CHAPTER 2

# AGRICULTURE, BIOENERGY AND FOOD SECURITY: USING BEFS TO GUIDE AGRICULTURAL CHANGE

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## 2. INTRODUCTION

### Agriculture: the need for regeneration

A potent argument for bioenergy development lies in the ability of the sector to unlock agricultural potential by bringing in much needed investments to raise agricultural productivity for the benefits of food security and poverty reduction. By providing the tools that test this thesis, the BEFS project can support the policy machinery in its consideration of whether bioenergy should be pursued and if so how. The starting point for the BEFS analytical framework is the recognition that agriculture remains an important sector for the livelihoods of the most vulnerable and poorest populations. Bioenergy is just one instrument amongst an array of other possible measures that may regenerate agriculture. The project therefore should not be seen as an endorsement of bioenergy. Ex ante, it is not possible to either support or reject bioenergy in a given context. What the BEFS tools offer are an exploration into bioenergy potential for the public good. Thus BEFS extends beyond a feasibility study of the sector. Instead it offers an integrated approach to analysing bioenergy potential that combines the technical viability/ feasibility of the sector with the social and economic objectives prevailing in the development agenda of Tanzania. Specifically, the project considers whether the agricultural sector firstly has the capability to support bioenergy developments and if so, can it do so for the benefit of the poor. The feasibility component of BEFS differs from the kind of feasibility analysis carried out by the private sector where principles of profit maximization dominate. By contrast, the BEFS feasibility component deliberately considers the extent to which the inclusion of smallholders in the industrial set-up can be cost competitive. This kind of analysis may provide strong support to governments in the dialogue with the private sector and can support to some extent the harmonization of private objectives with broader social objectives.

### The food and energy nexus

The advantages for promoting biofuels in Tanzania are numerous. The diversification of domestic energy supply would lead to increased energy security as well as hedge against energy price fluctuations, overcome energy access shortages and the resulting negative effects on overall development. As Tanzania is a net importer of oil, domestically produced biofuels may remove some of the uncertainty associated with development budgets because of reductions in the oil import bill while increasing foreign exchange savings. The returns generated by the industry could have a positive impact on food security especially if smallholders in rural areas play a key role in supplying feedstocks. Moreover, the dependency on firewood for fuel needs would be reduced. As women

have the primary responsibility for gathering firewood, new energy sources would release their time for other more remunerative activities with positive effects for their food security. The development of agro-industry can offer new rural employment opportunities. The combined effect would be to increase the standard of living of the rural poor and also improve the linkages between agriculture and other sectors in the economy. Understandably there are concerns about biofuels because of the competition it creates for the resources needed to produce food crops. Secondly, given the interests of largely private investors there is a risk that smallholders may be overlooked in biofuel developments in favour of large-scale production units. These are valid concerns. However, the issue is less about food-feedstock competition but rather one of how to regenerate a stagnant agricultural sector so that yields increase improving the incomes of poor farmers. Maintaining the status quo of Tanzanian agriculture is not an option. This will not improve livelihoods nor will it protect natural ecosystems. The integration of food crops with biofuel production could offer a solution for sustainable land use. Capital, technology transfer and capacity building are essential ingredients of an agricultural revolution. Biofuel investors can bring in these necessary requisites to Tanzanian agriculture to address both food and energy security.

While biofuel production and processing in Tanzania is in its infancy, in the future there is scope that with the right policies the many smallholders that characterize Tanzania's agricultural landscape may be more involved in biofuel crops. The challenge will be one of how to integrate them in the value chain. Clearly, leaving the industry entirely to market forces could isolate smallholders. Much depends on the route which bioenergy development takes. A poorly considered bioenergy development path could bypass smallholders and severely compromise the food security of the poor. Thus, for Tanzania the key consideration is how best to manage the process of biofuel development in order to maximize potential gains and minimize the costs. The BEFS tools are one instrument that can help guide the policy process in deciding the best pathway for biofuel development.

## 2.1 UNDERSTANDING THE EFFECTS OF BIOENERGY ON FOOD SECURITY

1. Bioenergy can impact on food security through changes in incomes and food prices. Income is an important element in the food security status of the poor. Income influences both the quantity and quality of food purchased by households. The exact effects of food prices on food security are more complex and require an understanding of whether households are net food producers and net food consumers. In general, higher food prices hurt net food consumers but farmers who are net food producers are likely to benefit from higher prices and increase their incomes, other things being equal. Some people will find they are better off while others are worse off.

2. Bioenergy production is likely to compete for inputs with food production. The main inputs are land, labour, water and fertilizer. Food crops that are used for bioenergy production compete directly with food supplies. In addition, competition for inputs

places an upward pressure on food prices, even if the feedstock is a non-food crop or is grown on previously unused land. The competition for inputs depends on agricultural efficiency which is a function of agricultural investment. The right agricultural management practices coupled with investment could allow for increased food production using fewer resources for a given amount of bioenergy. A system that allows for synergies between food and energy production could improve yields of food crops while addressing energy demand.

3. Bioenergy developments place particular pressures on smallholders and the rural poor. Increased demand for food crops generated by the biofuel sector could lead to increased food prices. The sheer speed of biofuel expansion may generate new pressures on land tenure arrangements, leading to alienation. Poor households may feel pressured to sell their lands or be forced to relocate in the rush to meet the increasing demands of the bioenergy sector for feedstocks. This has happened to some degree in Mukuranga. Contractual arrangements with large-scale biofuel producers could potentially disadvantage smallholders unless comprehensive legal structures exist to protect their rights. With the development of new second generation technologies, the first generation technologies developed in Tanzania may become non-competitive. Finally, much depends on the long-term price trajectory of fossil fuels. Should these come down permanently, the biofuel sector would not be able to compete.

## 2.2 BIOENERGY, THE ENVIRONMENT AND FOOD SECURITY

Bioenergy development, through its effects on the environment, affects food security indirectly in a number of ways. Environmental constraints can limit the biophysical and technical production of bioenergy and food. Water is a limiting factor in energy crop production. However, where bioenergy crops are grown on marginal land this may improve the quality of the land making previously unproductive agricultural land productive. This has implications for local incomes. Ex ante, it is difficult to say whether the effects of bioenergy on the environment have positive or negative effects. This can only be considered at very local levels. However, there are a number of issues relevant for food security.

1. Sensible use of agrochemicals and fertilizers can increase crop yields. However, widespread use of these inputs has adverse effects on land and water quality. Excessive applications of fertilizer reduce water quality. How agriculture is managed is critical for sustainable food production.

2. Food and bioenergy production face water constraints on their production. Understanding the water needs of crops and how this need can be beneficially altered under diverse agricultural management systems is an important step to maintain and even augment agricultural production be it for food or for bioenergy. Irrigation and new biotechnology can increase yields of crops for food and bioenergy production and should be considered as part of a larger agenda for agricultural improvement.

3. How land is used and for what purpose affects long-term soil productivity. Different crop production techniques alter the soil quality. Soil quality is also affected by livestock grazing which may have implications for the productivity of new lands brought under crops. Intensive agricultural practices deplete the soil of nutrients rapidly impacting on productivity and food availability. Consequently, lower productivity affects the availability of food resources. Some bioenergy crops, notably jatropha, can be grown on poor or marginal lands which can contribute to the improvement of soil quality extending the total area of land under crop production. However, it should be noted that the evidence for the long-term viability of jatropha is largely absent. Whilst in theory it appears to do well on marginal lands much more research is needed to consider the degree to which jatropha can be scaled up and whether productivity levels can be enhanced even on poor lands.

The food and energy nexus is complex especially for a poor country such as Tanzania. Although, global food and oil prices have started to come down, future high prices remain a concern for the country. A focus on agricultural development in Tanzania is critical in order to achieve long-term sustained food security. Can a bioenergy sector serve as a catalyst for wider agricultural growth and development? Bioenergy may yield higher returns on investment compared to conventional agriculture. This could lead to an overall increase in rural investment, making capital available for enhancing agricultural productivity levels of all production systems but particularly those of food. Feedstocks such as sugar cane, cassava and sunflower can be sold in both food and fuel markets and so hedge against the risk of failure in energy markets in particular. Environmental degradation and loss of biodiversity can be reduced depending on the bioenergy system developed.

The Government of Tanzania is enthusiastic about the potential benefits of bioenergy and is doing much to help facilitate new investment in the sector and to ensure that poor farmers are not bypassed (see Chapter 3). The BEFS analysis of Tanzania provides some important directions for policy while the BEFS tools can be used to incorporate new concerns in the analysis of bioenergy. These are discussed in the next sections.

## 2.3 THE BEFS APPROACH

In order to assist countries in the development of a food secure bioenergy industry, the BEFS project has developed an assessment approach to analyse the impacts of bioenergy developments on food security. The approach uses real country data to run the assessment.

BEFS mainly focuses on **food availability and access**, the strongest links between bioenergy production and food security. While there are clear concerns with respect to utilization and nutrition and price stability, the complexity of the analysis does not permit a full examination of these dimensions. However, as all four dimensions are interlinked, addressing food availability and access will ultimately affect nutrition and long-term food access.

Within the BEFS approach there are two key elements to the BEFS assessment, namely:

a. ***The feasibility of producing bioenergy***
This element of BEFS allows the country to identify:

- the areas potentially most suitable for bioenergy production;
- which production chains are technically viable and most competitive;
- how to integrate smallholders competitively into bioenergy production.

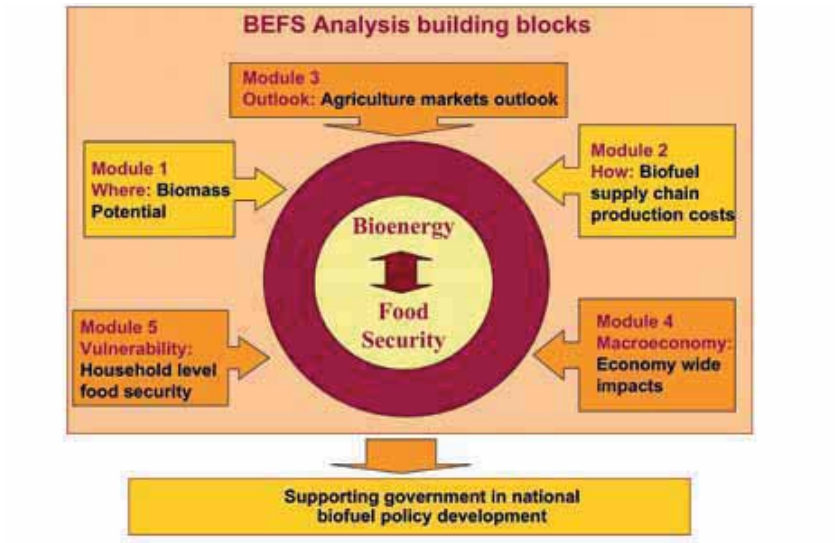
b. ***The economy wide and food security viability of bioenergy development***
This element of BEFS allows the country to assess:

- whether bioenergy developments in the country can lead to economic growth and poverty reduction;
- which trade-offs may be in place;
- what the agriculture markets outlook is and how bioenergy might impact this;
- household level food security and vulnerability;
- food-feedstock competition areas.

In order to achieve this, BEFS uses an Analytical Framework which consists of five building blocks, namely *Module 1: Biomass Potential, Module 2: Biofuel Supply Chain Production Costs, Module 3: Agriculture Markets Outlook, Module 4: Economy-wide Effects, Module 5: Household-level Food Security.*

Figure 2.1 illustrates the questions answered by each module.

FIGURE 2.1
**The BEFS Approach.**



These five technical components of BEFS form ***a technical basis that can feed in and support development of bioenergy policies and regulations in Tanzania*** and places policy-makers in the position to make informed decisions. In particular, the BEFS tools are designed to help answer the following key question for guiding bioenergy policies:

### 2.3.1 THE FIVE MODULES OF THE BEFS APPROACH AND ITS QUESTIONS

*Module 1: Biomass Potential*

The analysis in Module 1 allows stakeholders to understand better the extent and location of areas suitable for bioenergy crop production under different agricultural production systems and level of inputs. The crops analysed in this module are cassava, sunflower, sugar cane, sweet sorghum and palm oil. Once the crop suitability has been determined, productivity and long-term sustainability of bioenergy developments can be assessed. Overall this will allow stakeholders to structure their land use planning strategy including for bioenergy developments, while identifying key food production areas.

This Module will help:

- identify the areas suitable and available for growing the relevant bioenergy crops;
- establish production and yields of different biofuel crops;
- illustrate the advantages and disadvantages of different agricultural production systems;
- establish in which areas there might be a conflict between food and bioenergy production.

*Module 2: Biofuel Supply Chain Production Costs*

Module 2 assesses bioenergy productions costs. Five feedstocks have been analysed in this Module, namely molasses, cassava, palm oil and jatropha. Each feedstock is assessed under different processing systems given the following conditions:

- stand alone versus integrated mill and refinery;
- plant scale: large, medium or small;
- feedstock origin: (a) commercial, (b) outgrowers (c) a mix of these two.

Based on the relevant mix of the above points, Module 2 evaluates the technical and economic viability of biofuel production given the local knowledge base and manufacturing capacity. This Module will allow stakeholders to determine which biomass supply chain is technically and economically feasible in Tanzania and to what degree outgrowers can be included; an important component within poverty reduction strategies.

This Module will help assess:

- costs of production of the biofuel at the factory gate and distribution to domestic and international markets;
- accessibility of technology and availability of infrastructure and the required human skills;

- opportunities for rural development through production systems inclusive of outgrower and combined plantations-outgrower schemes;
- processing of waste by-products into valuable co-products focusing on use in local settings.

*Module 3: Agriculture Markets Outlook*

Module 3 focuses on domestic agriculture markets and can assist Tanzania in understanding the impact of international and domestic biofuel policies on its domestic markets. The Module is based on an OECD-FAO outlook tool that assesses the impact of policies for a ten-year outlook period. The analysis presented investigates the impacts of domestic and international bioenergy developments on domestic food production trends. This Module gives stakeholders an understanding of how international and domestic policies on biofuels may impact the domestic industry with implications for food security.

This Module will help assess:

- what is the domestic market outlook;
- what is the impact of bioenergy development on the domestic agriculture market;
- what is the influence of international policies.

*Module 4: Economy-wide Effects*

Module 4 builds on the results of production costs derived in Module 2 and links them to the national economy of Tanzania. From a policy perspective, it is important to assess whether the implementation of a new sector, such as bioenergy, can be beneficial for economic growth and poverty reduction. In order to strategically target poverty reduction, linking the production costs results to the economy-wide effects can help policy-makers consider the necessary interventions needed to include small-scale outgrowers in the development of the sector and the preferred combination of large-scale estate and the small-scale outgrowers scheme. This Module utilizes a Computable General Equilibrium model of Tanzania's economy. The structure of the model includes a detailed breakdown of the agricultural sector and of the other sectors of the economy. The bioenergy sector competes for resources (land, labour, inputs and capital) and is initially very small. The sector consequently grows due to investments in the sector. Biofuel scenarios differ according to their production technologies and strategies, namely feedstock, scale of feedstock production and intensive versus extensive strategies.

This Module will help assess:

- the economy-wide trade-offs bioenergy poses;
- which bioenergy production chain is most growth enhancing;
- which bioenergy production chain is most poverty reducing;
- which sector loses and how the allocation of resources change.

*Module 5: Household-level Food Security*

Developing a domestic biofuel sector takes time. The establishment of a new industry typically requires a medium- to long-term perspective. However, households, in the short term can still suffer food security impacts because of international price movements, some of which may be caused by biofuel policies being implemented elsewhere. It is important to realize that, while there may have been no significant bioenergy developments within the country to date, international biofuel mandates have been gaining steam. Changes in food prices derive from international and domestic supply and demand shocks which include additional biofuel demand. In the short term, household food security is affected by the increase in food prices. From a policy perspective, it is necessary to understand how the price changes can impact the *country as a whole* and which price changes the poorer segments of the population are most vulnerable to. We initially assess which price changes the country is most vulnerable to by investigating the country's macroeconomic net trade position by crop. Secondly, we look at actual price movement in key food crops over relevant time periods.

This Module will help assess:

- the most important food crops;
- recent price trends in key food crops;
- which price changes the country as a whole is most vulnerable to;
- which are the most vulnerable segments of the population.

## 2.4 BEFS IN TANZANIA: THE POLICY ISSUES

Before deciding on how to realize a bioenergy sector it is important to understand the full range of net impacts of bioenergy pathways on food security issues. The BEFS tools allow for a comprehensive analysis of how different bioenergy pathways can affect poverty and food security. In doing so BEFS can help inform and shape the direction of policy so that it promotes a sector that contributes to inclusive growth and development.

There are a number of conditions that influence bioenergy development at national level. These are:

- the agro-ecological and agro-edaphic conditions and availability of land resources;
- the suitability, productivity and production potential of various biofuels feedstock;
- the technical capabilities needed for the biofuels industry.

These factors determine the *where* and the *how* of setting up an industry. However, any consideration of these factors needs to be accompanied by an analysis of how bioenergy impacts on the agricultural sector, the wider economy and the household. Bioenergy developments have impacts on national food systems which could be positive or negative but require rigorous analysis to determine the precise nature of these effects. Suppose Tanzania chooses a particular pathway for bioenergy development based only on the biophysical and technical feasibility factors because this is the most cost-effective choice.

That pathway may have wider impacts on food security through adverse changes in prices, income and employment. Thus, knowing what the likely impacts *a priori* are of certain choices may alter the *where* and the *how* of bioenergy development. Policy instruments and institutional developments can be constructed in order to adapt to changes or shocks to the food system so that Tanzania's goals on food security and poverty reduction are not compromised.

## 2.5 THE BIOENERGY AND FOOD SECURITY CROP LIST IN TANZANIA

The analysis within the assessment addresses a number of bioenergy and food security crops. These crops will be the common thread throughout the analysis, although each Module may focus on particular crops because of the nature of the analysis as well as issues of data availability.

The list of bioenergy crops was put forward by the government and includes **cassava, sugar cane, palm oil, jatropha, sweet sorghum** and **sunflower**.

The key **food security crops** were selected on a per capita calorie consumption basis, (Table 2.1).

TABLE 2.1

**Calorie contribution by commodity for Tanzania.**

| Ranking | Commodity | Calorie share |
|---|---|---|
| 1 | Maize | 33.4 |
| 2 | Cassava | 15.2 |
| 3 | Rice (Milled Equivalent) | 7.9 |
| 4 | Wheat | 4.0 |
| 5 | Sorghum | 4.0 |
| 6 | Sweet Potatoes | 3.3 |
| 7 | Sugar (Raw Equivalent) | 3.3 |
| 8 | Palm Oil | 3.0 |
| 9 | Beans | 2.9 |
| 10 | Beverages, Fermented | 2.7 |
| 11 | Milk - Excluding Butter | 2.2 |
| 12 | Bovine Meat | 1.8 |
| 13 | Pulses, Other | 1.7 |
| 14 | Plantains | 1.5 |
| 15 | Millet | 1.4 |
| *Subtotal share for selected items* | | 88.5 |
| Total Calories per capita | | 1 959 |

*Source: FAOSTAT*

In order to identify the most important food security crops, crops were ranked based on their calorie contribution share. What this means is that the amount of calorie intake by crop for the country as a whole was determined. Based on the calorie contribution ranking, the crops that provide the highest share of calories in Tanzania are, in order of

magnitude, maize, cassava, rice, wheat, sorghum, sweet potatoes, sugar, palm oil, beans and plantains. For example, as shown in the Table, maize contributes 33.4 percent of calories to the country as a whole, 15.2 percent comes from cassava, 7.9 percent from rice, 4.0 percent from wheat and 4.0 percent from sorghum. Other crops all contribute less that 4 percent to calorie intake, as for example sweet potatoes, sugar, palm oil and beans. It can be noted that maize and cassava together provide households close to half of their calorie intake.

For completeness, Table 1 also includes non-crop food stuffs as, for example, dairy products and meat, nevertheless the table shows that access to livestock products remains limited.

An overview of the crops by Module is provided in Table 2.2

TABLE 2.2

**Crop list by Module of the BEFS Analytical Framework**

| Module 1 | Module 2 | Module 3 | Module 4 | Module 5 |
|---|---|---|---|---|
| Sugar cane, cassava, sweet sorghum (2 types), palm oil (2 types), sunflower | Sugar cane, cassava, palm oil, jatropha and molasses | Coarse grains (maize, wheat, sorghum), rice, roots and tubers (cassava, sweet potatoes), vegetable oils and jatropha | Cassava, sugar cane, molasses and jatropha | Mainly maize cassava and rice |