practices on the operation being assessed. Operators can implement a number of good practices in order to minimize the risk of negative environmental impacts from their operations. These practices can improve the efficiency and sustainability in the use of land, water and agricultural inputs, with positive environmental and socio-economic effects, including on food security. Under indicator 2.2,

39 "Agricultural Systems at Risk: human pressure on land and water", http://www.fao.org/fileadmin/templates/solaw/images_maps/map_5.pdf

40 Land scarcity in rainfed agriculture was assessed by comparing the rural population density with the suitability for rainfed crops. On the map, land is considered scarce if the population density is higher than the highest quintile in the density distribution for each suitability class. Land scarce areas in climates with an Aridity Index lower than 0.65 (where the Aridity Index is defined as Yearly Precipitation divided by Yearly Reference Evapotranspiration) are considered both land and water scarce. Irrigated areas are considered water scarce if already more than 20 percent of the renewable water resources in the river basin is consumed by irrigated crops (SOLAW 2011). As this is a global map, potential issues of land and water scarcity at the local level might not be captured.

six key good agricultural practices, which are described in the BEFSCI report on good environmental practices in bioenergy feedstock production (FAO 2012), are considered:

- Crop Rotation or Intercropping[41];
- No- or Minimum Tillage[42];
- Soil Cover[43];
- Integrated Pest Management[44];
- Integrated Plant Nutrient Management[45], and
- Sustainable Irrigation[46].

Operators should indicate which of these practices they implement on a regular basis within their core production. If none of these practices are implemented on the operation being assessed, there could be a potential risk to food security. If up to two practices are implemented, there may be no significant influence on food security. If at least three good practices are implemented, there could be a potential benefit for food security. The score is calculated based on the number of practices implemented, with the assumption that the greater number of practices implemented will reduce negative impacts on natural resources and thus provide greater potential for food security.

The third indicator under part two addresses land use efficiency (2.3). Under this indicator, the operator should enter the yield per hectare (i.e. tons/ha) for each crop produced by the operation[47]. The operation yield is then benchmarked against average yield data for each relevant crop in the country where the operation is located. These data can be found on FAOStat[48].

The higher the land use efficiency of the operation, the lower the pressure on land resources and the risk of a potential competition with other uses such as food production. If the yield of the operation is higher than the country average there could be a potential benefit for food security, while, if it is lower than this average, there could be a potential

41 *Crop Rotation* is the practice of cultivating a variety of crops in succession on the same field. Under Intercropping, farmers grow and manage two or more crops simultaneously on the same field.

42 *No- or Minimum Tillage* is the practice of minimizing or completely eliminating land tillage.

43 *Soil cover* refers to the use of vegetation to cover the surface of soil either through cover crops, in which a type of annual or perennial crop is grown specifically for soil improvement purposes, or by leaving crop residue on the farm after harvest to shield the soil.

44 *Integrated Pest Management (IPM)* is an ecosystem approach to crop protection that incorporates different management strategies and practices to grow healthy crops, prevent pest attack and minimize pesticide use.

45 *Integrated Plant Nutrient Management (IPNM)* refers to "maintenance and adjustment of soil fertility and of plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of benefits from all possible sources of plant nutrients in an integrated manner"(Dudal and Roy 1995).

46 Sustainable Irrigation may be achieved through precision irrigation approaches/systems, such as deficit irrigation, supplemental irrigation, and wastewater harvesting for irrigation; and through irrigation technologies, such as drip irrigation, microsprinklers, and spate irrigation.

47 Crops grown on subsistence plots established by the operation should not be considered under this indicator. Crops grown for livestock grazing (e.g. grasses) should be included. If intercropping is practiced (i.e. two or more crops are grown simultaneously on the same field), the Land Equivalent Ratio should be determined for each of these crops. For further guidance on this, please refer to Mead and Willey (1980).

48 FAOStat (under Production – Crops/Livestock primary): http://faostat.fao.org/site/339/default.aspx. With regard to crops, yield data on FAOStat are presented in hectograms/hectare. Once the operator obtains these data and enters them into the tool, the yield will be automatically converted into tons/hectare in order to compare with the operation's yield. Concerning livestock, data are expressed in several different measurement units in FAOStat, so it was not possible to include a standard conversion factor. These data should be converted to tons before entering them into the tool.

risk to food security. If the operation yield is the same as the country average (within +/- 5 percent), there may be no significant influence on food security.

The last indicator under this part addresses fertilizer use efficiency (2.4). In order to assess the efficiency of fertilizer application, operators should enter the kilograms/hectare of total fertilizer [N (nitrogen), P (phosphate), K (potassium)] applied in the production of each crop[49]. The operator should then consult the Iowa State University's World Fertilizer Model – The World NPK Model (Rosas 2011) for the average fertilizer application by crop/country and enter the information. This information is then combined with the yield information entered under indicator 2.3, in order to determine the kg of fertilizers applied for each ton of output and provide a score based on comparison of operator information with the country/crop average of the fertilizer input/output ratio.

Inefficient fertilizer use can lead to negative impacts on both soil and water quality, with negative repercussions on food security. In addition, at the macro level, inefficient use of fertilizers can lead to a downward pressure on the supply and an upward pressure on the price of these key agricultural inputs. For this reason, if the fertilizer use efficiency of the operation is lower than the country average, there could be a potential risk to food security. On the other hand, if the operation uses fertilizers more efficiently (per unit of output of a certain crop) than the country average, there could be a potential benefit for food security. If the fertilizer use efficiency of the operation is the same as the country average (within +/- 5 percent), there may be no significant influence on food security.

3.4 PHYSICAL DISPLACEMENT, CHANGE IN ACCESS TO RESOURCES, COMPENSATION, AND NEW INCOME GENERATION

The third and final part of the BEFSCI Operator Level Food Security Assessment Tool addresses the access dimension of food security, and more precisely both physical and economic access to food.

This part covers the following aspects:

- physical displacement and compensation[50] (3.1);
- displacement of income and community development/income generation (3.2), and
- displacement/improvement of access to assets (3.3).

Indicators 3.1 – 3.3 also address the mechanisms used by the operators to obtain the information. For assessing both physical and economic displacement (3.1 and 3.2), and displacement of – as well as increased – access to assets(3.3), the following mechanisms[51] are considered:

49 Crops grown for livestock grazing (e.g. grasses) should be included.

50 For further information on physical displacement and compensation, please refer to FAO's Committee on World Food Security (2011).

51 For further information on mechanisms to assess displacement, compensation, income generation, and change in access to resources, please refer to IFC (2011).

- Satellite imagery;
- Census;
- Socio-economic surveys and studies, and
- Mapping of customary rights.

In addition, under 3.1, the mechanisms for designing compensation for physical displacement are included, namely:

- Free, Prior and Informed Consent[52];
- Continuous consultation with affected communities;
- Procedures to determine eligibility, and
- Grievance mechanisms and arbitration mechanism(s).

The inclusion of these mechanisms aims to provide the reviewer with additional qualitative information on the operation being assessed. However, the mechanisms do not affect the score.

The first indicator under the third part addresses household physical displacement and compensation (3.1). Under this indicator, operators should insert the number of female-headed households and male-headed households physically displaced by the operation, or directly the total number of households if gender-disaggregated data are not available (3.3.1).

In order to determine the number of households physically displaced by the operation, and the percentage receiving compensation, operators can begin by consulting available maps and aerial imagery that provide information on population settlements, and census and socio-economic data for the area where the operation is located. In assessing physical displacement, both the area from which people will be displaced and the area where people will be resettled should be mapped in detail. By consulting these sources and gathering these data, the operator can gather an initial indication of the population likely to be affected by the operation. These data should then be validated through a socioeconomic survey and impact assessment covering all of the affected people[53].

Operators should then enter the number of female-headed households and male-headed households (or the total number of households, if gender-disaggregated data are not available) receiving compensation among those physically displaced, if any.

The level of compensation received by people is not addressed under this indicator. In order to determine compensation, operators should consult with the project-affected people and provide them with opportunities to participate in the planning, implementation, and monitoring of any compensation or resettlement programme, especially in developing procedures for determining eligibility for compensation, and in establishing grievance

52 The underlying principles of *Free, Prior and Informed Consent (FPIC)* can be summarized as follows: (i) information about and consultation on any proposed initiative and its likely impacts; (ii) meaningful participation of affected peoples; and, (iii) representative institutions.

53 For further information on conducting a socioeconomic survey and impact assessment, please refer to RSB (2011).

mechanisms and arbitration. Particular attention should be paid to vulnerable groups (e.g. indigenous people, women, children, elderly, disabled) to ensure their participation in the consultation process on compensation[54].

If the operator compensates any less than 100 percent of the physically displaced population, there could be a potential risk to food security, while if all of the displaced people receive compensation, there may be no significant influence on food security.

If data under 3.1.1 are entered in a gender-disaggregated way, it is possible to see if and how female-headed households and male-headed households are displaced and/or compensated differently, providing additional qualitative information to the reviewer, but with no influence on the score.

The second indicator under this part addresses displacement of income and community development/income generation (3.2). Under this indicator, operators should enter the number of female and male individuals (or the total number of individuals, if gender-disaggregated data are not available) respectively with income generating activities displaced (3.2.1) and benefitting from community development/income generation as a result of operation (3.2.2). The following income generating activities are considered:

- Subsistence plots;
- Contract or sale of goods and services;
- Wage employment, and
- Land lease contract.

In order to determine the number of households with income displaced by the operation, the operator can begin by consulting available census and socio-economic data for the area of the operation, for example on the type and number of income generating activities in the area, and percentage of the population working in each activity This should be followed with a socio-economic impact assessment of the affected population to determine how many people will lose income generating activities (such as ability for own production, contracts, wage employment, etc.) as a result of the operation. With regard to income generation, operators should enter the number of subsistence plots planned and of contracts expected (for the sale of goods and services, for wage employment, and for land leases).

If the number of individuals with income-generating activities provided by the operation is higher than the number of individuals with activities displaced by it, there could be a potential benefit for food security. On the other hand, if there are more individuals with income-generating activities displaced than created, there could be a potential risk to food security. If the number of individuals with income-generating activities displaced and created is the same (within +/- 5 percent), there may be no significant influence on food security.

The net income change in the area as a result of the operation is not captured under this indicator. In addition, this indicator does not address whether the income generating activities created by the operation benefit the same people whose income generating activities were displaced by the latter. If data are entered in a gender-disaggregated way,

54 For further guidance on how to structure consultations on compensation, please refer to IFC (2011).

additional qualitative information (which does not affect the score) on potential gender-differentiated risks and benefits from the operation are provided to the reviewer.

The third and final indicator under this part addresses displacement/improvement of access to assets (3.3). This indicator seeks to address the impacts of the operation on access to key resources for food security, namely infrastructure (e.g. roads, bridges, community structures), natural resources (e.g. water), energy source/electricity, and agricultural inputs (e.g. seeds and fertilizers) and facilities (e.g. greenhouses and storage facilities). Under this indicator, operators should enter the number of female and male individuals (or directly the total number, if gender-disaggregated data are not available) with displaced (3.3.1) or increased (3.3.2) access to the aforementioned assets as a result of the operation.

In order to determine the change in access to resources/assets as a result of the operation, the operator can begin by consulting available maps and census information which identify key features such as population settlements, infrastructure, natural vegetation areas, water resources, and land use patterns The review should include an assessment of both individual assets and assets held collectively such as water resources, community structures, agricultural inputs and facilities, forests used for fuelwood extraction, etc. This information should then be complemented by a socio-economic impact assessment of the affected population, to understand how many individuals' access to resources will be affected[55]. The operator can then enter projected individuals that will have increased access to assets as a result of the operation. The same sources used to determine displacement can be used to identify which individuals will benefit from increased access to assets as a result of the operation. An example could be the number of individuals receiving cook stoves from the operator, or the number of individuals gaining access to electricity as a result of the project.

If the number of individuals with new/improved access to assets is higher than the number of individuals with displaced access to assets, there could be a potential benefit for food security. If there are more individuals with assets (or access to them) displaced by the operation than with increased access to such assets, there could be a potential risk to food security. If the number of individuals with displaced and increased access to assets is the same (within +/- 5 percent), there may be no significant influence on food security.

Under indicator 3.3, it is not considered whether the increased access to assets generated by the operation benefit the same people whose assets (or access to assets) were displaced by the latter. If data are entered in a gender-disaggregated way under 3.3, additional qualitative information on potential gender-differentiated risks and benefits from the operation are provided to the reviewer.

55 For further guidance on how to assess access to assets, please refer to IFC (2011).

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CHAPTER 4

RESPONSE TO THE IMPACTS OF BIOENERGY ON FOOD SECURITY

As discussed in the introduction to this report, modern bioenergy development, through its environmental and socio-economic impacts, may have positive or negative effects on the four dimensions of food security: availability; access; utilization, and stability.

In order to ensure that modern bioenergy development is sustainable and that it fosters rural development and food security, countries need to address the risks associated with this development. The set of good environmental and socio-economic practices and the related policy instruments that the Bioenergy and Food Security Criteria and Indicators (BEFSCI) project has compiled can help countries prevent and manage these risks (FAO 2012b, 2012c and 2012d).

Once the modern bioenergy sector is in place, it is important to assess and respond to the impacts of bioenergy on food security. To this goal, as described in this report, BEFSCI has developed a set of indicators that can be used to **assess the impacts of bioenergy on food security at both national and project levels**.

With regard to the national level, BEFSCI has contributed to the development of an **internationally-agreed indicator** for assessing the effects of bioenergy use and domestic production on the price and supply of a national food basket. As described in the second chapter, the measurement of this indicator consists of two main steps, the second of which includes three tiers, which provide a range of increasingly complex approaches for the evaluation of the effects of bioenergy production and domestic use on the price and supply of nationally-determined food basket(s):

Step 1: Determine the relevant food basket(s) and its components.

Step 2: Assess the links between bioenergy use and domestic production and changes in the supply and/or prices of relevant components of food basket(s):

- Tier I: "Preliminary indication" of changes in the price and/or supply of the food basket(s) and/or of its components in the context of bioenergy developments resulting from collecting data on price and supply.
- Tier II: "Causal descriptive assessment" of the role of bioenergy (in the context of other factors) in the observed changes in price and/or supply.
- Tier III: "Quantitative assessment" using approaches such as time-series techniques and Computable General Equilibrium (CGE) or Partial Equilibrium (PE) modelling.

At the project level, BEFSCI has developed a tool that can be used to assess how an existing or planned agricultural operation with a bioenergy component may affect food security. The BEFSCI **Operator Level Food Security Assessment Tool**, which was described in the third chapter, consists of three parts:

1. Change in the supply of food to the domestic market.
2. Resource availability and efficiency of use.
3. Physical displacement, change in access to resources, compensation and income generation.

Each part includes a number of indicators, which address key environmental and socio-economic aspects of agricultural operations that are directly linked to one or more dimensions of food security.

For each indicator, specific thresholds and a scoring system are provided, based on the following three categories:

- Potential Benefit for Food Security.
- No Significant Influence on Food Security.
- Potential Risk to Food Security.

When negative impacts on food security are detected through the aforementioned indicators, in order to put in place adequate measures it is important to **identify and assess**, through specific tools and methodologies, the **drivers of these impacts**.

BEFSCI has compiled a set of 30 **tools and methodologies** that can be used 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, and which may have repercussions on food security (FAO 2012a). These tools and methodologies address a broad range of environmental and socio-economic dimensions related to food security, namely:

- biodiversity (including agrobiodiversity);
- soil quality;
- water availability and quality;
- woody biomass and residues;
- local food security;
- community development;
- energy security and local access to energy;
- gender equity, and
- cross-cutting issues (including employment, wages, income and smallholders inclusion).

In the BEFSCI report on tools and methodologies (FAO 2012a), the relevance of each of these dimensions for food security and how it may be impacted by modern bioenergy development is discussed.

Once the main drivers of the impacts on food security have been identified through the aforementioned tools and methodologies, the next step entails **verifying** the extent to which **good environmental and socio-economic practices** that can be beneficial for the environmental and socio-economic dimensions, negatively affected by bioenergy, have been – or could be – **implemented**. This can be done both for the sector as a whole and for individual operations.

Building on FAO's work on good practices in agriculture and forestry, the BEFSCI project has compiled a set of good environmental practices that can be implemented by bioenergy feedstock producers in order to minimize the risk of negative environmental impacts from their operations, and to ensure that modern bioenergy contributes to climate change mitigation while safeguarding and possibly fostering food security (FAO 2012b). These practices can improve both the efficiency and sustainability in the use of land, water and agricultural inputs for bioenergy production, with positive environmental and socio-economic effects, including a reduction in the potential competition with food production. In addition, these practices can minimize the impacts of bioenergy feedstock production on biodiversity and ecosystems, which provide a range of goods and services that are key for food security.

BEFSCI has also compiled, based on a producer survey, a set of good socio-economic practices that can help minimize the socio-economic risks and increase the opportunities associated with bioenergy feedstock production, with positive effects on food security (FAO 2012c).

Combined, the good practices that BEFSCI has compiled address all the main environmental and socio-economic dimensions relevant for food security that modern bioenergy development may impact. When the adoption of these practices in bioenergy feedstock production is measured, particular attention should be given to those that can be beneficial for the environmental and socio-economic dimensions that are found to be negatively affected by bioenergy through the assessments described above.

If the uptake of the aforementioned good practices is relatively limited, this might be due to the lack of an **enabling environment** and of proper policy incentives.

Most of the good practices that BEFSCI has compiled present various challenges and there are a number of both economic and non-economic barriers to their implementation. If proper policy instruments and incentives are not in place, the costs of implementing these practices might be too high for producers. Measures to reduce and possibly remove the non-economic barriers that limit the adoption of the aforementioned practices would be needed as well.

BEFSCI has identified a range of **policy instruments** that can be used by governments in order to require or promote good environmental and socio-economic practices in bioenergy feedstock production, such as biofuel mandates with sustainability requirements (FAO 2012d). If these instruments are already in place but the uptake of good practices remains low in the bioenergy sector, a revision of such instruments would be necessary, in order to strengthen their effectiveness and provide producers with proper incentives for the implementation of these practices, as well as disincentives for the bad practices.

In addition to being ineffective, the policy instruments in place could have unintended negative effects, including on food security.

When negative impacts on food security are detected, after the additional steps described above have been carried out, an overall **revision** of the **bioenergy policy** in place and of the associated targets and instruments might be necessary.

Bioenergy policies and targets should be based on a sound information set and on a thorough assessment of the natural resource base, of the viability of domestic bioenergy production and use, and of the environmental and socio-economic implications of different bioenergy development pathways.

FAO's **Bioenergy and Food Security (BEFS)** project has developed an **Analytical Framework (AF)** in order to help countries develop this information set and make informed decisions with regard to the establishment of the domestic bioenergy sector (FAO 2010). The BEFS AF, which has been applied in a number of countries, consists of four main components and related tools:

- Diagnostic Analysis: Agricultural Outlook.
- Natural Resources Analysis.
- Techno-Economic and Environmental Analysis.
- Socio-Economic Analysis.

If the bioenergy policy and the associated targets are already in place and negative impacts from the bioenergy sector are identified, the BEFS AF could be used to inform the revision of such policy and targets.

In addition, in the shorter term, when modern bioenergy development is found to have negative impacts on food security, for instance by contributing (among other factors) to an increase in agricultural commodity prices, a certain degree of at least temporary flexibility could be introduced into bioenergy policies in order to reduce their volatility-exacerbating effects.

In recent years, several countries (particularly within the G20) have put in place a number of instruments in order to stimulate biofuel production and use, such as subsidies, tax expenditures and mandates. These instruments can be designed so as to make bioenergy policies flexible. For instance, among the options that have been considered for introducing such flexibility, biofuel mandates and/or subsidies could be made conditional on prices or inventories, and could be "automatically" reduced, at least on a temporary basis, if the level of that variable passes a given threshold. Clear and predictable rules and procedures would need to be designed in order to ensure the effectiveness, efficiency and transparency of such mechanism. Alternatively, governments could purchase call options on grain from biofuel producers, to be exercised when a food crisis occurs, according to pre-defined criteria and based on clear and predictable rules and procedures as well (FAO *et al.* 2011).

This flexibility could contribute to the alignment of bioenergy policies with food security policies and objectives. The aforementioned mechanisms, however, present a number of technical, operational and political economy problems that should be further researched and analysed, also in order to shed light on their possible effects.

One of the main factors affecting the viability of these mechanisms in a certain country is the degree of technological and economic flexibility of the bioenergy sector, both on the production and on the consumption side. If this flexibility is relatively high, with technological pathways and business models allowing the same plant to produce food and/or fuel from the same feedstock (and possibly from other feedstocks as well) – on the production side – and with flexible fuel vehicles allowing biofuels and fossil fuels to be mixed in any proportion on the consumption side, flexible bioenergy policies could be a viable option. On the other hand, if this flexibility is limited or completely lacking, the bioenergy sector might not be able to cope with flexible policies and the resulting market uncertainty. In this case, the potential negative effects on the sector and the associated repercussions in terms of economic development and employment (which are very important for food access) should be carefully evaluated and weighed against the potential benefits of flexible bioenergy policies.

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FAO BEFSCI OPERATOR LEVEL FOOD SECURITY ASSESSMENT TOOL - VERSION ONE

Operation Overview	
Name (Company/Sponsor/Organization)	
Bioenergy feedstock(s)	
Total hectares	
Latitude/Longitude	

Key	
	Potential Benefit for Food Security
	No Significant Influence on Food Security
	Potential Risk to Food Security

For each food basket item supplied by the operation and by the same area prior to the operation, insert data below

1. CHANGE IN THE SUPPLY OF FOOD TO THE DOMESTIC MARKET

1,1 Former/current land-use (prior to operation)

	Yes/No	hectares
Subsistence agriculture		
Commercial agriculture		
Livestock grazing		
Fallow land		
Others (specify)		

1,2 Supply of food basket items prior to the operation

Yes, input data below	
No, proceed to indicator 1.3	

CROPS	Production (tons)	Export ratio* (0.00)	Domestic supply (tons)
Cereals and tubers	75	0,2	60
Pulses			0
Sugar crops			0
Oilseeds			0
Vegetables			0
Fruit			0

LIVESTOCK	Slaughtered animals** (heads)	Live weight (Yield*** in 0.1 gr)	Carcass percentage**** (0.00)	Production** (tons)
Meat (small animals)	10	2217	0,2	0,0004434
	Slaughtered animals** (heads)	Live weight (Yield*** in hectograms)	Carcass percentage**** (0.00)	
Meat (large animals)	10	250	0,4	0,1
	Producing animals (heads)	Yield*** (hectograms per animal)		
Milk	50	25000		2,5
	Producing animals (heads)	Yield*** (grams per animal)		Production** (grams)
Eggs				

1,3 Supply of food basket items from the operation

- Yes, input data below
- No, proceed to part 2

CROPS	Production (tons)	Export ratio* (0.00)	Domestic supply (tons)
Cereals and tubers	75	0,2	60
Pulses			0
Sugar crops			0
Oilseeds			0
Vegetables			0
Fruit			0

LIVESTOCK	Slaughtered animals** (heads)	Live weight (yield*** in 0.1 grams)	Carcass percentage**** (0.00)	Production (tons)
Meat (small animals)	10	2217	0,2	0,0004434
	Slaughtered animals** (heads)	Live weight (yield*** in hectograms)	Carcass percentage**** (0.00)	
Meat (large animals)	10	250	0,4	0,1
	Producing animals (heads)	Yield*** (hectograms per animal)		
Milk	50	25000		2,5
	Producing animals (heads)	Yield*** (grams per animal)		Production (grams)
Eggs				

1,4 Change in the supply of food basket items to the domestic market

CROPS	tons
Cereals and tubers	0
Pulses	0
Sugar crops	0
Oilseeds	0
Vegetables	0
Fruit	0

CROPS

Greater than 0	Potential Benefit for Food Security
Equal to 0	No Significant Influence on Food Security
Less than 0	Potential Risk to Food Security

LIVESTOCK	tons
Meat	0
Milk	0
	grams
Eggs	0

LIVESTOCK

Greater than 0	Potential Benefit for Food Security
Equal to 0	No Significant Influence on Food Security
Less than 0	Potential Risk to Food Security

*If data on exports for the specific area/operation considered is not available, use as a proxy the national average export ratio for each item, based on data on production and exports from FAOStat: http://faostat.fao.org/site/339/default.aspx (production); http://faostat.fao.org/site/342/default.aspx (exports).

** If the number of slaughtered animals is not available, assume all live animals for meat production (see report for further guidance) as slaughtered

*** If data on meat/eggs/milk yields for the specific area/operation considered is not available, find information on country, animal average yields at FAOStat: http://faostat.fao.org/site/569/default.aspx#ancor

**** If data on carcass percentage and/or carcass weight is not available, operators should enter the average dressing percentage based on available literature

2. RESOURCE AVAILABILITY AND EFFICIENCY OF USE				
2,1	**Land and Water Scarcity**			
	Insert GIS coordinates of operation, http://www.fao.org/fileadmin/templates/solaw/images_maps/map_5.pdf			
	No land and water scarcity			
	Low land and water scarcity			
	Moderate or High land and water scarcity			
2,2	**Land Use Management (check boxes for good practices implemented)**	**Yes/No**		
	Intercropping or Crop Rotation			
	No- or Minimum Tillage			
	Soil Cover			
	Integrated Pest Management			
	Integrated Plant Nutrient Management			
	Sustainable Irrigation			
	At least three practices			
	Up to two practices			
	None			
2,3	**Land Use Efficiency***	**National average yield**		
	Enter yield (tons) per hectare	Enter national average yield**	tons	
	75	80000	8	**(Converted from hectograms to tons)**
	Higher than national average of same crop			
	Equal to national average of same crop (within +/- 5%)			
	Lower than national average of same crop			
2,4	**Fertilizer Use Efficiency**			
	Fertilizer Application Rate (N, P, K)			
	50			
	National Average Application Rate***			
	75			
	Fertilizer Application Efficiency (Input/Output) (kg/tons)			
	0,666666667	**Fertilizer application rate/yield of operation**		
	National Average Application Efficiency (Input/Ouput) (kg/tons)			
	0,106666667	**National average fertilizer application rate/yield**		
	Relationship to national average input/output ratio			
	Lower than national average of same crop			
	Equal to national average of same crop (within +/- 5%)			
	Higher than national average of same crop			

* Crops grown on subsistence plots established by the operation should not be considered under this indicator

** Find information on national average yields at FAOStat: http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567

*** Find information on national average application rate at http://www.card.iastate.edu/publications/synopsis.aspx?id=1156

3.	**PHYSICAL DISPLACEMENT, INCOME GENERATION, COMMUNITY DEVELOPMENT, AND CHANGE IN ACCESS TO RESOURCES**						
3,1	Physical Displacement of Households	Yes, input data below					
		No, move to indicator 3.2					
			Yes	No			
A	Mechanism(s) to assess displacement (check box)	Satellite imagery					
		Census					
		Socioeconomic surveys and studies					
		Mapping of customary rights					
B	Mechanism(s) to design compensation	Free Prior and Informed Consent					
		Continuous consultation with affected stakeholders					
		Procedures to determine eligibility					
		Grievance mechanisms and arbitration framework established					
		Female headed households	Male headed households	Total number of households			
	Total number of households physically displaced	100	75	175			
	Total number of households receiving full compensation	110	115	225			
3.1.1	Displacement Compensation Ratio	110	153,3333333	128,5714286			
					100%	No Significant Influence on Food Security	
					Under 100%	Potential Risk to Food Security	
3,2	Displacement of Income through Land Acquisition (check box)	Yes, input data below					
		No, move to indicator 3.2.2					
			Yes	No			
A	Mechanism to assess displacement of income(check box)	Satellite imagery					
		Census					
		Socio-economic surveys and studies					
		Mapping of customary rights					
3.2.1	Individuals with Income Generating Activities Displaced		Female individuals	Male individuals	Total number of individuals		
		Subsistence plots					
		Contract or sale of goods and services					
		Wage employment					
		Land lease contract					
		Total	0	0	0		
3.2.2	Individuals Benefitting from Community Development/Income Generation as a Result of Operation	Subsistence plots					
		Contract or sale of goods and services					
		Wage employment					
		Land lease contract					
		Total	0	0	0		
3.2.3	Impact on Community Development/Income Generation	Income generation/displacement	#DIV/0!	#DIV/0!	#DIV/0!	105% (or more) of the number of individuals with activities displaced is benefitting from new activities	Potential Benefit for Food Security
						No significant impact (within +/- 5%)	No Significant Influence on Food Security
						Less than 95% of the number of individuals with activities displaced is benefitting from new activities	Potential Risk to Food Security

3,3	Displacement of Assets through Land Acquisition (check box)	Yes, input data below					
		No, move to indicator 3.3.2					
			Yes	No			
A	Mechanism to assess displacement (check box)	Satellite imagery					
		Census					
		Socio-economic surveys and studies					
		Mapping of customary rights					
B	Mechanism to assess increased access to assets (check box)	Satellite imagery					
		Census					
		Socio-economic surveys and studies					
		Mapping of customary rights					
			Female individuals	Male individuals	Total number of individuals		
3.3.1	Displacement of Assets or Access to Assets through Land Acquisition	Infrastructure (e.g. roads, bridges, community structures)	20	10	30		
		Natural resources (e.g. water)	30	15	45		
		Energy source/electricity	40	20	60		
		Agricultural inputs (e.g. seeds and fertilizers) and facilities (e.g. greenhouses and storage facilities)	10	10	10		
		Total	100	55	145		
3.3.2	Community Development through Increased Access to Assets	Infrastructure (e.g. roads, bridges, community structures)	15	20	35		
		Natural resources (e.g. water)	15	40	55		
		Energy source/electricity	15	60	75		
		Agricultural inputs (e.g. seeds and fertilizers) and facilities (e.g. greenhouses and storage facilities)	10	10			
		Total	55	130	165		
3.3.3	Impact on Access to Assets		55	236,3636364	113,7931034	105% (or more) of the number of individuals with displaced access to assets is benefitting from new/improved access to assets	Potential Benefit for Food Security
						No significant impact (within +/- 5%)	No Significant Influence on Food Security
						Less than 95% of the number of individuals with displaced access to assets is benefitting from new/improved access to assets	Potential Risk to Food Security

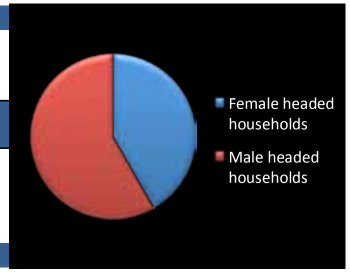
Operation Overview	
Name (Company/Sponsor/Organization)	
Bioenergy feedstock(s)	
Total hectares	
Latitude/Longitude	

Key	
	Potential Benefit for Food Security
	No Significant Influence on Food Security
	Potential Risk to Food Security

1. CHANGE IN THE SUPPLY OF FOOD TO THE DOMESTIC MARKET			
1,1	Former/Current land-use (prior to operation)	hectares	
	Livestock grazing	10.000	
	Subsistence agriculture	2.000	
1,4	Change in the supply of food basket items to the domestic food market		tons
	CROPS	Cereals and tubers	10.000
		Vegetables	2.000
	LIVESTOCK	Meat	-5.000

2. RESOURCE AVAILABILITY AND EFFICIENCY OF USE		
2,1	Land and Water Scarcity	Low land and water scarcity
2,2	Land Use Management	At least three practices
2,3	Land Use Efficiency	Higher than national average of same crop
2,4	Fertilizer Use Efficiency	Higher than national average of same crop

3. PHYSICAL DISPLACEMENT, INCOME GENERATION, COMMUNITY DEVELOPMENT, AND CHANGE IN ACCESS TO RESOURCES			
3,1	Physical Displacement of Households		
A	Mechanism(s) to assess displacement	Satellite imagery	
B	Mechanism(s) to design compensation	Continuous consultation with affected stakeholders	
3.1.1	Displacement Compensation Ratio	150%	Disaggregated by gender
3,2	Displacement of Income through Land Acquisition		
A	Mechanism(s) to assess displacement of income	Socio-economic surveys and studies	
3.2.3	Impact on Community Development/Income Generation	110%	Disaggregated by gender
3,3	Displacement of Assets through Land Acquisition		
A	Mechanism(s) to assess displacement	Mapping of customary rights	
B	Mechanism(s) to assess increased access to assets	Socio-economic surveys and studies	
3.3.3	Impact on Access to Assets	-2%	Disaggregated by gender



Summary of results

Potential Benefit to Food Security	No significant influence on food security	Potential Risk to Food Security
Change in the supply of food basket items (crops) to the domestic market	Land and Water Scarcity	Change in the supply of food basket items (livestock) to the domestic market
Land Use Management	Displacement Compensation Ratio	Fertilizer Use Efficiency
Land Use Efficiency		
Impact on Community Development/Income Generation		

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ENVIRONMENT – CLIMATE CHANGE – BIOENERGY – MONITORING AND ASSESSMENT

FAO - ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER

FAO's Bioenergy and Food Security Criteria and Indicators (BEFSCI) project has developed a set of indicators that can be used to assess the impacts of bioenergy on food security at both national and project levels. In addition, BEFSCI has identified a range of possible responses to these impacts.

Modern bioenergy development, through its environmental and socio-economic impacts, may have positive or negative effects on the four dimensions of food security: availability; access; utilization, and stability.

In order to capture the complex relationship between bioenergy and food security and determine how the former affects the latter, assessments of the impacts of bioenergy on food security need to be carried out at both national and project levels, taking into account the international dimension as well.

If negative impacts are identified through these assessments, appropriate responses should be implemented.

The indicators that the BEFSCI project has developed can be used to carry out such assessments. With regard to the national level, the BEFSCI report describes an indicator for assessing the effects of bioenergy use and domestic production on the price and supply of a national food basket. With regard to the project level, BEFSCI has developed a tool that can be used to assess how an existing or planned agricultural operation with a bioenergy component may affect food security.

The BEFSCI report describes also a range of possible responses to address the impacts identified through the aforementioned indicators at both national and project levels.




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