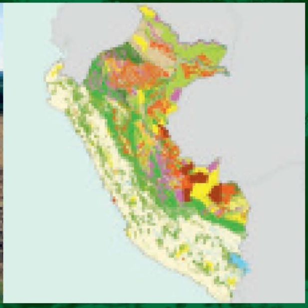
ISSN 2071 - 0992

40

Bioenergy and food security

The BEFS Analysis for Peru



Supporting the policy machinery in Peru

BEFS

ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER

ENVIRONMENT CLIMATE CHANGE [BIOENERGY] MONITORING AND ASSESSMENT

ENVIRONMENT – CLIMATE CHANGE – BIOENERGY – MONITORING AND ASSESSMENT

FAO - ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER

40

ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER

ENVIRONMENT CLIMATE CHANGE [BIOENERGY] MONITORING AND ASSESSMENT

Bioenergy and food security

The BEFS Analysis for Peru

Supporting the policy machinery in Peru

Edited by: Yasmeen Khwaja

BEFS

The Bioenergy and Food Security Project
Food and Agriculture Organization of the United Nations

FOREWORD

Bioenergy, and particularly liquid biofuels, have been promoted as a means to enhance energy independence, promote rural development and reduce greenhouse-gas emissions. In principle there are many benefits offered by bioenergy developments but these need to be balanced against the impacts on food security and the environment. While there has been a rush by many governments to develop bioenergy alternatives to fossil fuels this has often been done in the absence of a wider understanding of the full costs and benefits of bioenergy. In this context, the Food and Agricultural Organization of the United Nations (FAO) with generous funding from the German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) set up the Bioenergy and Food Security (BEFS) project to assess how bioenergy developments could be implemented without hindering food security.

The BEFS project is unique - in many ways ahead of its time. Usually projects focus on a single issue but BEFS sought to approach the problem of food security in an integrative and comprehensive manner. The project inherently understood that promoting food security through bioenergy or indeed any other instrument could not be done in a one-dimensional way. Rather it required balancing the many issues that have an effect on bioenergy and food security and considering them jointly to arrive at a set of considerations that better reflected reality and could support policy in a more meaningful way. The project developed an analytical framework comprised of a series of technical analyses which allows for a holistic assessment on bioenergy development and food security. This analytical framework has been implemented in Peru, Tanzania and Thailand.

The analysis presented in this document describes the implementation of the BEFS Analytical Framework in Peru. The analysis provides an entry point into the issues surrounding bioenergy and food security. The results arising form the analysis should not be seen as definitive but they do provide strong direction in terms of identifying the policy priorities. As part of the activities under the project training is provided to build in-country capacity in the use of the BEFS tools so that the analysis may be repeated and extended to reflect the prevailing policy priorities and also to support policy adjustments as the bioenergy sector evolves.

Roberto Cuevas García
FAO Representative Peru

Heiner Thofern
BEFS Project Coordinator FAO Rome

ACKNOWLEDGEMENTS

The diverse nature of the technical analysis in Peru has emphasised many important policy issues. This policy compendium would not have been possible without the support from a number of people, institutions and NGOs who have engaged in an important discussion with the policy team that has built on the results of the technical analysis carried out in Peru.

We give special thanks to Roberto Cuevas García, the FAO Representative to Peru, and Heiner Thofern, the BEFS Project Manager, for all their support and encouragement.

This compendium is the outcome of the collaboration between the BEFS Technical and Policy Teams in Peru who provided their expertise, support and advice in guiding the policy work. In addition, the policy team received valued advice and comments from representatives of various government ministries, institutions and NGOs. Particular thanks goes to: Víctor Barrena, Marianella Crispín, Jaime Fernández-Baca, , Henry García, Jaime Gianella, Ana Cecilia Gutiérrez, Salomón Helfgott, Cayo Ramos Taipe, Alfredo Rivera, Silvana Vargas and the Laboratorio de la Telemetría de la Universidad de Molina, Juan Carlos Ocaña Canales, Roxana Guillén Quispe, Ethel Rubín de Celis Llanos.

The following colleagues were instrumental in developing the work of the BEFS project in Peru: Manuel Villavicencio, Jazmine Csafranca, Alberto Garcia, Erika Felix, Yasmeen Khwaja, Irini Maltsoglou, Mirella Salvatore, David Dawe, Miguel Trossero, Fernando Chanduvi, Peter Wobst, Carlos Ariel Cardona Alzate, Luca Tasciotti, Noelia Flores, Mario Bloise, Michela Marinelli, Scott Pellow, David Laborde (IFPRI) and Perrihan Al-Riffai, (IFPRI).

The policy team is especially grateful to Stephanie Vertecchie, Antonella Pallaoro, Paola Correa, Walter Coronado, Ursula Moscoso, Fredy Salazar and Ligia Calderon who provided invaluable administrative and communication support.

CONTENTS

1 1. EXPLAINING THE CONTEXT OF THE BIOENERGY AND FOOD SECURITY PROJECT IN PERU

1 1.1 INTRODUCTION

2 1.2 AGRICULTURE, BIOENERGY AND FOOD SECURITY IN PERU

4 1.3 BIOFUEL AND BIOMASS

5 1.4 FOOD SECURITY AND POVERTY

5 1.5 BEFS - SUPPORTING RURAL DEVELOPMENT AND FOOD SECURITY IN PERU

7 1.6 USING BEFS TO SUPPORT THE POLICY MACHINERY IN PERU
7 1.6.1 Agriculture markets outlook in Peru
7 1.6.2 Natural resource analysis in Peru
7 1.6.3 Liquid biofuel production costs in Peru
8 1.6.4 Socio economic Analysis in Peru

8 1.7 POLICY CONSIDERATIONS

10 1.8 USING THE TECHNICAL WORK AS A BASIS FOR ORIENTING POLICY
10 1.8.1 Key outputs in the BEFS project in Peru

11 1.9 CONCLUDING REMARKS ON BEFS IN PERU

13 2. UNDERSTANDING THE BIOENERGY AND FOOD SECURITY POLICY LANDSCAPE IN PERU

13 2.1 CONTEXT OF THE BEFS PROJECT IN PERU

16 2.2 AREAS IN WHICH BEFS PROGRESS INTERACTS WITH OTHER GOVERNMENT INITIATIVES

18 2.3 BIOENERGY AND FOOD SECURITY

21 2.4 BIOENERGY AND SOCIAL CONFLICTS

23 2.5 BIOFUEL REALITY IN THE REGIONS OF PERU

25 **2.6 SITUATION OF SPECIFIC TYPES OF BIOFUEL**
25 2.6.1 Liquid biofuels
31 2.6.2 Solid biofuels
32 2.6.3 Gaseous Biofuels

35 **2.7 CONCLUDING REMARKS**

39 **3. USING THE BEFS ANALYSIS TO INFORM BIOENERGY POLICY DEVELOPMENT**

39 **3.1 INTRODUCTION**

41 **3.2 HOW BEFS INFORMS POLICY**

44 **3.3 USING THE BEFS RESULTS FROM PERU TO INFORM POLICY**
44 3.3.1 Agricultural market outlook
45 3.3.2 Natural Resources analysis
54 3.3.3 Liquid biofuel production costs
55 3.3.4 Socio economic analysis

59 **3.4 KEY THEMES EMERGING FROM THE PERU ANALYSIS**

60 **3.5 BIOENERGY AND BIOFUEL KEY MESSAGE FOR RURAL DEVELOPMENT**

62 **3.6 HOW CAN BEFS SUPPORT LONG-TERM POLICY THROUGH ONGOING DIALOGUE?**

64 **3.7 CONCLUDING REMARKS**

67 **4. RURAL DEVELOPMENT AND BIOENERGY: AN ALTERNATIVE APPROACH**

67 **4.1 INTRODUCTION**

67 **4.2 DISCUSSION**

71 **4.3 CONCLUDING REMARKS**

CHAPTER 1

EXPLAINING THE CONTEXT OF THE BIOENERGY AND FOOD SECURITY PROJECT (BEFS) IN PERU

Yasmeen Khwaja

1.1 INTRODUCTION

Bioenergy, and particularly liquid biofuels, have been promoted as a means to enhance energy independence, promote rural development and reduce greenhouse-gas emissions. In principle there are many benefits offered by bioenergy developments but these need to be balanced against the impacts on food security and the environment. While there has been a rush by many governments to develop bioenergy alternatives to fossil fuels this has often been done in the absence of a wider understanding of the full costs and benefits of bioenergy. The impacts of bioenergy, and more specifically biofuels, on food prices, economic growth, energy security, deforestation and climate change vary by feedstock, as well as the method and location of production. This makes it difficult to draw general conclusions about the net impacts of bioenergy which can hinder sound policy development. However, a critical issue lies in the ability of the bioenergy sector to use the natural resources on which it depends in a sustainable manner and for the benefit of those communities that rely on this natural resource base for their livelihoods. Policy development for bioenergy requires concerted and coordinated strategies across a number of sectors from agriculture to environment to energy to public works.

Throughout most of the developing world agriculture plays a critical role in supporting the livelihoods of the very poor. This is even the case where agriculture represents a relatively small proportion of GDP. In the last 50 years the importance given to agriculture by many developing country governments has dwindled. Perversely cheap global food prices removed the incentive for long-term investment in agriculture resulting in structural stagnation within the sector. This stagnation became painfully evident in the food crisis that started in 2005 and peaked in 2008, and represented the first serious global food crisis for three decades. What emerged was a renewed and wider recognition of the essential role played by agriculture in supporting the food and livelihood needs of the poor. Since then there have been serious concerns over the promotion of bioenergy because of the competition the sector creates for resources used for food production and environmental preservation. The effect of biofuel production on food prices remains a major cause for concern. High prices for key agricultural crops can have negative impacts on developing countries, especially those that are highly dependent on imports to meet their food requirements. The extent to which higher crop prices hurt or help poor people in developing countries varies depending on their net position as producer or consumer.

Even though agriculture contributes very little to GDP in Peru compared to other developing countries, it has a critical role in supporting the livelihoods of the very poor and ensuring their food security. However, agriculture is an untapped sector with lots of potential and its relatively poor productivity is strong argument for governments to find a range of alternative measures that boost not only this sector but rural development in general. Even though the contribution of agriculture sector to GDP is 8percent, the sector remains important for rural populations dependent either directly or indirectly on the sector. Peru has enacted a national liquid biofuel strategy. The concern is that in meeting the mandates set for ethanol and biodiesel, the poor may be bypassed. The key question is one of whether this mandate can be met simultaneously the promotion of some socio-economic objectives. The BEFS tools serve to examine if and how smallholders can play an important role in helping to meet the mandate. Peru has three distinct regions where the natural geography inevitably underpins the manner of development. All three regions practise agriculture but it is clear that a one-size-fits-all agricultural/bioenergy policy cannot work in Peru. The emphasis in Peru needs to centre on a full consideration of the portfolio of options that bioenergy presents. Thus, the bioenergy debate must extend beyond the production of liquid biofuels to consider also alternative energy sources using sustainable woody biomass and residues or by-products generated in the agriculture and forestry sectors. The creation of local energy provision using "free" biomass resources from residues can do much for poverty reduction by providing cheaper energy and also offering new income earning opportunities.

The BEFS project analyses the extent to which bioenergy can be an instrument to enhance agricultural productivity for the benefit of the poorest groups which includes smallholders. It is not an *ex ante* endorsement of bioenergy but rather an exploration into whether a bioenergy sector can be economically viable and if so, can the sector be structured in a way that delivers on socio-economic fronts. This policy compendium is structured as follows. This chapter, (Chapter 1) presents the context of the Bioenergy and Food Security Project in Peru. Chapter 2 considers the Bioenergy and Food Security Policy landscape in Peru in order to contextualise the policy setting against which the BEFS analysis takes place. Chapter 3 provides a discussion on how the use of the BEFS analysis in Peru and the tools developed. Finally chapter 4 presents a discussion that helps orient bioenergy policy for sustainable development.

1.2. AGRICULTURE, BIOENERGY AND FOOD SECURITY IN PERU

The performance of the Peruvian economy is very much a function of the geography of the country. This is characterized by three distinct regions: an arid costal region (costa), the mountains of the Sierra (the Andes) dominating the central zone and tropical forest (the selva) to the north and east of the country bordering Colombia and Brazil. The metropolitan area of Lima is generally considered separately from these areas. Thirty six point four percent of the population lives in the costa areas, 38 percent in the Sierra, 23.7 percent in the Selva. Twelve percent of the total population lives in Lima. The most densely populated sub-regions are costa norte, sierra centro, sierra sur and Lima. Mining dominates the Peruvian economy and in the period 2002-2009 the growth rate moved from 4 percent to an impressive 9 percent. High world prices for minerals and metals and a policy on sustained trade liberalization helped to stimulate the economy although this rate of growth fell slightly as a result of the global recession of 2009.

High growth rates of recent years helped reduce the national poverty rate by 15 percent between 2002 and 2008. However, there remains large disparity in income levels across segments of the population with a strong divide between rural and urban households. Poor household's income in rural areas is close to half of the urban poor. The food expenditure share for households in Peru remains a significant share of total expenditure. Overall households spend close to 40 percent of their income on food and this share increases substantively for the very poorest of the population. The poorest households spend 50 percent of their expenditure on food and in rural areas, this share amounts to three fifths of total household expenditure (see Household Analysis, chapter 8 in the BEFS Technical Compendia).

Most of Peru´s arable land is in the costa region where the bulk of agricultural production takes place in the river valleys along the costa. In the Sierra (Andean), agriculture is largely subsistence and in the Amazon (jungle) regions, agriculture has developed much more slowly although there are some exceptions[1] (see discussion in Land Suitability Analysis, Chapter 3 BEFS Technical Compendia). Total agriculture area is roughly 24 percent of total land area. Agricultural areas can be increased and there is the potential to do so but there is equally concern that this is at the cost of widespread deforestation. Forest areas cover 70 percent of total land and include the tropical rainforest of the Amazon. Climate plays an important role in Peru's agricultural development. The climate is tropical in the Amazon regions. By contrast, west of the Sierra Mountains drought is a serious problem. Agriculture is highly dependent on irrigation systems in the costa regions (See Land Suitability and Water Analyses in BEFS Technical Compendia, chapters 3 and 4 respectively). Peru's main food export crops are sugar and coffee. Potatoes, alfalfa and plantains are non-tradeables while poultry, rice, maize, and palm oil are among the main food imports. Most of the tradable crops are grown in the costa regions. The non-tradable crops are mostly cultivated in the Sierra and the Selva. Most farmers are small scale producers farming an average of 1-5 hectares and are found in the Sierra region. Small farms grow potatoes, maize and plantain while the large commercial farms and rice, sugar cane, maize, coffee, and alfalfa. Better access to financial and infrastructure services means that nearly all commercial agriculture is located along the costa.

In spite of strong macro-economic performance underemployment in Peru remains high and inflation exceeds the Central Bank's 1-3 percent target. A high dependence on minerals and metals means the economy's fortunes move with fluctuations in world prices. The extreme geography of the sierra and the Selva combined with poor infrastructure

1 San Martin in the Selva Region provides a notable exception to rural development strategies that center on raising agricultural productivity (see Chapter 3 of the Policy Compendium).

linking these regions to the costa has meant that growth has been confined to Peru's costa areas. Not all Peruvians have enjoyed the benefits of growth.

1.3 BIOFUELS AND BIOMASS

In order to stimulate demand for liquid biofuel production and use, Peru established mandates in 2007 setting mandatory blending of ethanol to 7.8 percent in 2010 and 2 and 5 percent biodiesel blend with diesel by 2009 and 2011, respectively. Bioenergy is seen as an important vehicle to diversify the country's energy sources as well as stimulate growth and employment opportunities. Bioenergy development is an important element in anti-narcotics initiatives. The development of bioenergy in the Amazon in particular is being promoted as a viable alternative to drug cultivation.

For ethanol [2] production, the main feedstock is sugar cane. Peru produces over 7 million tonnes of sugar cane concentrated in the costa region. Sugar cane in Peru is all year and yields range from 53 to 190 MT per hectare. The ethanol industry estimates that about 200 000 ha of sugar cane are under development for ethanol. Maple Energy, a biofuel company, plans to produce 30 million gallons of ethanol from over 10 000 ha in the dry areas of Northern Peru. Sugar cane will be produced under drip irrigation using water from the Chira River. The use of drip irrigation is seen as efficient. However, there are widespread concerns that sugar cane expansion may threaten environmental sustainability because of mono-cropping, soil erosion, crop disease and failure (See Water Analysis in BEFS Technical Compendia, chapter 4). Biodiesel production is also under development in Peru. The main feedstocks are palm oil and Jatropha.

Palm oil production is around 48 000 tonnes per year. Palm oil production is also expanding in the Amazonian provinces of Ucayali, San Martin and Loreto, where deforested land is being converted to palm oil plantations. Such an expansion of palm oil for biodiesel in the poorly developed Amazon region is being pushed as part of Peru's anti-narcotics strategy by creating alternatives to drug cultivation. Through the mandates, Peru has signaled a clear commitment to liquid biofuels. The BEFS analyses show however that land and water pose significant constraints to large scale biofuel development. About 40 percent of land in Peru is under forest and almost half is protected. This means the amount of actual land available for agricultural production is in fact quite limited (see Land Suitability Analysis in BEFS Technical Compendium Volume I, Chapter 3). Most arable land is used for sugar cane for sugar. Palm oil has the potential to grow on some deforested lands.

The bioenergy debate in developing countries has tended to focus much on liquid biofuels thereby ignoring the potential to develop other forms of bioenergy. Woody biomass and its conversion to bioenergy is an important new energy market. Many rural economies could potentially benefit from bioenergy developments utilizing woody and residue biomass which

2 Ethanol as discussed in this report refers to ethanol for use in transport sector.

could provide employment to those engaged in its development as well as supply energy to poor communities who have no access to energy. However, just because the potential for use of woody and residue biomass for energy production does exist in Peru is some regions, this requires regional and national government commitment for the opportunities to be realised. An important dimension on use of woody and residue biomass for development in Peru is the local benefits created that can help resolve local energy needs. Indeed, given the geography of Peru providing grid electricity is simply not a viable option across the country. Thus finding local solutions for energy access becomes an important element in poverty reduction initiatives.

1.4 FOOD SECURITY AND POVERTY

Thirty nine point three percent of the Peruvian population lives below the national poverty line- this is equivalent to 10 770.967 million people (ENAHO, 2008). Of this 3 764.688 million or 13.7 percent live in extreme poverty. Although the country ranks 82nd out of 177 countries (2006 HDI), it characterizes for its stark disparities reflected in a Gini coefficient of 0.55 (1 indicating complete inequality).The percentage of the population not having enough calories to eat is 31.6 percent (ENAHO) and chronic infant malnutrition is a staggering 21.5 percent (ENDES, 2008). 33.1 percent of children less than five suffer from anaemia (MONIN, 2008) and the figures are much higher in the highlands (60-70 percent). Insufficient allocation of public resources in the areas of health, education and infrastructure, as well as limited availability of farming land and very low yields of agricultural production in areas higher than 3 000 meters above sea level make the Southern Andean population extremely vulnerable to food insecurity. Forty two percent of the population cannot cover the minimum required caloric intake (2 100 kcal). A lack of access to food commodities, poor consumption patterns, inadequate child care and nutrition practices and poor educational levels among mothers, are the main causes of chronic undernutrition in Peru (see Escobal, 2010 for a fuller exposition on rural poverty and development).

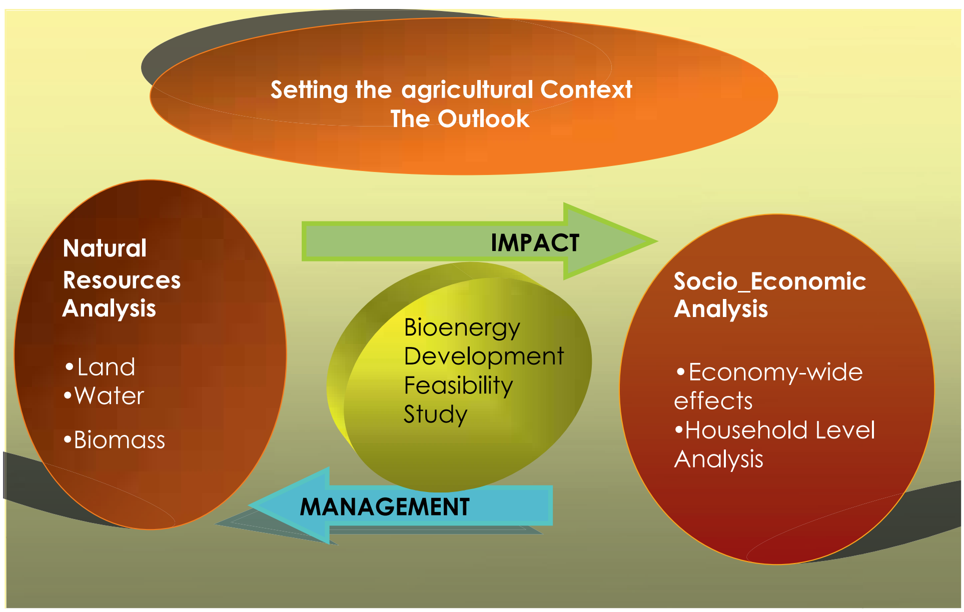
1.5 BEFS - SUPPORTING RURAL DEVELOPMENT AND FOOD SECURITY IN PERU

Within the BEFS analytical framework three important relationships are examined: agriculture and poverty, energy and poverty and energy and agriculture. Bioenergy has linked energy and poverty issues with the agricultural sector bringing a new set of considerations to the development agenda. It has been well-documented that agriculture remains central to poverty reduction and consequently food security in the developing world. At the same time inadequate energy access is an often overlooked dimension of poverty which locks many people into a poverty trap. Bioenergy has linked in a very direct way the energy sector with agriculture with implications for poverty and food security. In principle, bioenergy developments offer a number of advantages. Firstly, bioenergy can be developed using widely available resources that can be converted to convenient forms of energy. Secondly, the bioenergy sector can create a new market for producers as well as offer new forms of employment that will positively impact on agricultural and rural incomes. Thirdly, bioenergy can contribute to green house gas emissions and other environmental objectives. Fourthly, the sector can offer direct access to cheaper forms of energy for poor households potentially thus improving the productivity of capital, both human and physical. However, for these benefits to be realized requires careful choices in the design and implementation of bioenergy policies. The BEFS analysis emphasizes that natural resource use for bioenergy will only be able to support sustainable development, livelihood promotion and environmental protection if these goals are well-integrated into policy design and implementation. The economic viability of bioenergy tends to require extensive land area which can affect food security, social welfare, and biodiversity. In addition bioenergy can place a strain on water and forestry resources. To minimize these impacts, energy planning needs to be more integrative across other sectors involving land-use planning, forestry planning, water planning and more effective governance. Given the limited financial resources and human capacity in developing countries the BEFS project places a strong emphasis on bioenergy developments based on readily available natural resources and the prevalent technology base. Integrating bioenergy generation into existing sector policies can help minimize risks.

The BEFS Analytical Framework (AF) in Peru, Figure 1.1, identifies the potential for bioenergy development from a natural resource perspective recognising the opportunities and pressures that changes in their use may offer to the poor. This approach is articulated in the diagram below. The analysis is not limited to liquid biofuels but considers the potential of using readily available resources generated from sustainable forest management and residues or by-products generated from agricultural and forestry activities for energy use. The results of the analysis strongly support the view that it is the management and structure of the sector that is vital to ensure that the gains are maximised and the risks as far as possible minimised.

Figure 1.1

BEFS Peru Analytical Framework



1.6 USING BEFS TO SUPPORT THE POLICY MACHINERY IN PERU

There are four key ways in which the BEFS project supports policy processes in Peru. These are:

- the development of research tools that are tested using country specific data to provide an analytical starting point for bioenergy issues (technical work)
- the promotion of a policy dialogue between key stakeholders using the results generated by the analysis (policy support)
- capacity building (training)
- South-south co-operation. Using local human capital to assist other developing countries in policy effectiveness for bioenergy

The profile of the BEFS analytical framework in Peru considers a number of technical and socioeconomic issues relevant for agriculture and bioenergy. In addition the analysis is supported through the consideration of both bioenergy and food security crops as well as availability of biomass from residues generated from the agricultural, agro industries and forestry activities.

The BEFS analysis is structured as follows:

1.6.1 AGRICULTURE MARKETS OUTLOOK IN PERU

The analysis of BEFS in Peru commences with examination of the agricultural outlook for Peru. What the analysis considers is how agricultural markets will evolve over the next ten years assuming that existing policies prevail. It captures the ability of the sector to cope with changes or not and thus can help guide policymakers in understanding what needs to e done today in order for the sector to perform well in the future.

1.6.2 NATURAL RESOURCE ANALYSIS IN PERU

There are three main components:

1.6.2.1 Land suitability for production of bioenergy crops: The analysis identifies the extent and location of areas suitable for bioenergy crop production under different agricultural production systems and input levels.

1.6.2.2 Water Resources: The analysis permits a better understanding of the effects that an increase in liquid biofuel production may have on water resources.

1.6.2.3 Biomass resources from residues: considers the spatial distribution of biomass residues supply and biomass consumption for fuel uses.

1.6.3 LIQUID BIOFUEL PRODUCTION COSTS IN PERU

This analysis looks at productions costs from a social perspective through an explicit consideration of how liquid biofuels production set-ups can incorporate small scale farmers and still be profitable. In essence, the study carries out a feasibility analysis but given the consideration of competitiveness through smallholder participation, the analysis lends support to governments in their dialogue with the private sector. Specifically, it permits some degree of harmonisation between profit- motivated interests of the private sector and the wider social objectives.

1.6.4 SOCIO ECONOMIC ANALYSIS IN PERU

1.6.4.1 Economy-wide Effects in Peru: 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, this module considers how the various liquid biofuel set-ups analysed in the liquid biofuel production cost analysis can contribute to wider socio-economic goals.

1.6.4.1 Household-level Food Security in Peru: this analysis examines how bioenergy may result in the price movements of key food crops with implications for household food security. The analysis offers profiling of vulnerable groups that may experience food insecurity as the agricultural sector adjusts and adapts to the demands of the bioenergy sector.

This technical work provides the "building blocks" for examining bioenergy and food security. They offer a number of analytical tools, the robustness of which is tested using country data. The results generated by the data should not be seen as definitive but instead as illustrative of the use of the tool. The analysis carried out in each country has two significant roles. First, the results represents a springboard for future analyses using the BEFS tools so that the information generated can be used to guide and fine-tune policy developments as the sector evolves. Second, the actual results of the current country analyses represent an important contribution to the debate on how policy should evolve in each country. It should also be noted that these analytical tools represent the basis of an analysis that can be extended and/or complemented by adding other components that reflect the policy objectives of individual countries. Over time some of these components may become less important while new ones are added to reflect the prevailing policy climate surrounding bioenergy and food security.

Finally, it should be noted that the results presented by the analysis are not intended to be definitive nor do they represent an end-point in the contribution made by BEFS to the bioenergy debate in Peru. The analysis has two main functions. First, it illustrates the use of the tools and secondly, the results, offer a starting point for policy-makers on some key issues surrounding bioenergy development in Peru. It is stressed that continued use and extension of the BEFS tools are essential to provide a more comprehensive analysis for policy development.

1.7 POLICY CONSIDERATIONS

Promoting a sustainable bioenergy sector that also seeks to enhance social welfare requires the development of policy constructs involving a range of stakeholders across a number of institutions and ministries. There are numerous economic, social, and environmental implications of bioenergy. In Peru, many policies already exist for managing natural resources but it is clear that for sustained bioenergy attention needs to be given to better enforcement of existing regulation, especially those covering deforestation. In addition, new pressures on agriculture generated by the competition over natural resources will require quite specific policies to protect the resource base and vulnerable households. The BEFS process has involved a number of dimensions to support and guide policy development. The analytical framework has provided a number of tools that can be used for ongoing analysis so that policy can be fine-tuned so that opportunities from the sector are better optimized and greater knowledge on the risks permit the placement of mechanisms to deal with them. In particular policies have to be promoted to support small farmers in accessing the financial dividends that arise from bioenergy and promoting the development of locally produced bioenergy such as biomass. The Sierra region emerges from the BEFS analysis as having quite limited bio-physical suitability for bioenergy. Significant bioenergy opportunities are unlikely to develop in this region. Given the divergence in regional growth rates where the Sierra is the poorest of all three main regions, it needs to be strongly understood that bioenergy must remain within a broader rural development plan that promotes other activities to redress some of these regional inequalities. The following points highlight the key areas for attention emerging from the BEFS project in Peru. Chapter 3 of this volume discusses the BEFS results and these points in more depth.

- Improved and effective coordination of public institutions is needed to orient and monitoring bioenergy developments. Because of the diverse impacts arising from the sector diverse government offices e.g. agriculture, forestry and natural resources, energy. BEFS has contributed actively to the promotion of this coordination with the establishment of a Multisectorial Bioenergy Commission. The functions of such institutions need to be pushed further to ensure greater dialogue across ministries.
- Land Policy needs to recognize the issues arising from changing land use and improve property and tenure rights. This is especially important for land belonging to indigenous communities.
- Regional bioenergy development should be underpinned by more disaggregated analysis, building on the BEFS tools, to determine crop selection so that no unnecessary pressures are placed on food crops. Regional development bioenergy and food production plans need to be harmonized to better promote community development.
- All regional and national policies need to be sensitive to environmental degradation arising from specific agricultural activities.
- Increased investment for infrastructure, agricultural extension and research is vital to create win-win situations for those involved in agriculture including bioenergy.
- Public-private partnerships can generate important investments but requite consideration of mechanisms such as tax exemptions.
- Feedstock and biofuel production involve risks related to fluctuating prices generated in global commodity markets including oil. Price supports should be considered to protect small holders from swings in income.
- Technology transfer through south-south co-operation can encourage best use of natural resources across regions and sub-regions by identifying best practices in technology and agricultural “know-how”.

1.8 USING THE TECHNICAL WORK AS A BASIS FOR ORIENTING POLICY

Training is provided to build in-country capacity in the use of the BEFS tools so that the analysis may be repeated and extended to reflect the prevailing policy priorities and also to support policy adjustments as the bioenergy sector evolves.

In the development of the BEFS project, the country work in Peru has instigated processes which enable policymakers to access important information that informs thinking on bioenergy, builds consensus around a course of action through dialogue and promotes capacity across a range of expertise: natural resources, environmental and industrial economics, agriculture, energy technology, food security and rural development. This has been done through a series of technical seminars, roundtable discussions and high level consultations which bring together technical experts, policy makers and key stakeholders. BEFS does not advocate prescriptive policy recommendations at the country level but seeks to shed light on key areas that stakeholders should pay attention to. By beginning the process of dialogue and sharing the use of tools to support decision-making, policy makers in Peru are in a stronger position to consider how best to develop a *sustainable* bioenergy sector that considers the welfare of the most vulnerable at its heart.

1.8.1 KEY OUTPUTS IN THE BEFS PROJECT IN PERU

1. Technical Compendium. this consists of two volumes:
   Volume I. This provides a detailed presentation of the analytical tools of BEFS and a discussion of the results and how these contribute to the policy dialogue.
   Volume II. This provides a detailed presentation of the methodologies used for each analysis and the data sources.
2. Policy Compendium. This consists of four chapters:
   Chapter 1:
   Explaining the context of the Bioenergy and Food Security Project inPeru
   Chapter 2:
   Understanding the Bioenergy and Food Security Policy Landscape in Peru
   Chapter 3:
   Using the BEFS analysis to orient bioenergy policy development
   Chapter 4:
   Rural development and bioenergy: An alternative approach

   The purpose of the policy work is to provide an analysis of the range of strategies needed in supporting rural development through bioenergy building on the results of the technical compendium.

3. Technical training. An integral element of the BEFS project is the transfer of knowledge in the use of the tools so that the policy machinery in Peru can guide future analyses of bioenergy, rural development and food security.

1.9 CONCLUDING REMARKS ON BEFS IN PERU

BEFS does not advocate prescriptive policy recommendations at the country level but the analyses do shed light on key areas that stakeholders should pay attention to. A broader message emerging from the BEFS project is the need for policy to support a wider range of public goods in order to facilitate rural development through bioenergy. There needs to be a focus on education, agricultural research and development, investment in transport and infrastructure in order to optimize the incentives that derive from private sector investment in bioenergy. Policy planning should avoid serious competition with food production. This does not mean that bioenergy should not be promoted in areas where food is produced but that the fundamentals of food production should be understood in order to determine the true nature of competition posed by bioenergy on food production. It is important in many cases to consider whether improved agricultural productivity especially for food crops can offset some of the competition over resources.

REFERENCES

Escobal, Javier (2010), Poverty and Rural Development: constructing markets from the bottom-up," Orlando Olcese Lecture – International Potato Center (CIP), April 12, Lima.

ENAHO - Encuesta Nacional de Hogares, Peru – The National Household Survey, Peru.

ENDES - Encuesta Demográfica y de Salud Familiar, Peru – The Demographic and Family Health Survey, Peru.

MONIN - El monitoreo nacional de indicadores, Peru – The National Monitor for Indicators, Peru.

CHAPTER 2

UNDERSTANDING THE BIOENERGY AND FOOD SECURITY POLICY LANDSCAPE IN PERU

Henry Garcia

2.1 CONTEXT OF THE BEFS PROJECT IN PERU

The Bioenergy and Food Security (BEFS) project is in a special situation following the central government promulgation in recent years for law and regulatory framework to promote liquid biofuel, both biodiesel and anhydrous ethanol. A number of regional governments are supporting bioenergy initiatives such as those of San Martin, Ucayali, Piura and Loreto, which are promoting biofuels through non-governmental organizations (NGOs) and private enterprise.

At the regional level, efforts are being made by San Martin, Ucayali and Loreto to promote the production and use of pure plant vegetable oil from jatropha and sunflower seeds, biodiesel from palm oil and jatropha as well as hydrated ethanol from sugarcane. In San Martin alone there are 16 private-sector and nine public sector liquid biofuel initiatives, Loreto has four private-sector and nine public-sector initiatives; and in Ucayali there are 20 private sector initiatives and six from the public sector to produce liquid. The total of 64 initiatives under way in the Peruvian Amazon[3] (SNV, 2006) is the clearest demonstration of the interest generated in the regions for projects of this type.

In terms of the regulatory framework, the Ministry of Agriculture through the National Energy Plan is defining a future vision, central and specific objectives for the development of bioenergy from biomass generated in the agriculture sector, and setting medium and long-term targets. This opens up a broad framework for promoting the use of biomass for solid and gaseous bioenergy projects, which traditionally have not received sustained government support. Nonetheless, a number of individual projects have been implemented, such as the installation of biodigesters in Cajamarca in the 1980s, which suffered several decades of failure owing to technical shortcomings in the design of the installations, compounded by socio-cultural problems with local population. Accordingly, there are major opportunities to be analysed, such as the exploitation of agricultural residues from rice husks, cotton husk, sawdust, sugar cane foliage which is burned in the fields, and others. The use of biomass from sugarcane foliage for energy is particularly significant as its exploitation would involve reducing consumption of bagasse in the refinery boilers and make this material available for use in the production of paper pulp or chipboard, depending on economic feasibility. Nonetheless, consideration needs to be

3 SNV, Baseline on biofuels in the Peruvian Amazon, 2006

taken of the fact that the refinery boilers would have to be adapted to the use of foliage instead of bagasse which implies a capital investment. The following chart shows the potential for electricity generation from biomass:

Table 2.1
Electric power generation potential using biomass

Region	Generation from biogas (Mwe)	Steam turbine combustion	Steam engine combustion	Stirling engine combustion	Gasification - Internal combustion motor	Gasification - Gas turbine
Amazonas	1.62	5.37	5.03	8.38	8.89	8.38
Ancash	2.53	8.18	7.66	12.77	13.54	12.77
Apurímac	2.59	0.94	0.88	1.46	1.55	1.46
Arequipa	4.94	6.40	6.00	10.01	10.61	10.01
Ayacucho	3.18	0.15	0.14	0.23	0.24	0.23
Cajamarca	4.66	5.88	5.51	9.19	9.74	9.19
Cusco	3.96	3.03	2.84	4.73	5.02	4.73
Huancavelica	1.56	2.33	2.18	3.64	3.86	3.64
Huánuco	2.62	1.88	1.76	2.94	3.12	2.94
Ica	0.45	1.59	1.49	2.49	2.63	2.49
Junín	1.97	0.11	0.10	0.16	0.17	0.16
La Libertad	3.08	47.31	44.35	73.92	78.36	73.92
Lambayeque	0.89	23.81	22.32	37.20	39.43	37.20
Lima	5.48	19.16	17.97	29.94	31.74	29.94
Loreto	0.39	15.68	14.70	24.50	25.97	24.50
Madre de Dios	0.37	4.70	4.40	7.34	7.78	7.34
Moquegua	0.25	0.00	0.00	0.00	0.00	0.00
Pasco	1.02	1.67	1.56	2.61	2.76	2.61
Piura	2.42	6.74	6.31	10.52	6.31	10.52
Puno	4.87	0.14	0.13	0.21	0.23	0.21
San Martín	1.41	11.29	10.58	17.63	18.69	17.63
Tacna	0.31	0.08	0.08	0.13	0.14	0.13
Tumbes	0.12	1.90	1.79	2.98	3.16	2.98
Ucayali	0.57	8.87	8.31	13.85	14.68	13.85
Total	**51.27**	**177.18**	**166.11**	**276.85**	**288.62**	**276.85**

Source: Prepared by the author.

A number of issues need to be taken into consideration in relation to the use of biomass from residue materials for energy production. Particularly, the alternative uses that this have, including industrial uses depending on the type of waste (chipboard, paper pulp, raw material for producing cement in the case of rice husk), fertilizer to prevent soil degradation, and so forth. Moreover, in relation to the energy use of residues from sawmills, there are a number of firms in the selva (Amazon jungle) that sell this material to other sawmills to locations in the coastal regions (costa), such as Tacna and Arequipa, where it is used to generate products such as broom handles, cardboard boxes, chipboard and others.

In order to support the decision process for the use of biomass residues as energy production, it is necessary to know the real energy potential, since this could very well be less than the theoretical calculated potential. One of the key aspects is to assess the trade offs between energy uses and alternative uses. In particular *"Consider the opportunity cost of using some of these residues materials in other more profitable uses, preserving a fraction for use as fertilizer to prevent soil quality degradation, while excluding protected natural areas and primary forests, and adding the criterion of physical accessibility, What potential exists for energy uses of biomass waste obtained from agricultural, agribusiness, forestry and livestock activities?"* This analysis is carried out by BEFS and presented in detailed in Chapter 5 of BEFS Technical Compendia Volume I and II.

The Ministry of Energy and Mines under the regulatory framework for renewable energies recently held an auction for electricity generation projects which consider the use of solid biomass from residues for energy production. As a result, a total of 26 projects were awarded, including two for electricity generation from biomass, namely the Paramonga power plant with a capacity of 23 MW and a cost of cUS$ [4]5.2 per kwh and the Huaycoloro landfill with a capacity of 4.5 MW and a cost of cUS$11.0 per kwh (OSINERGMIN, 2010). The potential for generation of electricity from biomass is substantive in particular for the use of residues from sugar operations from the existing 11 refineries in the country and hundreds of municipal waste dumps, some of which, in the future, could be converted into sanitary landfills like Huaycoloro. Sanitary landfills offer great potential as waste management practices are improved through media campaigns or, in particular, by imposing fines on illegal dumping. In this regard, the Ministry of the Environment is undertaking the "National evaluation of municipal solid waste management services in Peru 2010." This initiative will be carried out in cooperation with the Inter-American Development Bank (IDB), the Inter-American Association of Sanitary and Environmental Engineering (AIDIS) and the Pan-American Health Organization (PAHO/WHO). The aim is to improve municipal solid waste management and coordination with the district and provincial municipalities.

MINEM is also planning to hold tenders in the coming months as part of the Strategic Sustainable Energy and Bioenergy Plan, and this could be a good opportunity to complement the efforts made by various stakeholders in the local domain. In addition, at the government level, a Multisectorial Bioenergy Commission has been set up with

4 US$ cents.

participation from the Ministries of Production, Energy, Environment and Agriculture, promoted by the BEFS Peru initiative. The commission has set up technical groups on various issues such as food security and poverty, policies, technologies, and others. The Commission sees this as a good framework for formally articulating intersectoral policies, and also because other public institutions have been convened through the technical groups, such as DEVIDA, CONCYTEC and civil society representatives such as SPDA, SNV, Soluciones Prácticas ITDG, GVEP International and others. To the extent that BEFS can contribute with its methodologies and tools to this process, the project will be extremely useful.

2.2 AREAS IN WHICH BEFS PROGRESS INTERACTS WITH OTHER GOVERNMENT INITIATIVES

Both in implementing the National Agro-Energy Plan and in the Strategic Sustainable Energy and Bioenergy Plan, the BEFS can make a valuable contribution to strengthening these processes. This would help to optimize budgets, to avoid duplication and reduce the times needed to achieve the proposed targets. A number of aspects of this are highlighted in the following table (2.2).

Table 2.2

BEFS linkages to Government Initiatives on Bioenergy

Agro-energy plan (MINAG)			BEFS
General objective	**Specific objective**	**Targets**	
Promote and strengthen inclusive and participatory business models to develop the agro-energy sector	Promote the formalization of land ownership and user rights	By 2012, mapping of zones with hydro-energy potential	The land component in the biomass potential category is undertaking a national land mapping on agro-energy crops. The BEFS through land suitability analysis provides the tools to carry out this.
Strengthen and implement the legal framework for sustainable bioenergy development	Identify sustainability criteria for each region and generate mechanisms for its implementation	By 2015, all regions have identified at least one activity and/or project related to agro-energy	The BEFS has generated information of the existing potential for agri-fuels and biomass projects
		By 2020 there is a 50 percent reduction in the rate of deforestation owing to the consumption of firewood and coal as an energy source nationwide.	The BEFS, through WISDOM methodology, is establishing a mapping of supply and demand for bio-mass residues for energy uses

Strategic sustainable energy and bioenergy plan (TDR preliminary version –MINEM)		BEFS
Components	**Component content**	
Component 1: Preparation of the strategic sustainable energy and bioenergy plan (PEESB).	- Promote sustainable development of these resources in the economic, environmental and social domains. The PEESB will pave the way for achieving the targets established in the areas of renewable energies and bioenergy. It will identify constraints and risks for the development of these areas and also actions to promote mechanisms to overcome them.	The methodologies and tools of the BEFS pursue the sustainable development of the agriculture sector, analysing the viability of bioenergy projects within that framework.
Component 2: institutional strengthening, design of mechanisms to promote renewable energies and bioenergy, and dissemination of results.	(I) Strengthening of the MEM and related institutions for the sustainable use of biofuels; (II) Design of tools and mechanisms (financial, fiscal or of another type) to promote bioenergy projects, guaranteeing their sustainability and the application of clean development mechanisms (CDMs); (III) Design of a research and development programme in renewable energies and biofuels; (IV) Dissemination of results obtained through national and regional workshops.	The BEFS includes preparation of a public policy document that includes an institutional analysis of proposals for strengthening. Regional workshops will also be held.
Component 3: studies of illegal, regulatory and tax framework, and proposals to promote renewable energies and bioenergy in Peru.	(I) Analysis of the legal, regulatory and taxation framework; (II) Definition of suitable proposal to promote the use of renewable energies and sustainable production of biofuels in Peru; (III) Study of the fiscal effects of the changes proposed on tax legislation.	These aspects are expected to be included within the policy documents to be produced in the project.
Component 4: analysis of the productive chain, identification of zones with potential for sustainable production and analysis of the demand for biofuels in Peru.	(I) Life cycle o analysis of the biofuels; (II) With support from a geographic information system (GIS) and basic information, zones with potential for energy crops will be identified, to determine and prioritize those with major potential for the sustainable production of biofuels; and (III) Analysis of demand, availability of raw materials and distribution channels.	The BEFS includes geographic information analysis to identify the adaptability and availability of land for growing agri-fuels drops and supply and demand of readily available biomass from residues for energy uses.

Once the BEFS project has been completed (scheduled for next May) MINEM and MINAG need to have coordinated to include the results of BEFS-Peru in these processes. This involves essential training in methodologies for appropriate staff of those organizations, as well as discussion and review of the main results.

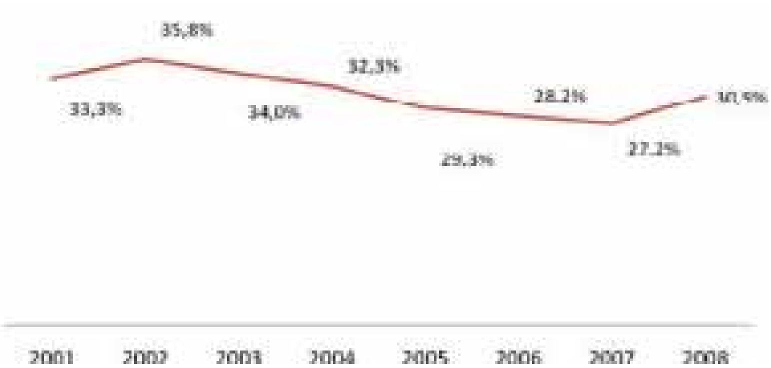
Nonetheless, given the government institutional frailty in terms high staff turnover, information platforms (website) and thematic technical committees need to be set up to provide services when required. This is an essential aspect that would do much to help institutional strengthening of the government. Otherwise the potential applications for the BEFS analytical tools in Peru will gradually fade into insignificance.

2.3 BIOENERGY AND FOOD SECURITY

Peru is in a state of food insecurity. The food insecurity in the country is mainly associated with low levels of income and inadequate use of food by the population. In 2008, roughly 30.9 percent of the national population suffered from calorie deficiency in their diet (Figure 2.1). This caloric deficit reached close to 42.5 percent in rural homes and 28.9 percent among urban families (CEPLAN, 2010).

Figure 2.1

Trend of population suffering from calorie deficit (percent of total)

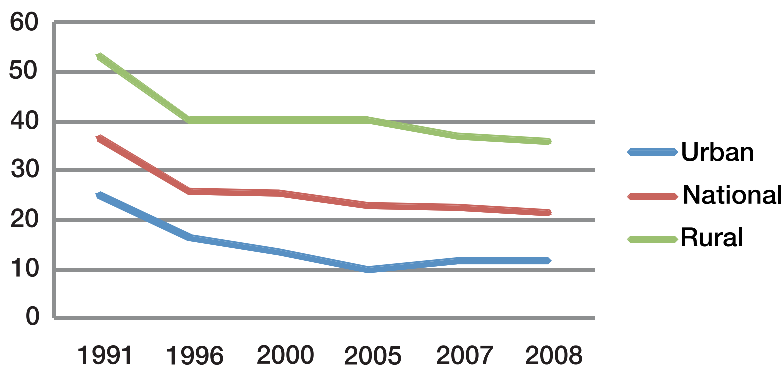


Source: Plan Peru, CEPLAN 2010.

Poverty is directly associated with chronic undernourishment. In 2008, 21 percent of children under 5 were suffering from chronic undernourishment; 50 percent suffer from anaemia and 11 percent display vitamin A deficiency; and in extremely poor households 35 percent of children under 5 suffer from chronic undernourishment compared to 13 percent of non-poor children. Nonetheless, these national aggregated indices conceal major differences between socioeconomic groups, in both urban and rural areas (Figure 2.2).

Figure 2.2

Chronic undernourishment in Peru (percent of children under 5 years of age)



Source: INEI, indicators of results identified in strategic programmes (ENDES 2000, 2005, 2007 and 2008

The 2004-2015 National Food Security strategy for Peru is being implemented against this backdrop. The general objective of the strategy is to prevent the risk of nutritional deficiencies and reduce levels of undernourishment, particularly among families with children under five years old, expectant mothers and those segments of the population in situations of greatest vulnerability; promoting healthy food consumption and hygiene practices, and ensuring a sustainable and competitive supply of domestically produced food products.

The strategy's targets include reducing chronic undernourishment among the under-fives from 25 percent to 15 percent, reducing micronutrient deficiencies, especially anemia among children under 36 months and pregnant women, from 60.8 percent and 50 percent, respectively, to under 20 percent in both groups. As chronic undernourishment is related to education and the family income level, the least affected by this problem are the children of mothers in the highest income quintile, of whom just 5.4 percent suffer from stunting, whereas the worst affected are children of mothers in the lowest quintile, with 45 percent chronic undernourishment rates. Although chronic undernourishment has been declining in the country, Peru still has a high level when compared to other countries in the region.

Despite these facts, Peru is in a promising phase in terms of the interest shown by the government in resuming programmes after an interlude of several years to combat food insecurity among the lowest-income groups as part of its development strategy, Previous work was done under a welfare-assistance approach consisting of social programmes that provided food through the so-called *Vaso de Leche* [glass of milk] programme, targeting popular food kitchens and mothers clubs; or through the JUNTOS programme, to periodically provide money to poorest population groups as means to access food.

Nonetheless, unlike previous years, the Ministry of Economy and Finance (MEF) is now responsible for the monitoring of results from the various programmes including the fight against poverty and child undernourishment. The MEF is instituting the budget by results approach to assign budget to other sectors and programmes. Under this approach, the MEF is working to design a food strategy, which it will apply in the coming months in coordination with other sectors. This approach is considered very important, because it goes beyond welfare support. It seeks to build capacity and empower the rural population so that, on the basis of the development of productive activities linked to each zone and optimal exploitation of local produced food resources (restoring ancestral uses of certain food products), they can help combat the existing food insecurity.

Some regions have also been holding roundtables to combat poverty, which convene central, regional and local government bodies, together with multilaterals and the private sector. Other notable efforts include those being implemented by the Presidency of the Council of Ministers through the Inter-sector Social Affairs Commission (CIAS) and the JUNTOS programme, through the CRECER strategy to combat child undernourishment, supported by FAO. All of these initiatives are aimed at combating child undernourishment and food insecurity.

Until a few years ago there was no national strategy such as those being articulated at present time, apart from isolated efforts by central government and a number of regional governments. Nonetheless, several issues remain to be resolved to ensure that these initiatives achieve better results, including updating of the National Agricultural Census, the most recent version of which was held in 1994. This study establishes the national agricultural production regime, and the land ownership regime, among other aspects which are important to food production. Another important issue is to define jurisdictions on these issues between the Ministry for Women and the Ministry of Agriculture. The Ministry of Agriculture has maintained an approach aimed more at productive analysis linked to specifically social issues. This is one of the reasons explaining the lack of leadership in terms of food security.

On aspects of food security, one of the most recent studies undertaken has been the "Impact of increasing food prices on the vulnerable population of Peru" by GRADE. This analyses how the rise in food prices, particularly commodities, is affecting the population's food consumption, particularly among the lowest-income groups, relating the food consumption basket to calorie consumption. It can thus establish the extent to which the rise in food prices is affecting the fulfillment of the population's calorie needs. It should be noted that multiple reasons may be forcing up prices, not necessarily linked to liquid biofuels.

In relation to bioenergy and its links with food security, there is an important issue to mention, namely the production of crude palm oil. This can be used as an input both for local production of refined oil for food consumption and for the production of biodiesel through a transesterification process. In this case, the Romero group a major producer of palm oil for food, is expanding its operations to incorporate the production biodiesel. The feedstock for the production of oil for food and for fuel is to be supplied by their plantations (17 000 ha). There is also the possibility that, if the international market price for palm oil biodiesel rises in relation to the prices of refined food oil, areas currently destined for the production of refined food oil will be turned over to biodiesel. This scenario will affect the volume of local production of refined food palm oil and could cause an increase in imports of food oils, and thus affect the local market price for this commodity, making it more expensive to use. This aspect shows the direct relations that can exist between the development of bioenergy projects and food security and needs to be evaluated. Moreover possible commercial opportunities for expanding palm oil cultivation areas for biodiesel production can place pressure on primary forests. This has already happened in the Barranquita district in the region of San Martin between (SPDA, 2008) as documented by the Peruvian Environmental Law Society (SPDA).

2.4 BIOENERGY AND SOCIAL CONFLICTS

In developing bioenergy-related projects, particularly large-scale ones and those targeting the residential sector, the social dimension needs to be taken into account. Examples include the ongoing project by SENCICO (SENCICO, 2010), GTZ and others to replace traditional wood-burning stoves with more efficient types through a process of certification and evaluation. This project forms part of the mass programme to upgrade half a million stoves, being promoted by the Presidency of the Council of Ministers with participation from other ministries, and regional and local governments. The process has a major social component, so the success of the programme depends heavily on adequate planning and execution by specialists. The project not only involves replacing one type of stoves with another, but understanding the population's sociocultural situation to facilitate the adaptation process and to ensure the good use of the improved stoves. The same approach can be used in programmes for heating homes using "Trombe" walls. This is currently being implemented by SENCICO and forms part of the government strategy to combat the devastating effects of frosts on low-income population groups living in high Andean zones. Incorporation of the social dimension would make it possible to avoid a repeat of the bad experiences that occurred in past projects implemented by NGOs in the same state.

The social dimension is different in the case of agrofuels, where land ownership is a crucial issue. Excluded from land located in protected natural areas or areas already under concession, extensive untitled areas are used informally by small-scale farmers. For this reason, the Government, through COFOPRI, has been working intensively on land titling programmes with thus far only partial results. With a land titling process under way and interest among business groups to develop sugarcane bioenergy projects on the north costa of Peru, or biodiesel production from palm oil in the Peruvian Amazon, the potential for social conflict clearly exists. This has already happened as mentioned above in the Barranquita district in the San Martin region where the Romero group destroyed primary forest zones to develop oil palm plantations, despite legal measures imposed and the opposition from the population and clergy (Figures 2.3 and 2.4). This not only generated a serious social dispute, but also caused irreparable environmental damage by destroying primary forest areas. In the case of sugarcane ethanol development by the Maple project in Piura (Analisis, 2009) abuse of the population has also been denounced. In this case, land was alleged to have been irregularly sold in the Chira Piura project, without taking account of the fact that there were population centers, homes and concession holders located in the area. This incident clearly infringe on the property rights and legal stability.

Figure 2.3

Deforestation associated with palm cultivation[5]

Figure 2.4

Deforestation in Barranquita - Oil palm plantations[6]

This type of situation undermines the population's belief in bioenergy projects. Given existing institutional weaknesses, it is worth asking what policy measures should be implemented and what type of control actions should be put in placed to avoid conflicts. Given the economic influence of powerful groups, local communities clearly have limited

5 Large volumes of timber are extracted from forests every day to make way for new palm oil plantations.

6 What previously was a forest is now an access road. Fauna and flora are the hardest hit by deforestation.

capacity to uphold their rights, particularly when the government is institutionally weak. Nonetheless, this does not mean that it is impossible to develop bioenergy through inclusive projects that generate employment for the local population and contribute to local economies. A participatory approach for bioenergy development is what institutions like SNV are promoting, through pilot projects in regions such as San Martin, Ucayali and Loreto.

Nonetheless, the following question arises in its own right: *What type of policies should the Government promote to generate commercial initiatives among private enterprises (which could be done without generating employment and local development apart from fulfilling their environmental and tax obligations) to ensure that they are inclusive?* In addition, if making a project of this type inclusive reduces its profitability, *Has the Government considered compensating the enterprise for this opportunity cost loss?* Here it is important to analyse whether what is being sought is to promote and give incentives, or rather to impose or oblige the private sector. A priori, it would seem that the promotion or incentives mechanism would be more easily accepted by entrepreneurs. *So, what type of incentives could the state give?* The idea of tax breaks in return for employing a certain percentage of previously trained local people sounds interesting. Commitments to purchase a given percentage of production, development of transport and communications infrastructure that improves opportunities for commercial exchange, provided the firm generates local employment and directly contributes to the development of the local economies, also seems to complement the above.

On the other hand, with a view to address problems caused by land-ownership disputes between small farmers and business groups, the National Industries Society (SNI) has put forward a new Land Trust Fund scheme. Under this arrangement, the small-scale farmer does not sell his land to a businessman but rents it to a third party as tenant for a given period of time. This tenant will negotiate use-concession conditions with farmer associations, signing an agreement and then negotiating a land-use concession with a firm interested in implementing a bioenergy project, for a given period. None of this would involve sale of the property, which would continue to be owned by the small-scale farmer. The farmer would thus avoid problems of lack of negotiating power vis-a-vis large entrepreneurs and would receive a more than fair price for the land without losing ownership of it. The intermediary would gain by negotiating with farmer associations the fairest price for rental of the land. The entrepreneur would also gain because he would not have to negotiate with hundreds of farmers but with just one intermediary. This proposal is still under debate and has not yet been implemented.

2.5 BIOFUEL REALITY IN THE REGIONS OF PERU

The development of biofuels and bioenergy generally, opens up an opportunity for strengthening the agriculture sector in developing countries such as Peru. However, this requires a process of strategic planning and taking account of sustainable development. These development opportunities manifest themselves in local job creation, the development of local and regional economies, an increase in regional government revenues in the form of payments for water or land-use rights, among other items.

Regional governments, such as those of San Martin, Ucayali, Loreto and Piura, have undertaken initiatives to promote biofuel projects in degraded or abandoned land areas, in coordination with entities such as the Peruvian Amazon Research Institute (IIAP), NGOs such as SNV of Holland, and Soluciones Prácticas ITDG. In the case of San Martin, Lambayeque and Piura, these processes have also been strengthened by setting up biofuel consensus roundtables. These have succeeded in involving private institutions which otherwise would have found it difficult to reaching agreement with the regional authority (Figures 2.5 and 2.6).

Nonetheless, these regional processes generally show that regional governments have shortcomings in terms of the technical staff involved in this process, as well as limited infrastructure for implementing projects with their own resources. Moreover, there is little information available on the region's natural resources base, supply and demand for biomass residues for energy uses, etc.

For these reasons, it is extremely important to engage the regions in the transfer of methodologies developed by the BEFS project in Peru. Clearly to be useful, such methodologies need to be applied on a regional scale but if staff from the regions is trained and regional governments acquire the necessary infrastructure and hire suitable staff, these processes will be achievable. Nonetheless, implementation is likely to be done in stages, starting first in the the regions where bioenergy development is well underway and then continuing with the others.

Figure 2.5

Biodiesel projects - Oil palm - San Martin

Figure 2.6
Oil palm plant at Espino - San Martin

2.6 SITUATION OF SPECIFIC TYPES OF BIOFUEL

2.6.1 LIQUID BIOFUELS

According to FAO's unified bioenergy terminology, liquid biofuels include ethanol and biodiesel. These fuels are mainly produced from bioenergy corps and are primarily discussed in the context of its use in the transportation sector.

2.6.1.a Anhydrous ethanol and hydrated ethanol

As part of its policy on liquid biofuels, the Peruvian Government is clearly making efforts to promote the use of anhydrous ethanol and biodiesel. In the case of anhydrous ethanol, there is potential for obtaining ethanol from sugarcane. Development of this industry is likely to be concentrated around sugar cane refinery plants in the north costa areas and centre of the country. In total there are 12 refineries with a potential for a production capacity of around 64 million liters per year of ethanol from molasses. Annual volumes of sugar cane processing amounts to between 6 million and 8 million tonnes (including both commercial scale and small-scale producers). The country total commercial sugar production ranges between 600 000 and 800 000 tonnes. Sugar cane production on the Peruvian costa has high productivity levels, averaging 110 and 160 tonnes per hectare per year (MINAG, 2007).

Nonetheless, there are water constraints along part of the Peruvian costa, particularly in the north, which raises the question of whether using water to grow agrobiofuel crops like sugar cane is more beneficial than using the water to grow other corps, including those that are less water-intensive crops. However, the issue of water resource availability also related to existing infrastructure for storage and distribution, and the technologies used to irrigate the crops. In both cases, there are opportunities for improvements; according to Ministry of Agriculture reports, less than 20 percent of water flowing into the Pacific Ocean is exploited, and the rest goes into the sea. Technology-based irrigation is a much more efficient option than the gravity irrigation used in various plantations. Nonetheless, it is important to note that the new sugar cane projects on the northern costa use droplet irrigation which is 98 percent efficient compared to the 55 percent efficiency rate of gravity irrigation. The National Water Authority assigns distribution quotas for water resource to new sugar cane projects only after demands for the population and other agricultural crops have been satisfied. Accordingly, the following issues arise in relation to this topic: *How much would be saved in terms of existing water consumption from technology-based irrigation implemented by new sugar cane production projects for ethanol on the northern costa of Peru* (Figure 2.7)*? What investment do such facilities require? To improve the rate of recovery of water discharged into the sea by 1percent, how much investment is needed in the construction of reservoirs and water distribution infrastructure? How much investment is needed to improve the storage capacity of the Poechos reservoir by 1percent, considering that only is very small part of the reservoir is sediment free? Which option is more profitable, dredge Poechos or build a new reservoir in that zone?* These are some of the questions that need to be answered to ensure that the development of new agro-energy crops production projects will not affect water availability.

Figure 2.7
The Caña Brava project in Piura production of anhydrous alcohol

Consideration should also be given to alternative biofuel crops such as sugar sorghum, which has a considerably lower water consumption than sugar cane (7 000 m^3/ha per year compared to 15 000 m3/ha per year). Pilot projects have been carried out for producing ethanol from sorghum (Figures 2.8 and 2.9) with very promising results, such as those implemented by Monder S.A.C. in Lambayeque (Gianella, 2009). Nonetheless, there are still many shortcomings to be resolved, such as evaluating yields and annual water consumption on a commercial scale.

Figure 2.8

Sorghum crops

Figura 2.9

Lambayeque experimental sugar sorghum project

On the other hand, in the Peruvian selva (where there is no lack of water) the productivity of sugar cane production is low (about half of the costa productivity level) for various reasons, including the fact that soils are continuously water-logged by rainfall and a problem of pest control in these plantations. Also, the areas cultivated with sugar cane are small affecting the economies of scale.

Nonetheless, there are regional initiatives (Figures 2.10 and 2.11) that have not yet received the Central Government's blessing, such as the use of pure vegetable oil and hydrated alcohol in the transport sector. Nonetheless, the lack of support has not prevented pilot projects of this type in regions such as Loreto, Ucayali and San Martin. In the case of hydrated ethanol, firms such as Riso Combustibles and Bioenergía S.A.C. produce fuel to be used in the San Martin region, particularly in motorcycles and adapted motorcycle taxis.

Figure 2.10

Hydrated ethanol plants - Selva[7]

Figure 2.11

Motorcycles adapted for hydrated ethanol

2.6.1.b Combustible pure vegetable oil

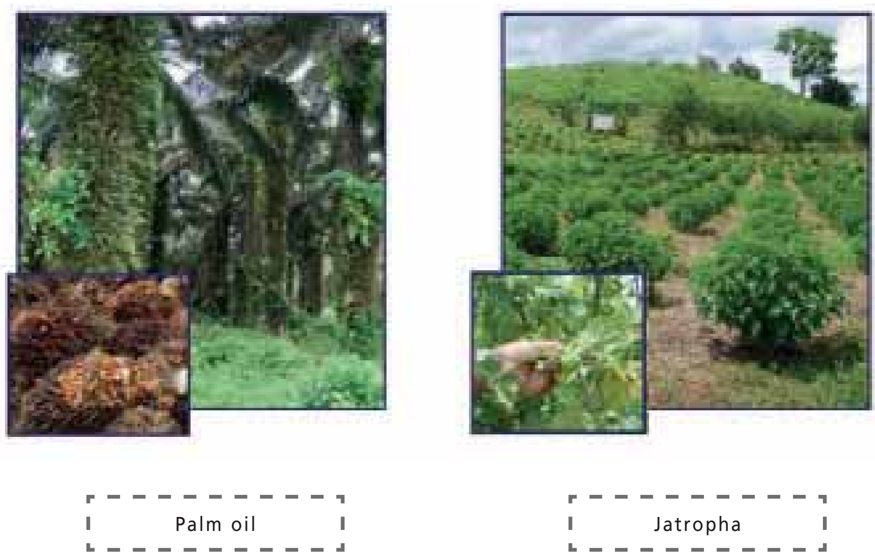
In the case of pure vegetable oils there are a number of pilot projects such as that being implemented by the DED-CFC consortium and WWP Latinoamericana S.A.C. in San Martín (Figure 2.11). The use of pure plant oil as substitute for diesel has the advantage that its international price is lower than diesel oil (about 30 percent, considering that the price of sale to the public of diesel is about US$0.85 per L, compared to the estimated production cost of pure vegetable oil of between US$0.4-0.6 per L) (PUCP, 2009). Nonetheless, for this market to develop, cheaper diesel engines adapted for use with pure vegetable oil are needed, which currently cost between US$350 and US$400 per engine. There is also the believe that the use of vegetable oil as fuel goes beyond environmental benefits but also offers a viable social option to serve local markets.

7 Image to the left: Sugarcane plantations cultivated with high technology by the firm Riso Biocombustibles- San Martín region. Image to the right: Microdistillery for producing hydrated ethanol fuel (AEHC) –Empresa Bioenergía - San Martín region.

Within the Peruvian context, incorporating this type of fuel would help improve development opportunities in rural zones, thereby contributing to diversification of the energy matrix. Nonetheless, there is a risk that given the lack of a legal framework to formalize its use, and defining quality standards and minimum specifications for the end-use equipment, they will not be able to enter a sustainable commercial phase and will gradually fade out of use (Figure 2.12).

Figure 2.12

Raw material for combustible plant oil and biodiesel production



2.6.1.c Biodiesel

In the case of biodiesel, two types of potential feedstock have been identified namely oil palm and *jatropha*. Nonetheless, they are both in very different stages of development. Edible oil palm has been used for decades from the commercial production of palm oil in agricultural lands. On the other hand, *Jatropha* is at an experimental stage and to date a number of *jatropha* pilot projects are been implemented in the Amazon region with participation from GTZ, DED, SNV, INIA and the regional government of San Martin. Apart from *Jatropha*, there have also been experiences with rapeseed, sunflower and castor oil, although the results have indicated a lesser potential than *Jatropha* and are less developed. The attractiveness of jatropha is that it requires little water, adapts well to high altitudes in the selva and can be developed on arid or deforested land provided the soils are not flooded. These are some of the reasons why there is so much interest in the *jatropha* commercial development. Nonetheless, the technology package for exploiting them is still in the development phase, and their production costs do not compete with those of oil palm.

Figure 2.13
Vegetable oil extraction plants

For oil palm according to SNV, there is an installed area of 44 882 ha of which 38 percent are in production, 34 percent in growth, and the other 27.74 percent in nurseries. Productive yields vary according to the production technology and level of inputs used, ranging from 10 to 15 tonnes of fruit per hectare per year, using the traditional technology and/or low inputs; whereas the use of high technology and/or inputs raises production to up to 25 tonnes of fruit per hectare per year. The Palmas del Espino extraction plant reports 25 percent extraction of crude oil, which produces 6.25 tonnes of crude oil per hectare per year. This firm has been working with this crop for 30 years, and has recently started new projects that will cover 15 000 ha of new plantations, to add to their existing plantations (Figure 2.14).

In addition to that commercial production, palm growing associations also cultivate oil palm. In Ucayali the association is called OLAMSA, and in San Martin it is Indupalsa, which, with support from the regional government of San Martin, have set up crude palm oil extraction plants, for commercial sale.

One of the emerging issues with regard to the cultivation of oil palm is that this crop uses farmland rather than abandoned or degraded land. Moreover, palm oil has an edible use and Peru has a deficit in terms of local supply of oil production to meet national food demand, which makes it necessary to import food oils. Oil Palm thus poses a direct impact to food security if this is used for the production fuels rather than for human consumption.

Figure 2.14

Palma del Espino plant - Biodiesel

2.6.2 SOLID BIOFUELS

Solid biofuels are the most widely type of bioenergy used in the local market. It is estimated that between 10 percent and 12 percent of total energy consumption is based on solid biomass. There is also consumption of dung, firewood which has been used in the residential and commercial sector for a long time; and also the commercialization of charcoal (mostly through informal enterprises) for use in the commercial sector. In both cases, the technologies used are informal, so that there are hundreds of thousands of wood burning cookers used in the residential sector mostly in the rural area, but also in the urban sector (Figure 2.15 and 2.16). There are also charcoal ovens. In addition, there is bagasse obtained from the sugar cane refineries and used in the agribusiness sector.

Figure 2.15

Traditional wood-burning cooker

Figure 2.16

Improved wood-burning cooker

2.6.3 GASEOUS BIOFUELS

Peru is fortunate in terms of the potential for biomass resources available. Nonetheless, biomass has several existing uses. In the case of biomass uses for energy generation only large scale generation within agro-industrial sector are considered economically viable in part due to production cost, the availability of raw material, storage and transport. Nonetheless, the following table (Table 2.3) illustrates existing potential:

Table 2.3

Types of bioenergy used in Peru

Type			Inputs	Production zones	Uses of biofuel
Liquid	1st generation	Biodiesel	Oil palm mainly	Amazonia	Transport, electric power generation in isolated communities
			Potentially: white pine nut, castor oil	Deforested costa and Amazonia	
			Rape seed mainly	Mountain	
		Combustible plantoil	Oil palm mainly	Deforested Amazonia	
			Potencialmente: piñon blanco, higuerilla	Deforested costa and Amazonia	
			Rape seed: potentially	Mountain	
		Anhydrous ethanol	Sugar cane potentially	North Costa mainly	Transport
			Sugar sorghum potentially	Ciast	
		Hydrated ethanol	Sugar cane potentially	Deforested Amazonia	
			Sugar sorghum potentially	Costa	
	2nd generation	Ethanol	Forestry residues	Sawmills throughout country	Transport
			Agricultural residues from crops such as sugarcane, rice and others	Zones producing these crops throughout the country	
		Pyrolisis oil	Wild cane, forestry residues, plant bio-mass generally	Amazonia, costa	Electric power generation, heat

Type		Inputs	Production zones	Uses of biofuel
Solid	Firewood for domestic use	Wild and planted trees and bushes	Costa, mountain and selva	Domestic use: cooking, basic productive processes in families or microenterprise, bakeries
	Dung, animal faeces	Animal residues	Mountain	Domestic use: cooking,, heating
	Charcoal	Wild and planted trees and bushes	Costa, mountain and selva	Domestic use: cooking, basic productive processes in families or microenterprise, bakeries
	Agricultural residues	Agricultural residues from crops such as sugarcane, rice and others	Zones producing these crops throughout the country	Electric power generation using heat produced by waste combustion
	Bricquets, pellets	Forestry or agricultural plant residues	Sawmills, zones producing these crops throughout the country	Combustion to generate heat (timber drying ovens)
Gaseous	Bio-gas	Forestry or agricultural plant residues	Costa, mountain and selva	Energy for domestic use, electricity generation.
	Gasification	Plant residues	Costa, mountain and selva	Energy for industrial use, electricity generation.

Source: 2009-Energy Plan - MINAG.

The main source for the generation of electric power based on biomass to supply the interconnected system, is that obtained from biogas generated by the anaerobic decomposition of plant and animal waste. Animal waste can be obtained from livestock ranches, poultry farms, and also from the combustion or gasification of biomass residues produced in activities from the agroindusttrial sector as well as the forest products industry (sawmills). Exploitable residues materials for these purposes include sugarcane bagasse, rice husk, wheat chaff and forestry waste. Also considered are residues produced by poultry, beef cattle and pigs.

Figure 2.17

Sugarcane bagasse - Tuman Lambayeque

Of the biomass currently consumed in Peru, the only type used for generating electric power through steam turbines in aqua-tubular boilers is cane bagasse. In 2008, 1 055 tonnes were used to generate electricity in sugar refineries, representing 3.1 percent of total energy consumed for electricity generation in 2008 (MINEM, 2009). Bagasse is a byproduct obtained from the processing of sugar cane, and is used in sugar refineries to co-generating energy to produce both electricity and generate heat in the form of process vapour. The table shows (Table 2.4) the potential installed in refineries in MW.

Table 2.4
Sugar refineries 2003 - Installed power

Firm	Name of Plant	Installed Power MW	Type	Region
Compania Peruana del Azucar S.A.	CT Compania Peruana del Azucar	3	Interconnected	Ancash
Complejo Cartavio S.A.	CT ASCOPE	9,8	Decentralized	La Libertad
Empresa Agroindustrial Cayalti	CT Turbinas-Planta Fuerza	7,2	Interconnected	Lambayeque
Empresa Agroindustrial Pomalca	CT Pomalca	12,5	Interconnected	Lambayeque
Empresa Agroindustrial Pucala, S.A.	CT Casa Fuerza-Fabrica	8,5	Interconnected	Lambayeque
Empresa Agroindustrial Tuman, S.A.	CT Tuman	8,4	Decentralized	Lambayeque
Empresa Agroindustrial Laredo	CT Laredo	5	Interconnected	La Libertad
Empresa Agroindustrial Casa Grande S.A.A.	CT Casa Grande	24,6	Decentralized	La Libertad
TOTAL		79		

Source: Ministry of Energy and Mines.

The energy production capacity varies depending on the type of technology that is employed in the process, since each technology has its own efficiency ranges. In addition, each technology entails specific investment requirements in terms of US$ per kilowatt. Nonetheless, the analysis does not include other factors such as the operating characteristics of technologies that make it more feasible to use certain types of biomass materials versus others. A generalization has been made to present the various technological options available on the market.

In addition, there is the potential for production of biogas to generate electricity, using waste from bovine animals, pigs and poultry. For that purpose, considering that only 5 percent of the existing population is concentrated in poultry farms or stables and that only 50 percent of the waste generated from an can be used. The result of this evaluation shown below (Table 2.5):

Table 2.5

Potential electricity generation using biogas

Region	Generation from biogas (Mwe)
Amazonas	1.62
Ancash	2.53
Apurímac	2.59
Arequipa	4.94
Ayacucho	3.18
Cajamarca	4.66
Cusco	3.96
Huancavelica	1.56
Huánuco	2.62
Ica	0.45
Junín	1.97
La Libertad	3.08
Lambayeque	0.89
Lima	5.48
Loreto	0.39
Madre de Dios	0.37
Moquegua	0.25
Pasco	1.02
Piura	2.42
Puno	4.87
San Martín	1.41
Tacna	0.31
Tumbes	0.12
Ucayali	0.57
Total	51.27

Source: Prepared by the authors

2.7 CONCLUDING REMARKS

- The current bioenergy situation in Peru shows that the country is going through a promising period in part due to the policy measures implemented over the last few years. These include the creation of the Multisectorial Bioenergy Commission, which brings together four ministries and various public and private bodies; the holding of the first auction to support electricity generation projects using renewable energy sources; and the holding of three national congresses on biofuel and renewable energy with wide-ranging participation from public and private bodies. In addition, there are some 84 initiatives for bioenergy projects under way in the Peruvian Amazon (SNV, 2006).
- Nonetheless, the institutional weakness of the govenrment and the lack of a clear and sustained policy developed based on solid technical criteria, means that market forces

may raise the risk of large enterprises exploiting small-scale farmers. An example of this is the Barranquita development in San Martin, where a dispute arose over the deforestation of primary forests for oil palm cultivation. An effort by various institutions to provide the government with tools and methodologies to help guide policies development that considers sustainable development of agriculture through bioenergy is extremely important. Efforts such as SNV, Swisscontact, Soluciones Prácticas ITDG, FAO BEFS and the State itself through IIAP and INIA have contributed much in this regard.

- To complement the policy measures already implemented, it is important to define policies on liquid biofuels in rural zones, with a clear aim of generating rural development, safeguarding food security, stimulating development of value chains and promoting the creation of market niches, as well as job creation. Before preparation of this type of policy, information on geographic zonification to identify areas suitable for bioenergy crops and to evaluate the supply of and demand for biomass from residues for energy uses, analysis of water availability, analysis of the impact of these projects on the local and national economy, and their incidence in terms of job creation are necessary. All these aspects are included in the BEFS methodological analysis.
- These policies should take account of the following aspects: What type of incentives should be provided to promote bioenergy projects (preferably in rural areas), once the areas that have potential for these initiatives are known, and following evaluation of the aforementioned aspects? What type of incentives should be used: tax, economic, or a mixture of the two? For how long should such incentives be maintained: medium or long term? What mechanisms will be used to ensure that long-term incentives are kept in place following changes in regional or national government?
- Another issue when defining bioenergy promotion policies is the need to clearly identify the key priorities for developing these projects. For example, projects with low environmental impacts, projects that generate large regional government revenues, inclusive projects with high rates of job creation that make a substantial contribution to improving the local population’s economy, among others. Moreover, mechanism and parameters to clearly monitor and weigh out these priorities need to be defined to guide evaluation and implementation of bioenergy project on the ground. In addition, as some parameters may be measurable and others non-measurable, how will the non-measurable parameters be weighted?

REFERENCES

Analisis, R. M. (2009). *Bajo la Lupa*. Downloaded in 2010, from http://www.bajolalupa.net/13/05_tex.html.

CEPLAN. (2010). Plan Perú 2021: *Plan Estratégico de Desarrollo Nacional*. Lima.

Gianella, J. (2009). COBER. Downloaded in 2010, from http://www.cober.pe/cober_i/dia2-a-Biocombustibles/04percent20Gianellapercent20Jaime.pdf.

MINAG. (2007). *La Industria Azucarera Nacional 1999* – 2006, p. 57. Lima.

MINEM. (2009). *Balance Nacional de Energía 2008*. Lima.

OSINERGMIN. (2010). *OSINERGMIN*. Downloaded in 2010, from http://www2.osinerg.gob.pe/EnergiasRenovables/Actas/Acta005.pdf.

PUCP. (2009). *Aceite Vegetal Combustible*. Downloaded in 2010, from http://www1.up.edu.pe/boletin/01i.php?pantalla=articulos&id=133&bolnum_key=104&serv_key=13.

SENCICO. (2010). SENCICO. Downloaded in 2010, from http://www.sencico.gob.pe/gin/NORMASpercent20PDF/ReglamentoGINCocinasMejoradas.pdf.

SNV. (2006). *Linea de Base de Biocombustibles en la Amazonia Peruana*. Lima.

SNV. (2006). *Línea de Base de Biocombustibles en la Amazonia Peruana*. Tarapoto.

SPDA. (2008). SPDA. Downloaded in 2010, from http://www.spda.org.pe/portal/_data/spda/documentos/20090701180046_ACSCpercent20No2.pdf.

CHAPTER 3

USING THE BEFS ANALYSIS TO INFORM BIOENERGY POLICY DEVELOPMENT

Jaime Fernandez Baca and Yasmeen Khwaja

3.1 INTRODUCTION

Imminent climate change-related events urge for the identification of policy-related mitigation strategies. Bioenergy is a foreseen alternative to reduce carbon emissions through the use of biomass for generation of heat and electricity and biofuels for transport. The role of bioenergy is also critical to enhance energy independence and promote sustainable rural development in particular in developing countries. Policy decision making is instrumental to this end. As part of these efforts, FAO promoted the Bioenergy and Food Security (BEFS) Project which examined how bioenergy development can become a tool to increase the productivity of the agricultural sector without jeopardizing food security. As part of the BEFS Project, a series of technical analyses have assessed the feasibility of bioenergy production in Peru. This chapter synthesizes their policy implications and considerations for rural development.

Even though the contribution of agriculture to the Gross Domestic Product (GDP) in Peru is relatively small compared to other developing countries, it has a critical role in supporting the livelihoods of the poor and extremely poor and ensuring their food security. However, agriculture is an untapped sector with high potential. Its relatively poor productivity could become a strong argument for governments to find a range of measures that boost not only this sector but rural development in general. Although agriculture contributes a modest 6 percent to GDP (Cuanto, 2009) compared to services at 62 percent, manufacturing at 14 percent and extractive industries at 11 percent, the sector remains important for some of the poorest segments of the population in Peru who rely on the rural economy for their food needs and livelihoods.

Peru has already enacted bioenergy related policies supporting liquid biofuel and use of solid biomass for heat and power. The recent auction on renewable energy considered a target for generating 60 percent heat and power from biomass-based energy. The national liquid biofuel strategy mandates for the use of biodiesel and ethanol in the transport sector. The concern is that in meeting these mandates, the poor, who rely on their land for livelihoods, may be bypassed and miss out on any opportunities bioenergy development offers for agriculture. Economic theory suggests that strong agricultural growth has beneficial effects on poverty. Peru has witnessed strong agricultural growth which has reduced rural poverty but at a much slower rate than urban poverty.

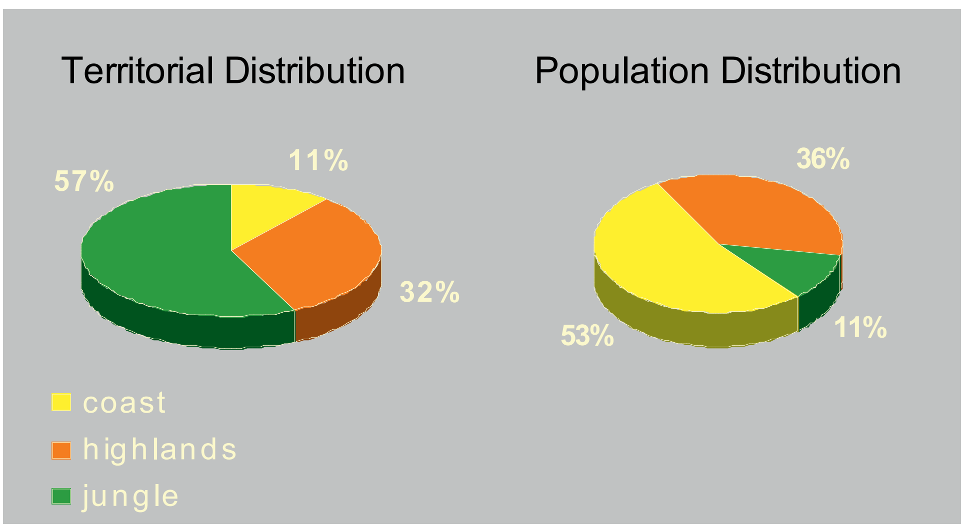
Consequently, urban-rural inequalities have widened. This is consistent with the argument that while agricultural growth is important for overall poverty reduction, it is the pattern of that growth that matters for inequality. The structure of competitive agriculture in Peru is increasingly shifting to large-scale commercial holdings which mean that poorer farmers are unable to access the profits generated by this growth.

Bioenergy and especially biofuel developments, in principal, hold much promise for improving agricultural growth for the benefit of the poor. However, while a mandate has been already set in Peru (see Chapter 2) feedstock production for liquid biofuel can have serious consequences on food production because they compete for the same resources. Thus, an important question is whether the mandate can be met without compromising the food security status of Peru.

The natural geography of Peru significantly influences development trends. Peru has three distinct geographical regions: the costa area, the Andean highlands and the Amazon basin (selva). They are characterized by an interesting territory – population pattern: While the costa concentrates the least amount of territory, it has the largest population. By contrast, the Amazon basin concentrates the largest territory and the least amount of population (see Figure 3.1). Across the three regions, there are many climates, soils and agroecological areas. Thus, they all practice agriculture but in very different ways. In the costa area agriculture is technologically and commercially advanced and contrasts sharply with the other two regions where agriculture is smaller in scale and, in the case of the Sierra, often subsistence-based. It is quite clear therefore that a *one-size-fits-all* agricultural which includes bioenergy policy would not be workable in Peru.

Figure 3.1

Peru – Territory and population percentage distribution by natural region



Source: INEI, 2007

The emphasis of agricultural policy needs to centre on a full consideration of the portfolio of options that bioenergy presents. That is, the bioenergy considerations must extend beyond the production of liquid biofuels to consider alternative energy sources for example, using residues from agriculture and forestry activities. The creation of local energy provision using cheap resources from residues can do much for poverty reduction by providing cheaper energy and also offering new income earning opportunities. Equally, rural development policies must acknowledge that bioenergy developments represent just one potential avenue for rural development but that this is not always open to all. It is critical that bioenergy policy is also framed within a wider rural development that considers alternative strategies for agriculture to avoid deepening inequalities. Part 2 of this chapter considers some of these alternative strategies.

Bioenergy is *not* a panacea for resolving all employment and social problems in rural areas. It may offer a significant opportunity that can benefit many. It is important to identify *what* those opportunities are and *for whom* they exist. This can help government dedicate appropriate resources to targeted areas where bioenergy could do much to enhance incomes of the local people. The Bioenergy and Food Security Project finds that careful and structured management of the sector is needed to guide bioenergy developments for the benefit of the poor. As bioenergy is rooted in agriculture, the starting point of the BEFS Analytical framework in Peru is within this sector. The BEFS tools provide a strong basis in an examination of whether the bioenergy sector, in meeting the mandates, can do so in a way that promotes rural development, livelihoods and food security.

3.2 HOW BEFS INFORMS POLICY

The BEFS Project considers that generating high-quality, accurate and timely information is a key input for the design, implementation and evaluation of sound public policy. The importance of information relies on the expectation that, among others, it could fulfill three policy-related goals: (I) Increasing the knowledge-base, (II) providing inputs for formulating, adjusting and/or improving strategies and (III) making evidence available. To this end, the development of appropriate, flexible, cost-effective and sustainable data-gathering instruments is a necessary condition for the success of the information-generating process.

In particular, when focusing on multidimensional problems such as bioenergy, special attention must be paid to the methodological and technical procedures used in the process of generating information. The efforts advanced in this field in Peru are discussed in the BEFS Technical Compendia Volume I and II where the aspects on natural resources (water, land and biomass), biofuel production economic feasibility and the socioeconomic analysis are presented. As a result, they have added information that nourishes the achievement of the three important policy-related interlinked goals namely:

1. I*ncreasing the knowledge-base on bioenergy.*- This goal has been achieved through the assessment of different resources which led to identifying, characterizing and quantifying

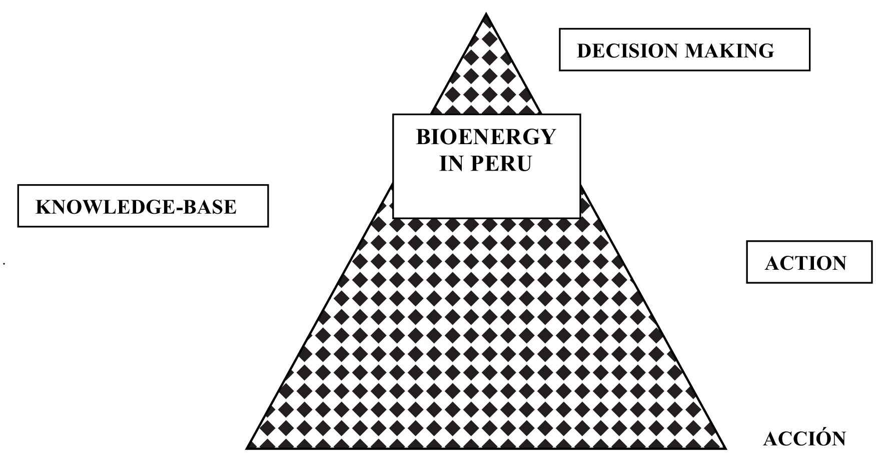
the potential for bioenergy production according to the Peruvian natural context. In addition, these assessments were relevant to validate measurement techniques on how to better approach bioenergy-related aspects.

2. *Improving strategies and action about bioenergy.*- Once information becomes available, it will increase the probability of formulating, adapting and/or improving bioenergy-related intervention strategies to better suit target population needs and expectations at the local, regional and national levels. In turn, information generated will serve as a basis for establishing and committing national and local actors towards the completion of bioenergy-related informed and realistic goals.

3. *Enhancing decision-making and dissemination.*- One of the major challenges policy-makers usually face is the lack or insufficiency of information to plan and design policies to respond to urgent matters (i.e. bioenergy among them). Thus, making accurate and updated information available is strategic for timely policy development.

Figure 3.2

Bioenergy and policy-related goals



Thus, in particular, the BEFS project analyses the extent to which bioenergy can be an instrument to enhance agricultural productivity for the benefit of the poorest groups which includes smallholders. It is not an *ex ante* endorsement of bioenergy but rather an exploration into whether a bioenergy sector can be economically viable and if so, can the sector be structured in a way that delivers on socio-economic fronts.

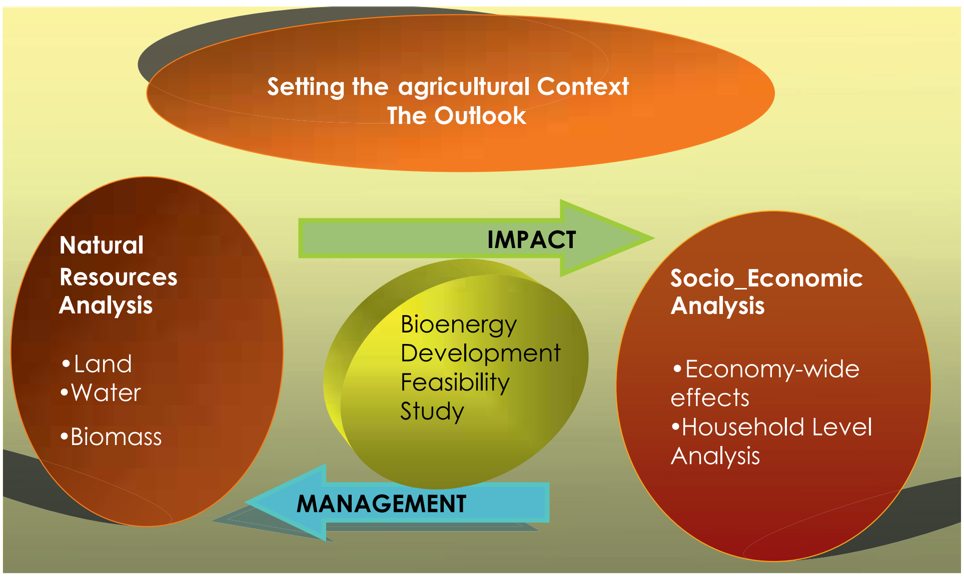
The starting point for the BEFS analysis is agriculture because this is the sector that the poor and extremely poor rely on for their livelihoods. However, the 21st century is seeing rapid changes to the sector driven by both national and international bioenergy policies within the context of promoting energy security and climate change mitigation.

These changes have a bearing on the welfare of vulnerable population groups and whilst bioenergy may theoretically offer many advantages these have yet to be properly explored. The BEFS analysis fills an important research gap by identifying the extent to which these opportunities actually exists and what risks emerge from bioenergy developments.

The BEFS analytical framework in Peru considers a number of biophysical, technical and socioeconomic issues and their interaction in the context of bioenergy. The diagram below articulates the BEFS approach (Figure 3.3). Bioenergy developments can have socio-economic impacts but knowing what impacts arise from particular bioenergy developments can aid governments to better structure, govern and manage the sector in order to minimise risks especially to poverty and food security and optimise opportunities related to agricultural growth, rural employment and income generation. The final goal of such approach is to promote the attainment of sustainable rural livelihoods.

Figure 3.3

BEFS analytical framework for Peru



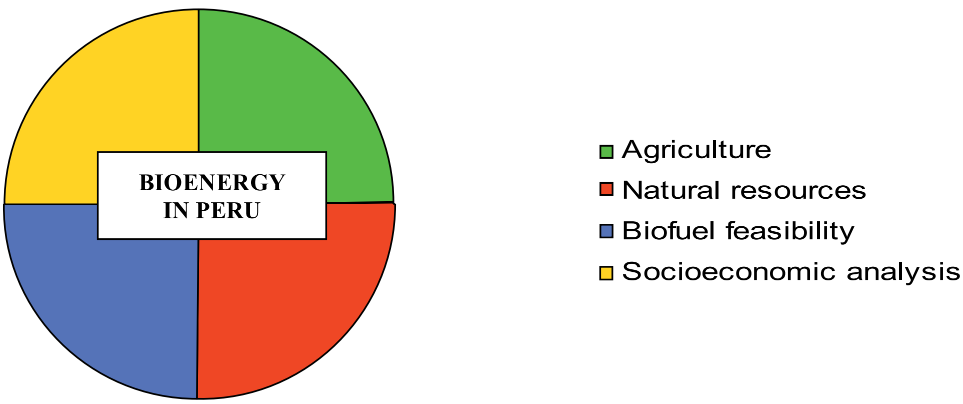
The BEFS Analytical Framework (AF) identifies the potential for bioenergy development from a natural resource perspective recognising the opportunities and pressures that changes in their use may offer to the poor. The analysis is not limited to biofuels but considers the potential of using residues biomass resources from agricultural and forestry activities for energy use. This is an important dimension in the Peru analyses because the discussion on bioenergy is not limited to a consideration of liquid biofuels. It is important that the entire range of bioenergy options is considered if rural development potentials are to be correctly analysed. Whilst the BEFS analyses are not fully comprehensive in this consideration it does emphasize the importance of alternative bioenergy options.

This chapter considers specifically how the technical work informs the policy debate surrounding bioenergy developments in Peru. It raises important issues emerging from the results and considers other themes relevant for the promotion of *sustainable* bioenergy development.

The four dimension of the analytical framework analysis and structured were discussed in detailed in Chapter 1. It is worth noting that these four dimensions are interdependent in the analysis of bioenergy (see Figure 3.4). Nonetheless, it should also be noted that these analytical results are not intended to be definitive nor do they represent an end-point in the contribution made by BEFS to the bioenergy debate in Peru. The analysis has two main functions. First, it illustrates the use of the tools and secondly, the results, offer a starting point for policy-makers on some key issues surrounding bioenergy development in Peru. It is stressed that continued use and extension of the BEFS tools are essential to provide a more comprehensive analysis for policy development.

Figure 3.4

Bioenergy analysis in Peru: Interdependent dimensions



3.3 USING THE BEFS RESULTS FROM PERU TO INFORM POLICY

3.3.1 AGRICULTURAL MARKET OUTLOOK

The agriculture sector is critical for food security and the livelihoods of several of Peru's poorest groups. Changes in the use of natural resources used for agriculture can place pressures on households that rely on these resources for their livelihoods. The agricultural outlook sets the context for agriculture over a period of 10 years. This enables an understanding of how agriculture will react and respond to changes in global and domestic agricultural markets. The outlook analysis helps identify whether the sector can adjust and cope with changes over time or whether policy changes are required today in order to avoid food insecurity, and increasing dependence on food and fuel imports. Ultimately, this will promote the sustainability of rural livelihoods in Peru.

Agricultural commodity prices can be influenced by energy prices, in particular prices for crude oil. Oil prices above US$90 per barrel would imply significantly higher food prices than the current level of US$60-70. Higher oil prices would also lead to higher demand for food crops as well as for feedstock for liquid biofuel production. The demand for liquid biofuels depends on a number of factors: the mandates set by the Peruvian government, as well as changes in policy interventions. Liquid biofuel development is already geared towards export markets. For example, Caña Brava and Maple are both focussed on exporting ethanol. Biofuel mandates can inflate prices for feedstock such as wheat, maize, oilseeds and sugar.

Broader impacts of climate change, risks of water stress and incidence of severity of floods, shifts in production frontiers can be captured in agricultural outlooks. These dimensions are important to consider as they may affect the actual performance of the agriculture sector in Peru.

3.3.2 NATURAL RESOURCE ANALYSIS

BEFS examines the biophysical limits to the development of bioenergy systems in a given region using a set of tools that allows the assessment of three key aspects: I) land suitability for development of bioenergy crops, II) water availability and III) available biomass residues from agricultural and forestry activities for potential energy use. The main results for each and their consequent policy implications are discussed below.

3.3.2.1 Land suitability

The analysis assessed the current availability of suitable land for bioenergy crops. The methodology, which is based on the agro-ecological zoning approach used by FAO, has two fundamental elements:

1) Assessment of total lands suitable for the production of bioenergy crops.
2) Estimation on the availability of the suitable land by excluding lands currently under agriculture or lands with environmental restrictions.

Total suitable land assessment has two stages: the first stage is a land resources inventory, where climate resources, soil and geomorphology are geo-referenced. The second stage consists of the land suitability assessment where crop requirements (i.e. climate, soil type and slope) are defined according to production systems and input levels used. The crops selected for analysis were: sugar cane with tillage production system and high input levels; oil palm with conservation agriculture and both high and low inputs; and jatropha with conservation agriculture and low inputs. Crop requirements are then contrasted with the agroclimatic and land resources inventory in order to identify the suitability of each area to grow each type of crop. Suitable areas are thus quantified, including the productivity that could be obtained, which gives the quantities of biomass that could be produced in a specific area.

The second element of the methodology consists in identifying zones that will be excluded from the identified suitable lands for environmental or social reasons. These zones include: wetlands, permanent forestry production areas, areas for reforestation, national and local protected areas and native communities. Other exclusion areas include: towns, reservoirs, timber and non-timber forest concessions, mangroves, permanent ice, rivers, lakes and lagoons. Finally, a third layer of exclusion is areas that are currently under agriculture. This last exclusion is aimed at avoiding the use of lands that could generate conflicts with food production and thus affect food security.

Main results from the land suitability analysis

The results show that, it will require examining alternative development scenarios in which current food crop areas are replaced by feedstock production. Given the limited agricultural area that Peru has (less that 5% of total land is used for agricultural production), how much of this potential expansion would be allowed? One major factor to set a limit would be the potential impact of such expansion on food prices. Another scenario would be to limit the development of new bioenergy crops only on new areas in the case of the costa.

In the case of the selva there are several risks inherent to the expansion of bioenergy crops. The land suitability analysis that was made restricts the potential bioenergy expansion only to degraded lands. Areas with crops and forests (including permanent production areas, protected areas and native communities) are not considered in the analysis. However, it is not immediately clear whether limiting feedstock crop production to these types of areas would also limit the economic viability of the bioenergy development. Other questions arise such as whether native communities would be interested in participating in bioenergy development, or how much expansion into forested areas will be allowed. Again, different scenarios need to be analyzed in order to set coherent goals for bioenergy development. Thus, land use planning is essential for establishing a common vision of how a given territory will be developed over the long term and in this respect BEFS can make an important contribution to this process.

Insufficient land use planning strategies, tenure rights and clarity in enforcement competences between different governmental levels are at the source of social conflicts that have already appeared in several regions in Peru related to bioenergy development. Strong governance should lie at the heart of bioenergy policy in order to manage the full range of impacts arising from biofuel developments. These themes are further discussed in section 4 of this chapter.

In the selva regions - especially in San Martin - different entities (including donor agencies; NGO's and even the local) have already been promoting the cultivation of jatropha among small landholders. The crop is seen as a potential solution for recovering the degraded soil in the jungle. However, further research is needed in order to identify the varieties best adapted to local conditions and that can produce the necessary yields to be a commercially viable activity. In this particular case, policy could be geared towards supporting a comprehensive research program on jatropha through partnerships between small landholders, research stations and private investors.

Policy considerations emerging from the land suitability analysis

How much land area will ultimately be devoted to feedstock supply should be based on a national strategy that responds not only to local and international demands of liquid biofuels, but also to the biophysical and social constraints present in each region of Peru. In this respect the BEFS land suitability analysis, which identifies the biophysical limitations for various feedstock, can be a powerful tool for policy-makers to define better how bioenergy developments should be conceptualized and implemented. While the land suitability assessment in BEFS was conducted at an aggregate national level, more detailed analysis at a localized level is necessary in order to determine more precisely the exact contribution the potential for each individual region in providing biofuel feedstock to meet national demand. However, extended application of the tool can help policymakers in Peru develop the broad guidelines as to where private and public investment in bioenergy development should occur.

The land suitability analysis considers the expansion of bioenergy crops into areas that are not currently under cultivation. In the costaal and sierra regions this would mean an expansion of the agricultural frontier, while in the selva it implies the expansion only into areas that are currently degraded (i.e. deforested with no crops or pastures). However, a bioenergy policy will need to define the type of expansion that will ultimately be allowed to happen. An informed decision in this respect will require examining alternative development scenarios in which current food crop areas are replaced by feedstock production. Given the limited agricultural area that Peru has (less that 5percent of total land is used for agricultural production), how much of this potential expansion would be allowed? One major factor to set a limit would be the potential impact of such expansion on food prices. Another scenario would be to limit the development of new bioenergy crops only on new areas in the case of the costa.

In the case of the selva there are several risks inherent to the expansion of bioenergy crops. The land suitability analysis that was made restricts the potential bioenergy expansion only to degraded lands. Areas with crops and forests (including permanent production areas, protected areas and native communities) are not considered in the analysis. However, it is not immediately clear whether limiting feedstock crop production to these types of areas would also limit the economic viability of the bioenergy development. Other questions arise such as whether native communities would be interested in participating in bioenergy development, or how much expansion into forested areas will be allowed. Again, different scenarios need to be analyzed in order to set coherent goals for bioenergy development. Thus, land use planning is essential for establishing a common vision of how a given territory will be developed over the long term and in this respect BEFS can make an important contribution to this process.

Insufficient land use planning strategies, tenure rights and clarity in enforcement competences between different governmental levels are at the source of social conflicts that have already appeared, as mentioned in the previous chapter, in several regions in Peru related to bioenergy development. Strong governance should lie at the heart of bioenergy policy in order to manage the full range of impacts arising from liquid biofuel developments. These themes are further discussed in section 4 of this chapter.

3.3.2.2 Water resource analysis

Water availability is a critical aspect to consider when planning an expansion of agricultural production to produce energy crops, especially in water-deficient regions such as the Peruvian costaal valleys. To address this issue, BEFS included a case-study of water availability in the valleys of Chira and Piura (Piura Region) to meet the current water demand of the two valleys as well as the demand arising from the expansion of an additional 23 976 hectares of land for sugar cane for ethanol production that will be progressively planted in the Chira valley by four national and international companies. Currently, the Chira valley has over 41 000 hectares of area under irrigation, while Piura valley has over 43 000 hectares. Both valleys are serviced by the Poechos reservoir. Water provision by the reservoir has declined over the years. To date the Poechos dam has lost nearly 50percent of its volume capacity since it was commissioned in 1976, owing to sedimentation caused by erosion in the headwaters. This volume is expected to keep decreasing in the future.

The water analysis was carried using the Water Evaluation and Planning System (WEAP) of which full details can be found in the Technical Compendia Chapter 4 Volumes I and II. The analysis considers water provision under four different scenarios:

1) Current situation,
2) Under projected expansion of sugar cane areas,
3) Under expansion of sorghum (instead of sugar cane) and,
4) Under expansion of sugar cane areas *with* the expansion of other crop areas.

Main results from the water resource analysis

The main result of the WEAP analysis based on a 75 percent confidence as the minimum acceptable water availability to agriculture, shows that, *under current conditions of water provision*, there is **not** enough water available to support the additional 23 976 hectares of sugar cane that are projected to be installed in the Chira valley for ethanol production. Of the four scenarios that were assessed, only the current scenario was assessed as acceptable. The current supply of water with a 75 percent confidence would only be enough to support an additional 10 000 hectares of sugar cane in the Chira valley (50 percent of what has been planned). The model took into account the increase of water demand for population until 2030, as well as a projected reduction of storage volume of Poechos dam until that year. The model also considered the use of groundwater as an additional water supply and the use of state-of the-art irrigation technology for sugar cane production for ethanol uses, with 85 percent irrigation efficiency. It is important to note that irrigation technologies that are currently used in both valleys have an average irrigation efficiency of 35 percent. Currently an average of 1.28 metric tons of food crops are produced for each thousand cubic meters of water used – agriculture in developed countries uses 30 – 40 percent of this amount. A better result is obtained when production of sorghum is considered instead of sugar cane, since this crop requires almost half the amount of water per hectare; however, the confidence level for water supply would still be unsatisfactory.

If the available water resources are in fact insufficient to support the additional 23 976 ha of sugar cane plantations, then the expansion of this crop to meet the demand of ethanol could result in the replacement of other crops that are currently planted in both Chira and Piura valleys, depending of the relative price of these products and whether sugar cane is favored over sorghum. Rice represents almost half of the agricultural surface area in Chira, while cotton and rice represents almost three quarters of Piura valley's area. Both valleys also have significant areas of crops for the export market (predominantly fruits). Therefore, the question that arises is whether the bioenergy crops could displace food crop production in both valleys due to competition for water. This situation reflects other costaal valleys where water is a scarce resource.

Policy considerations emerging from the water resource analysis

It is clear that agriculture in the costal regions of Peru will face an enormous challenge in terms of water availability in the future. Whether agricultural production is intended for food or for liquid biofuels, this will have to be produced with less water because of the pressures that come from urbanization, industrialization of the agricultural sector and climate change.

In the future agricultural producers need to increase water use efficiency and improve agricultural water management. Given the anticipated increase in demand for food and water and increasing pressures from climate change, clear action will be needed to deal with the competing demands for freshwater. One course of action should involve improving overall irrigation efficiency. For instance, the average irrigation efficiency in Chira and Piura valleys is around 35 percent, due to the use of surface irrigation (low application efficiency) and unlined canals (low conveyance efficiency) which result in a significant loss of water. Improving irrigation systems by providing lined canals and more advanced irrigation methods such as sprinkler or drip irrigation could increase irrigation efficiency to 60 percent or beyond. These changes would make agriculture more productive and efficient. The increase in water use efficiency in these valleys would be in the interest of all stakeholders, including private liquid biofuel developers, small landholders and the government. Policy options could involve promoting public-private collaborations whereby large bioenergy developments could contribute to improve overall water use efficiency beyond their area of intervention.

The increase in irrigation efficiency would also need to be accompanied by better crop programming that optimizes the use of water. In this respect, options to provide incentives to use bioenergy crops that are less demanding of water should be considered. For instance, sweet sorghum consumes considerably less water than sugar cane, and therefore is an alternative that should be further assessed. Similarly in current food crop production areas, options include replacing crops with high water demand with other crops that are less demanding of water. For instance, it has frequently been suggested that rice should not be produced in the costa, but in the selva instead were there are less limitations on water. However, this has important implications for local rural livelihoods and needs careful assessment.

Increasing overall water availability will also require irrigation infrastructure in terms of water storage capacity. As indicated above, in Chira-Piura the storage capacity of the Poechos dam that supplies water to both valleys has nearly halved since it was constructed more than 30 years ago. Adequate water supply to meet future demand from bioenergy crops will require considerable public investment to recover water storage capacity, which may include building new dams or increasing the capacity of the existing one. However it should be noted that public funds have high opportunity costs given the many competing needs these funds have, including investments in roads and other services that may have more direct impacts on the rural poor.

The Chira-Piura case illustrates clearly the need to improve the management of the headwaters that feed irrigation schemes. In the case of the Poechos dam, deforestation and unsustainable land management practices are generating large sediment loads that have been responsible for the considerable reduction of the reservoir's storage capacity. Headwaters go as far as Ecuador (in Loja region) and in the north of Peru (Ayabaca). Therefore, a significant expansion of the agricultural frontier in Chira-Piura should necessarily be accompanied by the implementation of a compensation mechanism for the implementation of land conservation practices in the headwater regions, which could be accomplished through a Payment for Environmental Services (PES) scheme. These types of compensation mechanisms could be an integral part of all bioenergy developments that operate under similar conditions as Chira-Piura.

All of the above options would necessarily require an adequate water-pricing policy that reflects the true cost of water provision. Frequently, the costs of water infrastructure or conservation of water sources are not captured in the rates charged to consumers. Any coherent policy on sound water use needs to implement water charges that not only cover for the infrastructure costs, but also reflect the scarcity of the resource as well as the environmental costs and benefits that arise from water use.

Finally, long-term planning requires taking into account the potential effects of climate change on future water availability. The present analysis did not take into account these effects and therefore may be presenting a somehow optimistic scenario on water availability. However, the BEFS tools are designed so that they can be embedded in a comprehensive climate change analysis. Thus, it is envisaged that future use of the BEFS tools in Peru would consider the biophysical suitability considering the effects of climate change.

3.3.2.3 Bioenergy potential woody biomass and biomass from residues

Another dimension of the natural resource analysis is the bioenergy potential that arises from the use of woody biomass and biomass from residues generated in the agricultural and forestry activities. As in many countries, wood fuel and charcoal in Peru are the main sources of energy in rural areas and poor urban dwellings. Currently about 11 percent of the total energy production of Peru comes from the use of solid biomass sources, mostly firewood and charcoal. As such forests are very important for rural populations since they supply wood and other essential goods for rural households. On the other hand, agricultural residues –especially in the costa but also in the selva – can also be an important source of energy use, although little has been done to take advantage of this potential.

BEFS analyses the bioenergy potential from woody biomass and biomass from residues generated in the agricultural and forestry activities through the Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) methodology. This is a spatially-explicit method that maps the supply and demand of biomass for energy uses. WISDOM quantifies the supply of biomass from direct and indirect sources. Direct sources include sustainable biomass exploitation from forestry activities in native forests and forest plantations, as well as residues from agricultural activities. Indirect sources include residues from agricultural and wood processing industries. On the demand side, the residential, industrial and commercial uses are considered. Residential uses include the use of fuelwood and charcoal for cooking and heating. Industrial uses include the use of fuelwood and charcoal in the industrial sector, while commercial uses include the demand from restaurants, hotels among others (full details on application of WISDOM-Peru and the results can be found in Chapter 5 of the Technical Compendia, volumes I and II).

Main results from the bioenergy potential from woody biomass and biomass from residues

Mapping of woodfuel supply and demand showed that, of a total of 194 provinces in Peru, 58 have deficits in woodfuel. These deficits are mainly concentrated in the provinces of the costaal and Andean highland regions of Ancash, Arequipa, Ayacucho, Cajamarca, Cusco, La Libertad, Piura, Puno and Tacna. Other provinces have balances of nearly zero and these are also concentrated in the costaal and Andean regions. Included are some provinces of Ancash, Apurimac, Ayacucho, Cusco, La Libertad, Lima and Tumbes. On the other hand, surpluses are found in the Amazonian provinces, especially, the ones belonging to the Loreto department, with values over 8 million tons, with a high of 50 million tons in the province of Maynas (Loreto). Other provinces that show significant surpluses are La Convencion (Cusco), Tambopata (Madre de Dios) and Oxapampa (Pasco).

The Sierra highlands show a deficit "hotspot" where the forestry resource is endangered. The main source of woody biomass for cooking and house heating in the highlands originates from the communal native forests, which are especially vulnerable to overexploitation due to their low resilience capacity. In places where forests have been depleted, communities tend to obtain their timber mostly from shrubs rather than trees. In the costa region the main source of fuelwood and charcoal comes from the dry forests of the North, which are being overexploited. In fact, the WISDOM-Peru analysis confirms deficits in the supply of woodfuels in those provinces that have these types of forests. Indeed, these deficits may be even higher, since there were insufficient data on charcoal and firewood use by the industrial and commercial sectors[8]. In the provinces of the selva region the balances show large surpluses of woodfuel, largely from residues of forest extraction activities in natural forests. The exception is the city of Iquitos and its surroundings, where the balance is negative.

Taking into account indirect biomass generated from residues from field crops, agro industry and wood processing industries in the analysis, the biomass balance of some areas improves. This is the case in several provinces in the costa, where the agricultural and agro-industrial activities generate important amounts of residues. Areas that showed net deficits in wood fuel supply switch to having net surpluses when these types of residues are considered.

Policy considerations emerging from the bioenergy potential from woody biomass and biomass from residues

Inadequate access to energy is a dimension of poverty that has negative implications for food security. The provision of energy opens an array of possibilities for households to improve their access to adequate amounts and varieties of food. For instance, access to energy provides the possibility of adding value to harvests, as well as new non-agriculture employment opportunities for the rural population, all of which improve household income and in turn access to food.

Out of the 70 000 small settlements of Peru, 50 000 of the smallest and most remote, still lack electricity. Reaching these households involves the highest costs in terms of extending the electrical network. There is an ongoing debate in Peru as to whether these populations should be resettled or if, in turn, technological alternatives should be sought to guarantee them with energy supply. The WISDOM analysis shows that many of Peru's regions have important volumes of biomass that could potentially be used to provide local energy

8 For instance, no figures were available for use of charcoal in restaurants in cities. These figures are presumably quite high and therefore the real deficits near the main coastal cities could actually be much larger.

solutions in rural areas. However, it remains to be determined what proportion of this biomass will actually be feasible for energy generation in each region. This would require extending the WISDOM analysis to carry out a more localized analysis in particular regions in order to define what is feasible and what is not. For example, woody biomass (including those derived from the harvesting of natural forests) and residues from forestry industries in the selva could be a potential source of energy for rural populations, either through direct use (i.e. burning for local electricity generation) or through the production of briquettes and biofuels using thermo-chemical processes. These two products could also be transported over long distances to areas that present woodfuel deficits.

With respect to agricultural residues, the WISDOM analysis shows a high potential for energy use, but policies are required to promote such use. Gianella (2010) estimates that 1 500 hectares of cotton could generate enough biomass residues to sustain a 3MW power plant that could operate 35 wells of 90 horse power each, which could aid in solving the water access problems faced by much of the costaal valleys of Peru. Similar use could be made of other agricultural residues such as from rice and maize, as well as from sugar cane leaves (which are already being used for the boilers of sugar refineries). Gianella (2010) also estimates that total agricultural crop field residues in the costa (using the average yields of the last 7 to 8 years and 40 percent of total crop residues generated) generates a volume that would allow the generation of 750-800MW during 7 500 hours-year, with a thermoelectric efficiency of 30 percent. This is an immense resource that is currently burned in the field. Moreover, using agricultural crop residues to generate electricity offers an alternative option to replace the current use of natural gas to power thermal plants. The tradeoff on economic opportunities is for natural gas, which has a higher energy value, to be more effectively used in activities with more value-added, such as in the petrochemical industry. In other words, burning natural gas for electricity is in a sense a waste of a valuable resource that can easily be replaced by agricultural and other types of residues. The available agricultural residues would allow the replacement of 150 million cubic feet of natural gas, which is the volume needed to operate a profitable petrochemical plant. As a result, it would be favourable to design policies that promote the establishment of small and medium energy-generation units that can add value and consolidate a market for these residues.

Finally, national and regional policies to promote high density forest or shrub plantations for energy used are required for areas that exhibit supply and demand balance deficits, especially in the Sierra region. For instance, high density plantations are promoted in Europe using eucalyptus and salix. However, a careful study is needed of the best locations in each valley and the potential energy that could be derived. High density and shrub plantations for energy purposes would have the benefit of controlling soil erosion, which is a critical problem in the Andean highlands. Policies to promote such plantations should build on lessons learned from reforestation projects experiences sponsored both by the government and the international cooperation in the highlands over the last 50 years.

3.3.3 LIQUID BIOFUEL PRODUCTION COSTS

Liquid biofuel production cost analysis is in essence a feasibility study to ensure that production costs are competitive. However, the scenarios considered to analyze competitiveness have a strong social dimension in that they explicitly consider how productions costs change when a proportion of the feedstock to the industry is supplied by smallholders. The following production scenarios were analyzed:

1) Production of anhydrous ethanol from sugar cane in the costa. Forty percent of feedstock is supplied by smallholders and 60 percent by a single large plantation.
2) Same as above but all production is supplied through one large plantation.
3) Production of hydrated ethanol from sugar cane in the selva. Forty percent of feedstock is supplied by smallholders and 60 percent by a single large plantation.
4) Production of anhydrous ethanol from molasses in the costa. Molasses have high opportunity cost.
5) Same as above but molasses have low opportunity cost.
6) Production of diesel from palm oil in the selva. Forty percent of feedstock if supplied by smallholder associations and 60 percent by a single large commercial plantation.
7) Same as above but feedstock comes from a single large commercial plantation.
8) Production of diesel from Jathropa in the selva. Forty percent of feedstock if supplied by smallholder associations and 60 percent by a single large commercial plantation. Smallholders have low productivity.
9) Same as above but smallholders have smallholders have a higher productivity.

Main results from the liquid biofuel production cost analysis

What the results suggest is that including smallholders in the supply chain can, *under some conditions,* be competitive with liquid biofuel production systems that are purely large scale. For governments, this type of analysis can be a powerful tool in negotiations with the private sector aligning better the purely profit-motivated interests of the private sector with those of the public good. Private sector investments might, as much as possible, meet wider socio-economic objectives. However, the onus is on governments to provide information to the private sector on how broader socio-economic objectives can be fulfilled.

Policy considerations emerging from the liquid biofuel cost analysis

There is a need to promote institutional constructs that support collective action by smallholders so that they can access more of the financial dividends offered from the bioenergy sector. The sugar and vegetable oil industries already have as common practice the purchase of part of their raw material from small landholders, who receive technical assistance from the companies that buy the harvest for processing. Similarly the Backus Beer Company buys corn from smallholders in Trujillo and also hires out technical assistance to these farmers to improve their yields. The company also helps farmers obtain bank credits by guaranteeing the purchase of their harvests. Policies to involve small landholders in the bioenergy sector can build on these experiences as a way of using bioenergy to promote rural development and the generation of income opportunities.

Smallholders that operate under associations have a stronger position to negotiate prices and also may have better access to technology that allows them to have higher yields that are comparable to large operations[9]. An important step would be to examine the key factors that explain why some producer associations are successful and to identify those factors that explain poor performance. In some cases producer associations can go as far as undertaking the industrial transformation of their own products, as has been the case of oil palm producers in Ucayali, who with UN funds have implemented an oil extraction facility. Whether this option would be feasible for the case of liquid biofuels or bioenergy production in general requires an in depth study.

For smallholders entering the bioenergy sector as feedstock suppliers brings new risks because liquid biofuel feedstock prices are a function of oil prices. However, commercial agriculture is always prone to price volatility, especially in the case of high value crops. In this sense liquid biofuel feedstock production would not be very different from the rest of agriculture. Nonetheless, the risk for bioenergy emerges from price volatilities in both agricultural and energy markets and policymakers in Peru would need to consider how best to support farmers during periods of high stress.

Bioenergy development can create opportunities for the poor through direct and indirect generation of employment that will increase income of families so that these have year-round access to adequate food. But to reap on these benefits does not necessarily imply that becoming a feedstock supplier is sufficient. Rather policy needs to find ways in which bioenergy developments create other opportunities in terms of better education and access to better nutrition and health, and other industries and services. Income benefits would therefore come either from direct participation in feedstock production, as paid workers in large operations or through access to cheaper energy sources that are produced locally and used for providing aggregate value to produce or generating other types of employment.

3.3.4 SOCIO ECONOMIC ANALYSIS

BEFS examines the socio-economic effect to the development of bioenergy systems in a given region using a set of tools that allows the assessment of two key aspects: the effects of the sector development on the whole country economy and the effects at the household level.

3.3.4.1 Economy-wide Effects[10]

In an examination of how a bioenergy sector can contribute to an economy the analysis

9 In a recent World Bank study it was shown that, in some cases, the yield per hectare if small landholders can be significantly higher than the one obtained in large plantations.

10 This brief was prepared by James Thurlow, who is a Research Fellow at the United Nations University's World Institute for Development Economics Research (UNU-WIDER), and at the International Food Policy Research Institute (IFPRI). James was a member of the BEFS team and conducted the CGE analysis for Tanzania.

provided by the CGE analysis shows how specific structuring of the bioenergy sector can contribute to a wider number of macro-economic goals: employment, GDP growth, exports, agricultural growth, poverty reduction. Depending on which of these multiple objectives takes priority a government may push for specific bioenergy developments.

Expanding biofuels production can have important implications beyond the biofuel feedstock and downstream processing sectors. This is because biofuels production may generate growth linkages (i.e., multiplier or spillover effects) to the rest of the economy. For example, producing biofuels requires intermediate inputs, such as transport services to get the biofuels to consumers or export markets. In this case, expanding biofuels generates additional demand for locally-produced services, which may create new jobs and income opportunities for workers and households linked to the biofuels supply chain. Moreover, these new incomes will eventually be spent on consumer goods and services, which again generate additional demand for non-biofuel products. Finally, there are macroeconomic linkages through which biofuels may stimulate economy-wide growth. For example, biofuels exports can relieve foreign exchange constraints, which often limit developing countries' ability to import the investment goods needed for expand production in other sectors. Together, these economic linkages can generate gains that are far larger than those generated within the biofuels sector alone.

However, while there are economy-wide gains to be had from expanding biofuels production, there are also constraints that may reduce production and incomes elsewhere in the economy. For example, biofuels production requires factor inputs, such as land and labor, which may be in limited supply in some countries. So allocating land to biofuels feedstock may reduce the land available for other crops. Indeed, increased competition over agricultural crop land has received considerable attention in the biofuels debate, largely because of concerns over food crop production and the possible implications of biofuels for developing countries' food security. However, even if unused land is available to produce biofuels, there may still be a displacement of labor from non-biofuel sectors, as laborers are drawn into biofuels estates/plants, or as smallholder farmers reallocate their time to producing feedstock crops. This means that as biofuel production expands, it may cause production in non-biofuels sectors to fall, thus offsetting at least some of the economy-wide gains mentioned above. Finally, biofuels producers may require tax incentives or supporting investments from the government, which reduces public revenues or investments for other activities, such as education or infrastructure (i.e., opportunity costs). This "fiscal displacement" may also slow development in non-biofuels sectors.

The above linkages and constraints imply that, in order to evaluate the full impacts and trade-offs of biofuels production, we need an analytical framework that looks beyond the direct private sector gains of biofuels producers. This framework would need to capture indirect or economy-wide linkages and constraints, while also considering both the macro- and microeconomic implications of biofuels. The economic method specifically designed to capture these impact channels is known as "computable general equilibrium" (CGE) modeling.

At the time of publication a CGE analysis is being carried out in Peru. Full details of this analysis will be available in a stand alone document at a later date.

3.3.4.2 Household-level Food Security

The household analysis considers the effects of price increases of key food commodities on households. Bioenergy places an additional source of demand on crops that are also used for food consumption. Prices are an important dimension of food security and can affect the net welfare position of the household. The analysis presented here can be seen as a tool to profile those likely to be vulnerable to price increases of key food crops.

Main results from the household-level food security analysis

a) Household level welfare impacts due to price increases in key food staples

- *Rice* is ranked as the first food security crop in Peru. Overall a 10 percent increase in the price of rice harms Peruvian households. The poorest segment of the population loses, on average, close to 0.1 percent of its welfare due to the 10 percent price rise. When distinguishing between urban and rural households though, the impacts vary by quintile and location.

  All urban households lose due to the price increase. The worst hit households are the first and second quintiles of the population. The bottom quintile in urban areas loses approximately 0.1 percent of their welfare due to the price increase.

  Wealthier households in rural areas generally benefit from the price increase (the fourth and fifth quintiles) while poorer households in rural areas lose.
- *Maize* is the second most important food crop in Peru. The increase in the price of maize tends to benefit the poorest segment of the population living in rural areas. In urban areas, all households are negatively hit by the price increase and the poorer segments of the population lose on average 0.1 percent of their welfare due to the price increase. The impacts in rural areas are quite diverse compared to the impacts in the urban areas. All rural households across the quintiles benefit from the price increase, with the poorest households benefiting the most. The rural poor gain approximately 0.2 percent of their welfare through the price increase.
- *Wheat* is the third most important food crop in Peru. The country is also a heavy net importer of wheat to meet domestic demand. Thus, as expected, impacts due to wheat price increases are severe throughout all quintiles of the population and across urban and rural locations.

  The poorest segment of the population suffers the most due to the price increase, whereby the 10 percent price increase leads to a reduction in household welfare of more than 0.3 percent. The urban poor lose on average 0.2 percent of their welfare while the rural poor lose close to 0.4 percent of their welfare.
- Potatoes, the country is a very large producer of potatoes and the welfare household level impacts are in line with the trade data presented. Overall, most households benefit from potato price increases whereby the price increase is positive for the

lower quintiles of the population, with the top two quintiles marginally losing. The poorer segment of the population increases their household welfare by 0.20 percent due to the potato price increase.

When distinguishing between the urban and rural poor the impacts are different but the urban poor still gain from the price increase. Poor urban households gain slightly from the price increase, while the remaining quintiles of the population in urban areas lose.

In rural areas, all quintiles gain from the price increase. The rural poor gain by approximately 0.3 percent on average.

- *Sugar*, at the household level impacts due to a 10 percent rise in the producer price of sugar are marginal for the country as a whole. Urban households are slightly negatively hit while rural households marginally benefit.

b) Household level impacts by region for rice and maize

The household level impact analysis can be extended using additional criteria that might be of interest to policymakers. The Peruvian government might want to further develop the analysis focusing on regions of specific interest given large discrepancies in growth across regions. The data show that large concentrations of poor households can be found in the central and southern Sierra region and in the Selva areas. From a poverty targeting point of view these regions would be an important starting point.

- *Rice:* assuming a 10 percent increase in the price of rice, the analysis shows that households gain from the price increase in the northern costa areas and in the selva, one of the poorer areas of Peru. All other regions, including the central and southern sierra stand to lose from the increase in the price of rice. From a vulnerability perspective, five regions and the Lima metropolitan area are vulnerable to rises in the price of rice. By contrast, the two remaining regions, costa norte and selva, benefit from the price increase. For those that lose, this loss is approximately 0.1 percent of their welfare. Households in the northern costa area, the households that benefit the most, on average increase their welfare by 0.05 percent.
- *Maize:* assuming a 10 percent increase in the price of maize, almost all regions stand to lose from the price increase except for Sierra Central and Selva. The Costa Sur and Lima areas are the most heavily impacted regions following the 10 percent price increase in Maize where households lose on average 0.14 percent of their welfare.

Policy considerations emerging from the household-level food security analysis

The BEFS household analysis indicates that the price of rice should be monitored closely since price increases impact on all poor groups of the population. The same applies to wheat, since Peru is a net importer of this commodity and any increase in the price of wheat has negative effects at the household level (the price of wheat in Peru has in fact been increasing over the last few years). Monitoring maize price increases will be important for the urban poor but not for the rural poor.

The BEFS household analysis tool alerts governments of where food security issues may arise due to price changes in basic foods. Such information can help the government plan specific interventions to mitigate the effects of price increases on the poorer segments of the population. Current government programs for poverty alleviation can serve as vehicles for helping poor households adjust to such price changes.

Peru has been implementing some mechanisms to help populations in extreme poverty, the most successful of which has been the Conditional Cash Transfer National Program "Juntos" which began implementation in 2005. The Program offers a US$30 per month cash transfer to families with children under 14 years or with a pregnant woman who live in extremely poor communities. Transfers are conditioned to the compliance of a series of requisites such as children school attendance and timely visits to health facilities of pregnant women and children. The Program has had some impact in increasing access to health and educational facilities among the target population. Compensation mechanisms such as Juntos could be used as a vehicle to provide a permanent safeguard against price fluctuations that might arise from bioenergy development. The effects of eventual fluctuations in the price of basic foods could also be monitored more accurately with the support of national data base such as the Household Focalization System (Sistema de Focalización de Hogares – SISFOH) that the Ministry of Economy and Finance has implemented to promote a more accurate focalization of social programs on poor and extremely poor households and, at the same time, to reduce filtration of non poor households.

Safeguard policies need to also take into account the effects of price fluctuations on the urban poor. Although the percentage of population that is affected by calorie deficits in urban areas is lower than in rural areas, in absolute terms it represents a larger population. Therefore the importance of also considering specific safeguard policies for the urban poor, which may vary from the ones applied in the rural sector, given the differences between urban and rural areas in terms of how population has access to food. For instance, food stamps could be an option to be explored for urban areas.

BEFS household analysis tool can provide relevant inputs to the Nutritional Strategic Program that the Ministry of Health has been implementing for the last three years and that is currently being monitored by the Ministry of Economy and Finances under the Results-based Budget (RBB). Moreover, BEFS household analysis could be incorporated as a tool in the Food Security Strategic Program that is currently being designed and will be implemented in 2011 under RBB.

3.4 KEY THEMES EMERGING FROM THE PERU ANALYSIS

Like most developing countries, the Peruvian government has multiple objectives to pursue which relate to growth, sector development, poverty reduction, food security, inequality, inflationary control and economic stability among others. Bioenergy development in Peru is seen as one important mechanism that could contribute to meeting some of these socio-economic objectives by promoting energy security, mitigation against climate change and contributing to growth. The BEFS project, through its varied analyses, can help identify the main issues that arise in pushing bioenergy developments by identifying the associated opportunities and risks that may impact on these objectives. BEFS offers the basis of a set of criteria that can be used to analyze different bioenergy pathways. These criteria can guide the government in defining which specific ways bioenergy should be developed for meeting wider social objectives. In this application of the BEFS tools the following themes emerge. However, it should be noted that future analyses building on the BEFS tools to incorporate new themes would raise new sets of issues.

3.5 BIOENERGY AND BIOFUELS: KEY ISSUES FOR RURAL DEVELOPMENT IN PERU

Bioenergy presents both opportunities and risks for rural development and food security. On the one hand, it could revitalize the agricultural sector, alleviate poverty and improve rural access to sustainable energy. However, if a sustainable management is not fostered, bioenergy could put food security at stake and hinder food access for the most vulnerable groups (Rossi & Lambrou, 2009; FAO, 2009). In this context, there are eight research and policy-specific issues that might need to be taken into account:

- **Guaranteeing basic energy supply for rural households.** Public investment for rural electrification has doubled as compared to 2006. The rural electrification coefficient has increased 27 percent from 2006 to 42 percent in 2009 (Coello, 2010). Despite this remarkable progress, out of the 70 000 small settlements of Peru, 50 000 of the smallest and most remote, still lack electricity. Reaching these has the highest costs in terms of extending the electrical network. The debate is still around whether these populations should be resettled or if, in turn, technological alternatives could be sought to guarantee them with energy supply. In this last respect, the potential of biomass residues to provide local energy solutions in remote locations should be further explored.
- **Considering the socio economic impact of land conversion.** Bioenergy, a less contaminant source alternative to conventional fossil fuel, has become an alternative in the context of climate change. However, its expansion in some countries is currently having an effect on the price of basic food products. This is related, among other factors, to a larger demand of rapid growth economies (China), unsuccessful harvest campaigns due to climate change and to the use of food crops to produce liquid biofuels (corn for ethanol) (IAASTD, 2009). Thus, policy needs to guarantee that promoting an energy alternative does not put food security at stake. A good example can be found in the use of arid land in the costa to cultivate sugar cane for anhydrous ethanol since it does not compete with food crops. Such expansion of the agricultural frontier may nevertheless generate a competition between food and non-food crops for the use of water. Second-generation biofuels could considerably minimize potential conflicts between bioenergy development and food security, since the required feedstock could consist of biomass from residues that do not

put pressure on agricultural land. However, it is uncertain whether technology for second-generation biofuels will be available in the short term.

- **Assessing the environmental impact of large scale plantations aimed at the liquid biofuel markets.** Liquid biofuel-associated emissions might not yet be large. However, the intensive production for energy in selva areas (oil palm) may negatively affect soil and underground water which could lead to deforestation and biodiversity loss (IAASTD, 2009). On the other hand, the development of large sugar cane plantations in the arid regions of the costa will increase stress on water resources. Such potential impacts need to be carefully analyzed and different alternatives to minimize these impacts should be assessed. For instance, the introduction of sweet sorghum may be a viable alternative to sugar cane for ethanol production because it requires less water use and therefore has a lower environmental impact in this respect.
- **Enhancing land use planning policies.** These policies should be grounded on solid information in order to ensure that agroenergy expansion occurs within environmental sustainability limits, avoiding unacceptable loses of natural habitats and the depletion of other natural resources such as soil and water. Additional management tools to support environmental sustainability of bioenergy developments are the Environmental Impact Assessment (EIA) and the Strategic Environmental Assessment (SEA). While an EIA is referred to an individual project, the SEA analyzes the cumulative impacts of various projects at a larger scale (e.g. watershed), thereby introducing the environmental variable into bioenergy development plans with regional or national scopes.
- **Promoting low-input and renewable energy supply alternatives.** "Modern" agriculture is based upon increasing amounts of energy from non-renewable sources, required for production, harvest and processing. Thus, improving agricultural systems and promoting sustainable rural livelihoods requires searching for new energy alternatives provided it is scarce. In this regard, Pimentel & Pimentel (2005) indicated that achieving agricultural sustainability among small and medium size growers implies, among others, to promote an efficient use of all energetic sources (solar, hydraulic and wind energy) as well as a rational biomass use (including the use of agricultural and forestry residues). In this respect, research and development of new technologies to take advantage of the existing biomass potential should be promoted.
- **Strengthening energy-related institutional platforms.** Aside from the previous considerations, consolidating planning, monitoring and managerial capacities is important for the satisfactory implementation of a national energy strategy that puts small landholding agriculture as one of its priorities provided it is "the" source of food supply for the entire country. These efforts, however, need to be implemented not only nationally but also locally. Increasingly stringent social and environmental sustainability standards from the liquid biofuel international market could be an opportunity to promote a better inclusion of smallholders in liquid biofuel development.

- **Planning across sectors and regions.** In order to ensure targeted use of public funds for bioenergy development in ways that promote wider social objectives, an integrated approach across a number of ministries: agriculture, energy, environment, water, forestry, production, women, transport and communications will be essential. Planning bioenergy development with social, economic, environmental, and food security goals and objectives requires the participation and commitments from all of these sectors. However, planning also needs to involve different levels of government (i.e. central, regional and local governments) in order to ensure that national and local plans feed into each other. A participatory decentralized planning framework will therefore facilitate the definition of policies and strategies that respond to the specific realities of each geographical region or territory but that also respond to broader national goals and strategies.
- **Ensuring governance across policy fields.** Coherent rules governing agriculture, energy, climate and broader development within the context of bioenergy are essential for consistency and stability of bioenergy policies that contribute to objectives in food security, poverty alleviation and natural resource management. Governance also requires clear delimitation of competences between the different sectors and government levels, which should also have enforcement mechanisms to ensure that bioenergy development occurs in compliance with land use plans and policies for environmental protection and natural resource management. In this respect, monitoring systems with concrete indicators are needed to assess the extent to which biodiversity policies contribute to the aforementioned objectives. Finally, solving the land tenure and ownership issues - still pending in many regions of Peru - is an essential requisite to achieve governance. This is especially true in the Amazon region, where a large majority of native communities and smallholders still do not have land titles.

3.6 HOW CAN BEFS SUPPORT LONG-TERM POLICY THROUGH ONGOING RESEARCH ANALYSIS AND DIALOGUE?

The Multisectorial Commission on Bioenergy will be the institutional platform for continuing the analysis and dialogue between technical experts and policy-makers that was initiated during the BEFS process. Besides the technical results that were produced, the BEFS process has consolidated a team of national experts that have acquired expertise in the application of the different analytical tools of BEFS. The process has also involved disseminating this knowledge among technical teams of the ministries of Energy and Mines, Agriculture and the Environment, as well as other consulting teams. The dialogue of BEFS experts with other technical experts and policy makers should continue in order for BEFS tools and methodologies to become an integral part of policy design and decision making on bioenergy development.

The Technical committee within the Multisectorial Commission has been an essential support for the BEFS process and is now supporting the development a National Bioenergy

Policy. The BEFS analytical framework could become an integral part of this policy design process through its application by the different technical groups that compose the Commission. BEFS could also be institutionalized across different government sectors for the design and implementation of national plans. For instance, BEFS tools should support the implementation of the Agroenergy National Plan, led by Ministry of Agriculture, as well as the Strategic Plan for Sustainable Energy and Bioenergy, which is led by the Ministry of Energy and Mines with support from the Inter American Development Bank. More specifically, the water evaluation and planning system (WEAP) could be an extremely useful tool for the National Authority for Water (ANA) and the Watershed Councils, especially for the elaboration of water resource management plans for each watershed. In order to ensure the adoption of the tools by the government, a suggested institutional arrangement could be to have the BEFS team become an advisory body of the Multisectorial Technical Commission that could provide training and technical support to the different ministries that compose the Commission.

BEFS analytical framework should also be used to support the on-going regional processes on bioenergy development. This is the case of the regions of San Martín, Lambayeque, Piura and Loreto, where Bioenergy Technical Boards (Mesas Técnicas) have been created to design local bioenergy development policies that originate from a consensus of the different stakeholders including, among other, regional government, farmers, private businesses and the decentralized units of the ministries. These local processes provide the opportunity to apply BEFS in specific territories, using a much more detailed level of information and adapting the tools to the reality of each area. Therefore, the expertise of the proposed advisory body for the Multisectorial Commission should also be made available to the regional and local governments.

In sum, based on a National Consultation conducted by the BEFS Project in May 2010, some complementary bioenergy-related long-term policy considerations might include the following:

- **Institutional arrangements.** These relate to the required platform in order to design, implement, monitor and evaluate bioenergy-related strategies in Peru. To this end, an important tool would be to prepare a stakeholder map of all relevant actors with emphasis on those at the governmental and private sectors. Moreover, such map would allow the identification of roles and responsibilities to be consolidated as part of the policy process.
- **Regulation.** In addition to institutional arrangements, regulation concerning bioenergy-related aspects might need to be organized, readjusted and disseminated among key stakeholders. To this end, it would be particularly relevant to involve further discussions between the public and private sectors aiming at the consolidation of advocacy coalitions in favor of sustainable rural livelihoods, as well as at the promotion of already existing managerial strategies and tools.

- **Measurement and documentation.** Aside from the current arrangements and regulation, Peru has embarked in systematically measuring the impact of several of its intervention. However, there is a need to consolidate measurement and documentations capacities. The BEFS methodological and software might be instrumental to this end so that the assessments could be replicated elsewhere.
- **Inter-institutional collaboration.** In addition to the above, one of the main opportunities Peru has is the existing Multisectorial Commission on Bioenergy. Thus, instead of creating a new space for collaboration, it would be highly advisable to consolidate the existing ones. As part of this process, it would be recommendable to actively involve the Ministry of Economy and Finance – especially its Public Budget National Directorate and the Multi-annual Programming Directorate – given that they are key decision makers.
- **Scaling up to sub-national levels.** As it has been discussed throughout this paper, it is likely that the "one-size-fits-all" solution might not succeed in a highly diverse context such as the Peruvian one. Thus, policy makers might be interested in adopting and adapting BEFS conceptual and methodological frameworks at the regional and local levels in order to support ongoing bioenergy, rural development and food security-related efforts.

3.7 CONCLUDING REMARKS

For bioenergy development to become one of the avenues for rural development it will be essential to consider the heterogeneity of rural population. Policies and solutions for rural development will be very different according to the ecological floor. For instance, in the Sierra there are farmers who are highly dependent on subsistence agriculture, but also depend on non-farm activities part of the year. Others in the higher parts of the valleys base their economy on livestock, especially sheep and camelids, while farmers in the lower valleys are more geared towards the commercial production. Each segment therefore presents different opportunities to benefit from bioenergy development and also require different types of safety nets for effects on food prices that biofuel development may have.

As discussed throughout this policy report, bioenergy development could be beneficial to the rural poor either through direct participation in feedstock supply or through the generation of new employment and income opportunities. Access to cheap sources of energy could make possible the creation of new non-farm activities that could provide new opportunities for income generation and poverty reduction in rural areas. In any case, in order to ensure that bioenergy becomes a sustainable alternative for rural development, related policies should be based on an intercultural approach, promoting participatory processes and outcome-oriented interventions. Such approach is discussed at length in Chapter 4.

REFERENCES

Cuánto. 2009. Anuario Estadístico Perú en Números 2009: Estadísticas del Progreso. Instituto Cuánto. Lima, Perú.

Coello, J. 2010. Energía y desarrollo rural. El año de las alternativas. En: Revista Agraria 118. CEPES. Lima, Perú.

Gianella, J. 2010. Personal Communication. Lima, Peru.
IAASTD. 2009. Bioenergía y biocombustibles: Oportunidades y limitaciones. Síntesis temática.

INEI. 2007. Censos Nacionales 2007: XI de Población y VI de Vivienda. Lima, Perú.

Pimentel, D. y M. Pimentel. 2005. El uso de la energía en la agricultura: Una visión general. En: LEISA, Revista de Agroecología 21 (1). ETC Sierra y Fundación ILEIA. Lima, Perú.

Rossi, A. & Y. Lambrou. 2009. Making sustainable biofuels work for smallholder farmers and rural households. Rome: FAO.

CHAPTER 4

RURAL DEVELOPMENT AND BIOENERGY: AN ALTERNATIVE APPROACH

Silvana Vargas

4.1 INTRODUCTION

This alternative approach is based on two perspectives: sustainable rural livelihoods and the community capitals framework. These perspectives have been disseminated by several international organizations (FAO, World Bank, DFID, CIAT) to promote strategies conducive to poverty alleviation and natural resource protection in rural areas. However, none of them has actually yet been applied to the discussion of bioenergy and rural development in the context of small landholding agricultural production. This is an attempt to do so.

In general, the literature suggests that the livelihoods to which vulnerable rural populations aspire should lead to achievable results according to their own expectations. These results include food security, less vulnerability to external threats, better health and education for families, higher income to buy what they cannot produce and a stable and productive natural resource platform (Scoones, 1998; CIAT, 2001). Bioenergy, as discussed in previous sections of this paper, could become a tool placed at the core of all these expectations.

4.2 DISCUSSION

In operational terms, the sustainable rural livelihoods approach has landed in a participatory methodology that has people's resources and potential as its core. To this end, several guiding principles have been identified and agreed upon (DFID & FAO, 2000). These include the following and could be applicable to the design of bioenergy-related interventions at the local level:

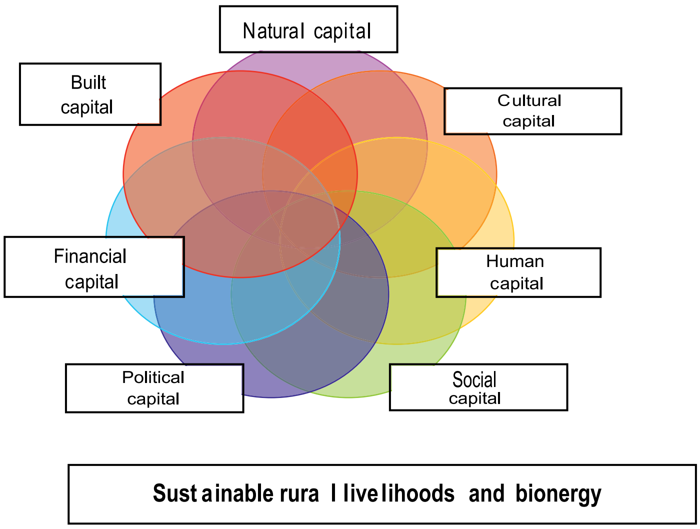
- **Involving people from start.** The "starting point" of the rural sustainable livelihoods approach is the analysis people's current resources and the way these change over time. This facilitates the identification of trends that, eventually, result in strategies to face adversity. In that vein, the approach emphasizes the active participation of the target population for the entire cycle research and/or project.
- **Promoting a holistic approach.** The approach recognizes that people adopt multiple strategies rather than a single linear one. In that sense, the analysis of rural livelihoods involves different levels, geographic areas and social groups. This allows for results triangulation and validation. Additionally, the approach recognizes that multiple stakeholder interaction (i.e., the private sector, ministries, community-based organizations, international agencies) is important.

- **Generating dynamic spaces.** Far from being static, social reality is extremely complex and in permanent change. This is explained by the co-existence of a range of external and internal factors that influence its structure and processes. Taking this into account, the rural livelihoods approach attempts to grasp this complexity and dynamism and its influence on the larger society.
- **Prioritizing people's potential.** The approach is based on the identification of the potential and opportunities that people themselves perceive rather than focusing, as many conventional approaches do, on their problems and needs. This, however, does not imply to overlook the context but to emphasize strengths over weaknesses. Thus, the approach supports and promotes the population's own strategies and mechanisms to satisfy their current needs.
- **Articulating "micro" and "macro" levels.** The approach examines, on the one hand, the influence of policies and institutions at the macro level. The idea is to understand how they affect livelihood alternatives and stress the need for policies to be defined considering the priorities and perceptions from the "micro" level. The articulation aims at promoting a horizontal dialogue between the different levels in order to create better conditions and opportunities for all, particularly the most vulnerable.
- **Emphasizing sustainability.** Sustainability is a main challenge for most interventions at the local level. In general, it could be understood as "the extent to which people can maintain current (positive) changes generated by an intervention once it is finished" (Bobadilla et al., 1998). This is important to achieve a lasting poverty reduction process. The sustainable rural livelihoods approach is an analytical tool to understand the interaction among livelihood strategies, policies and institutions. However, this needs to be tailored according the specific contexts. In many cases, this involves readjusting several elements to reflect social, cultural, political and economic realities.

Thus, one of the tools through which the sustainable rural livelihoods approach can be operationalized is the "community capitals framework". It analyzes community assets, as well as the way it organizes its efforts to achieve rural development. This is done through a systemic approach by combining type of capital investment, interaction among capitals and outcomes (Emery and Flora, 2006). The analysis includes seven types of capital: natural, cultural, human, social, political, financial and built. Following the approach of sustainable rural livelihoods, the community capitals framework also stresses potential rather than needs (Figure 4.1).

Figure 4.1

Community capital Framework: Interaction among capitals



In specific terms, each capital refers to the following issues:

- **Natural capital** refers to goods and services that characterize a particular place, including natural resources (air, water, soil and biodiversity), geography and natural beauty. Natural capital helps "connecting" the other types of capital to a specific geographic setting and facilitating the relationship among people.
- **Cultural capital** reflects the way in which people understand and experience the world, as well as their different strategies. This type of capital involves the worldview and cultural expressions such as language, food, art, clothing, etc. The cultural capital influences that people's voices be "heard." Additionally, this type of capital facilitates the understanding about how creativity and innovation nurture and influence each other.
- **Human capital** includes the skills and abilities people have and those that should be generated or enhanced by access to external resources. This process is aimed at increasing the potential of people, identifying effective practices and accessing information for the benefit of communities. Moreover, human capital refers to the ability to leading people to recognize their differences and focus on their assets (rather than on needs) through active inclusion and participation. Additionally, since human capital is usually identified with formal education, this approach gives priority to other types of local knowledge and the way these combine to create something different.
- **Social capital** is easily understood as the interrelationships and networks among people. These relationships can be either "bonding" (i.e., to the inside) or "bridging"

(i.e., to the outside) – meaning, working inside a community or with external entities such as government agencies and NGOs. In other words, social capital reflects the connections between people and social organizations. In some ways, social capital is the "glue" to facilitate that events will take place. Social capital promotes social cohesion.

- **Political capital** mirrors access to power and organizations, particularly with regard to resources. Political capital also refers to the ability of people to find their own voice and participate in actions that promote community welfare. In other words, this type of capital is understood as the ability to influence standards, regulations and the distribution of resources and norms.
- **Financial capital** is referred to the financial resources available to invest in building community capacity, supporting the development of enterprises, facilitating civil society initiatives, promoting social responsibility and accumulating wealth for future community development. This capital comes from savings, earnings, loans and investments. It increases the capacities of all the other capital types.
- **Built capital** includes the infrastructure to support the six previous types of capital. Among others, it includes housing, transport, communal houses, soccer fields, etc. It provides a platform for the generation of human and social capitals. The built capital becomes "human-made infrastructure" for the production of the other capitals.

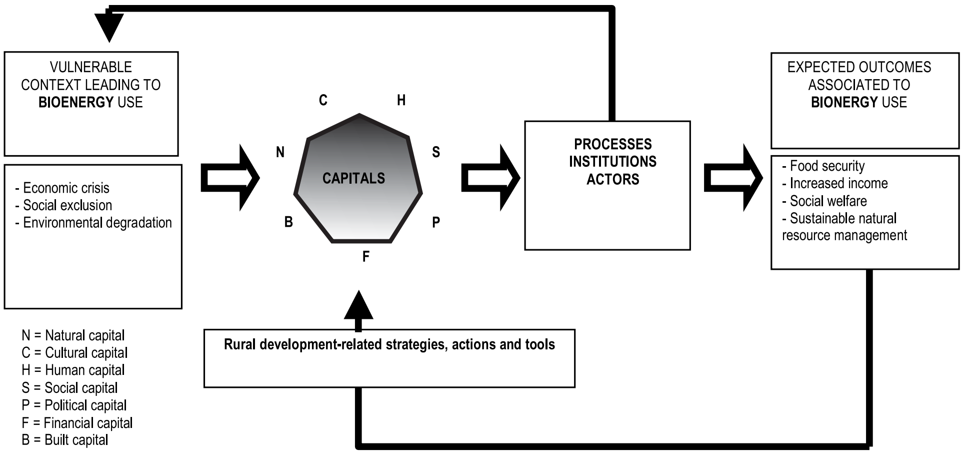
Methodologically, once the seven capitals are identified, it is possible to analyze which ones are the strongest and to establish interactions among them to define how to best utilize and support those that are less strong. This provides information for formulating relevant working strategies that are pertinent to the desired interventions.

The linkage between the sustainable rural livelihoods approach and the community capital framework is a conceptual alternative for understanding social change (Figure 4.2). In particular, addressing bioenergy effects on rural development might have to analyze how these seven capitals are configured and linked together to influence the various processes, institutions and actors oriented to generate outcomes such as higher incomes, greater welfare and sustainable use of natural resources. All of this needs to be framed in response to a context that is signed by a severe economic crisis, social exclusion and environmental degradation.

One of the central aspects of this approach is the generation of strategies, actions and tools. These, in contrast to conventional social theory, consider that actors are able to decide about their lives and entitle them to have a leading role in social dynamics. Thus, discussing the role of bioenergy within a rural development context could benefit from this approach in order to have communities themselves discuss the potential advantages and challenges of this alternative. Given that this approach prioritizes positive aspects, it has the added value of increasing community self-esteem.

Figure 4.2

Bioenergy and rural development: Applying the community capitals framework



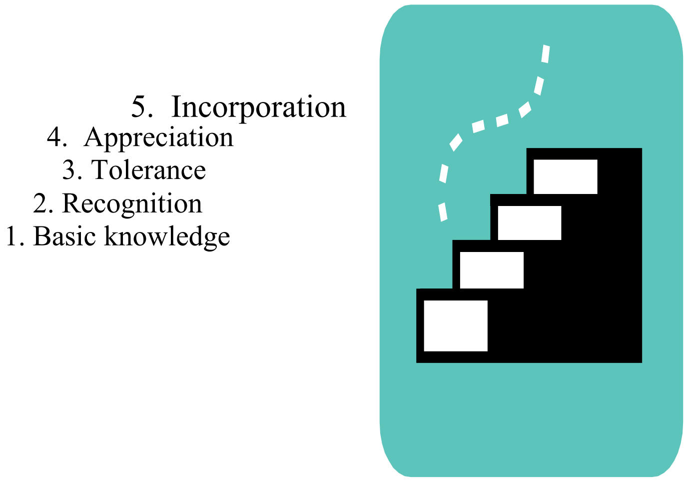
4.3 CONCLUDING REMARKS

Research and policy-making play a major role in ensuring that bioenergy becomes a sustainable alternative for rural development. As such, both of them need to facilitate processes in which food security is not put at stake and guarantee that its benefits reach vulnerable small landholding agricultural workers. In short, related policies should be based on an intercultural approach, promote participatory processes and outcome-oriented interventions. To this end, the following concluding remarks could support the analysis and further implementation of sustainable bioenergy experiences within a rural development context.

a. **Promoting sustainable bioenergy-related interventions from an intercultural approach.** Although this approach is currently part of the public discourse, some conceptual work is needed prior to its implementation. For instance, it is necessary to understand what it is and who is involved. Conceptually, inter-culturalism can be understood as a process of interaction, recognition and value of various expressions, discourses and cultural identities in a given space and time. Thus, intercultural communication refers to the set of strategies through which inter-culturalism is expressed, disseminated and communicated. It is worth noting that, generally, when speaking of the intercultural approach only target populations are prioritized. However, the approach also involves institutional staff (e.g., NGOs, Government, private sector). The approach can be operationalized into five stages: basic knowledge, recognition, tolerance, appreciation and incorporation (Figure 4.3). Attaining each of these stages implies the use of specific criteria and tools.

Figure 4.3

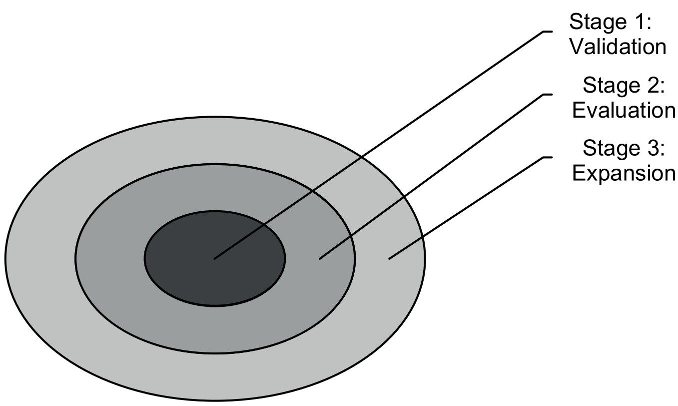
Sustainable bioenergy-related interventions: Stages of an intercultural approach



b. Implementing sustainable bioenergy-related gradual strategies. Strategies need to be tested before being expanded. The implementation of sustainable bioenergy-related interventions will need to work at three levels: validation, evaluation and expansion (Figure 4.4). Validation involves small-scale pilot testing to identify an experience's operational aspects in practice. Evaluation is the analysis of the validation results to identify "bottlenecks" and make the necessary adjustments. Finally, the expansion is the process of scaling-up the intervention once its assumptions and methodology have been tested and reviewed.

Figure 4.4

Sustainable bioenergy-related interventions: Stages



c. **Strengthening measurement systems and indicators.** If a sustainable bioenergy-related intervention is implemented, it would be highly advisable that it be measured and monitored throughout. In that sense, indicators are a crucial tool to learn about the progress that is being made to attain goals and targets. Indicators should follow the "S.M.A.R.T." rule. This means they should be specific, measurable, achievable, relevant and time-bound. In addition, given that results-based management is currently being promoted, it is advisable that the indicators matrix includes the "IPRI" indicators: input, output, outcome and impact (Table 4.1). We include a matrix applied to the potential implementation of a sustainable bioenergy-related intervention.

Table 4.1
Sustainable bioenergy-related interventions: Indicators matrix

Indicator type	Definition	Example
Input	Resources facilitated by the intervention	Number of brochures on advantages of sustainable bioenergy-related interventions
		Number of training videos about successful experiences of sustainable bioenergy-related interventions
Output	Goods and services produced by the intervention	Percentage of leaders trained in sustainable bioenergy-related interventions
		Percentage of local producers that have participated in experience exchange meetings about sustainable bioenergy-related interventions
Outcome	Changes occurred as a result of the intervention	Percentage of leaders that adopt new knowledge on sustainable bioenergy-related interventions
		Percentage of local producers that adapt sustainable bioenergy-related interventions to their context
Impact	Long-term changes	Number of validated participatory sustainable bioenergy-related interventions replicated in other communities
		Percentage of local producers that have a better quality of life due to sustainable bioenergy-related interventions

d. **Using effective communication tools throughout the sustainable bioenergy-related interventions.** An intervention might be technically sound, however, if it does not count on adequate communication strategies, there is a high risk it might not achieve its goals. In that sense, the way in which the relationship "sender-message-receiver" is established is important during the design, implementation and monitoring stages. Fortunately, there is now a range of tools to facilitate the process. Table 4.2 summarizes some specific recommendations on that line.

Table 4.2
Sustainable bioenergy-related interventions: Promoting intercultural communication

Design:
- Conduct a participatory preliminary assessment.
- Identify previous experiences (both successful and unsuccessful.
- Promote dialogue and consultation with stakeholders.
Implementation:
- Validate assumptions before implementation.
- Ensure the use of clear and accurate messages and of audio-visual materials.
- Involve local people as "agents of development".
- Foresee the target population as "partner".
Monitoring:
- Emphasize the use of participatory monitoring techniques.
- Develop a minimum set of indicators under the IPRI model.
- Document the process.
- Promote experience exchange.

e. **Involving other relevant actors.** Based on available information, it is advisable to develop a working plan that articulates the experience of other institutions that could collaborate and cooperate in the area. This strategy can contribute to implement cost-effective interventions, avoid duplicating mistakes and improve success in the area. To do this, as shown in Figure 4.5, is important to set a common goal: promoting sustainable bioenergy-related interventions.

Figure 4.5
Sustainable bioenergy-related interventions: Inter-institutional articulation

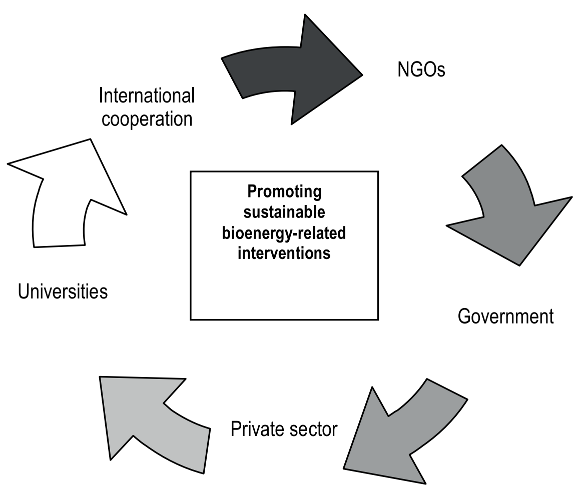
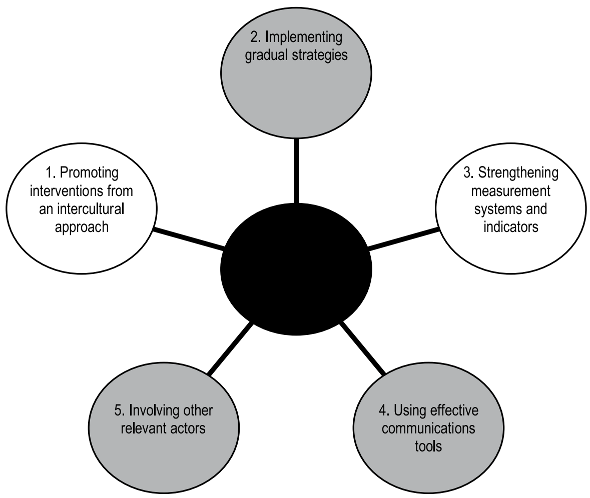


Figura 4.6

Sustainable bioenergy-related interventions: Synthesis of concluding remarks



Finally, as a general summary, it is worth emphasizing that these 5 concluding remarks constitute a "system" (Figure 4.6). That is, they are interdependent. The fulfillment of one of them does not guarantee success so, as much as possible; they should be implemented in parallel.

REFERENCES

Bobadilla, P., del Aguila, L. & M. Morgan. 1998. Diseño y evaluación de proyectos de desarrollo. Serie Manuales de Capacitación 3. PACT. Lima, Perú.

Centro Internacional de Agricultura Tropical – CIAT. 2001. Medios de vida sostenibles en zonas rurales. El plan estratégico del CIAT para 2001-2010 (Resumen). Cali, Colombia.

Departamento para el Desarrollo Internacional – DFID & Organización de las Naciones Unidas para la Agricultura y la Alimentación – FAO. 2000. Experiencias y lecciones interinstitucionales del Foro sobre la aplicación de enfoques de medios de subsistencia sostenibles. Pontignano (Siena), Italia.

Emery, M. & C. Flora. 2006. Spiraling-Up: Mapping Community Transformation with Community Capitals Framework. COMMUNITY DEVELOPMENT: Jour. Comm. Development Soc. Vol. 37, No 1.

FAO. 2009. Bioenergy and food security. Key Facts Sheet. FAO. Rome, Italy.

Scoones, I. 1998. Sustainable Rural Livelihoods – A framework for analysis. IDS Working Paper 72. Institute of Development Studies, at the University of Sussex. Brighton, UK.

FAO ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT SERIES

1. **Africover: Specifications for geometry and cartography, summary report of the workshop on Africover, 2000 (E)**
2. **Terrestrial Carbon Observation: the Ottawa assessment of requirements, status and next steps, 2002 (E)**
3. **Terrestrial Carbon Observation: the Rio de Janeiro recommendations for terrestrial and atmospheric measurements, 2002 (E)**
4. **Organic agriculture: Environment and food security, 2002 (E, S)**
5. **Terrestrial Carbon Observation: the Frascati report on in situ carbon data and information, 2002 (E)**
6. **The Clean Development Mechanism: Implications for energy and sustainable agriculture and rural development projects, 2003 (E)*: Out of print/not available**
7. **The application of a spatial regression model to the analysis and mapping of poverty, 2003 (E)**
8. **Land Cover Classification System (LCCS) + CD-ROM, version 2, Geo-spatial Data and Information, 2005 (E)**
9. **Coastal GTOS. Strategic design and phase 1 implementation plan, 2005 (E)**
10. **Frost Protection: fundamentals, practice and economics- Volume I and II + CD, Assessment and Monitoring, 2005 (E), 2009 (S)**
11. **Mapping biophysical factors that influence agricultural production and rural vulnerability, 2006 (E)**
12. **Rapid Agriculture Disaster Assessment Routine (RADAR), 2008 (E)**
13. **Disaster risk management systems analysis: a guide book, 2008 (E, S)**
14. **Community based adaptation in action: a case study from Bangladesh, 2008 (E)**
15. **Coping with a changing climate: considerations for adaptation and mitigation in agriculture, 2009 (E)**

Availability: August 2010

Ar	Arabic	**F**	French	**Multil**	Multilingual
C	Chinese	**P**	Portuguese	*	Out of print
E	English	**S**	Spanish	**	In preparation

FAO ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER

Groups: 1. Environment, 2. Climate Change, 3. Bioenergy, 4. Monitoring and Assessment

1. **Inventory and monitoring of shrimp farms in Sri Lanka by ERS SAR data, 1999 (E)**
2. **Solar photovoltaic for sustainable agriculture and rural development, 2000 (E)**
3. **Energía solar fotovoltaica para la agricultura y el desarrollo rural sostenibles, 2000 (S)**
4. **The energy and agriculture nexus, 2000 (E)**
5. **World wide agroclimatic database, FAOCLIM CD-ROM v. 2.01, 2001 (E)**
6. **Preparation of a land cover database of Bulgaria through remote sensing and GIS, 2001 (E)**
7. **GIS and spatial analysis for poverty and food insecurity, 2002 (E)**
8. **Environmental monitoring and natural resources management for food security and sustainable development, CD-ROM, 2002 (E)**
9. **Local climate estimator, LocClim 1.0 CD-ROM, 2002 (E)**
10. **Toward a GIS-based analysis of mountain environments and populations, 2003 (E)**
11. **TERRASTAT: Global land resources GIS models and databases for poverty and food insecurity mapping, CD-ROM, 2003 (E)**
12. **FAO & climate change, CD-ROM, 2003 (E)**
13. **Groundwater search by remote sensing, a methodological approach, 2003 (E)**
14. **Geo-information for agriculture development. A selection of applications, 2003 (E)**
15. **Guidelines for establishing audits of agricultural-environmental hotspots, 2003 (E)**
16. **Integrated natural resources management to enhance food security. The case for community-based approaches in Ethiopia, 2003 (E)**
17. **Towards sustainable agriculture and rural development in the Ethiopian highlands. Proceedings of the technical workshop on improving the natural resources base of rural well-being, 2004 (E)**
18. **The scope of organic agriculture, sustainable forest management and ecoforestry in protected area management, 2004 (E)**
19. **An inventory and comparison of globally consistent geospatial databases and libraries, 2005 (E)**
20. **New LocClim, Local Climate Estimator CD-ROM, 2005 (E)**
21. **AgroMet Shell: a toolbox for agrometeorological crop monitoring and forecasting CD-ROM (E)****
22. **Agriculture atlas of the Union of Myanmar (agriculture year 2001-2002), 2005 (E)**
23. **Better understanding livelihood strategies and poverty through the mapping of livelihood assets: a pilot study in Kenya, 2005 (E)**
24. **Mapping global urban and rural population distributions, 2005 (E)**
25. **A geospatial framework for the analysis of poverty and environment links, 2006 (E)**
26. **Food Insecurity, Poverty and Environment Global GIS Database (FGGD) and Digital Atlas for the Year 2000, 2006 (E)**
27. **Wood-energy supply/demand scenarios in the context of the poverty mapping, 2006 (E)**
28. **Policies, Institutions and Markets Shaping Biofuel Expansion: the case of ethanol and biodiesel in Brazil, in preparation (E)**
29. **Geoinformation in Socio-Economic Development Determination of Fundamental Datasets for Africa, 2009 (E, F)**

30. **Assessment of energy and greenhouse gas inventories of sweet sorghum for first and second generation bioethanol, 2009 (E)**
31. **Small scale Bioenergy Initiatives: brief description and preliminary lessons on livelihood impacts from case studies in Asia, Latin America and Africa, 2009 (E)**
32. **Review of Evidence on Dryland Pastoral Systems and Climate Change: Implications and opportunities for mitigation and adaptation, 2009 (E)**
33. **Algae Based Biofuels: A Review of Challenges and Opportunities for Developing Countries, 2009 (E)**
34. **Carbon finance possibilities for agriculture, forestry and other land use projects in a smallholder context, 2010 (E, F, S)**
35. **Bioenergy and Food Security: the BEFS analysis for Tanzania, 2010 (E)**
36. **Technical Compendium: description of agricultural trade policies in Peru, Tanzania and Thailand, 2010 (E)**
37. **Household level impacts of increasing food prices in Cambodia, 2010 (E)**
38. **Agricultural based livelihood systems in drylands in the context of climate change: inventory of adaptation practices and technologies of Ethiopia. in preparation (E)**
39. **Bioenergy and Food Security: The BEFS Analysis for Peru, Technical Compendium Volume 1: Results and Conclusions; Volume 2: Methodologies, 2010 (S)**
40. **Bioenergy and Food Security: The BEFS Analysis for Peru, Supporting the policy machinery in Peru, 2010 (E, S)**
41. **Analysis of climate change and variability risks in the smallholder sector: case studies of the Laikipia and Narok districts representing major agro ecological zones in Kenya, in preparation (E)**
42. **Bioenergy and Food Security: the BEFS analysis for Thailand, 2010 (E)**

Availability: August 2010

Ar	Arabic	**F**	French	**Multil**	Multilingual
C	Chinese	**P**	Portuguese	*	Out of print
E	English	**S**	Spanish	**	In preparation

The FAO Technical Papers
are available through the authorized
FAO Sales Agents or directly from:

Sales and Marketing Group - FAO
Viale delle Terme di Caracalla
00153 Rome - Italy

Background image in this page elaborated from "L'Encyclopédie Diderot et D'Alembert"

Other images: All photos are from the FAO Mediabase.

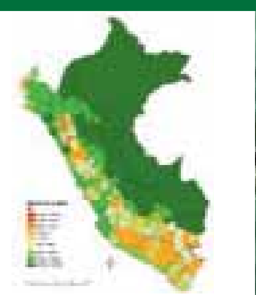
Copies of FAO publications can be requested from Sales and Marketing Group - Communication Division
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla - 00153 Rome, Italy

E-mail: publications-sales@fao.org
Fax: (+39) 06 57053360
Web site: http://www.fao.org

Environment and Natural Resources series design: studio@bartoleschi.com, 2004

Bioenergy, and particularly biofuels, have been promoted as a means to enhance energy independence, promote rural development and reduce greenhouse-gas emissions. In principle there are many benefits offered by bioenergy developments but these need to be balanced against the impacts on food security and the environment. While there has been a rush by many governments to develop bioenergy alternatives to fossil fuels this has often been done in the absence of a wider understanding of the full costs and benefits of bioenergy. In this context, the Food and Agricultural Organization of the United Nations (FAO) with generous funding from the German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) set up the Bioenergy and Food Security (BEFS) project to assess how bioenergy developments could be implemented without hindering food security. The project developed an analytical framework comprised of a series of technical analyses which allows for a holistic assessment on bioenergy development and food security. This analytical framework has been implemented in Peru, Tanzania and Thailand.

The analysis presented in this document describes the implementation of the BEFS Analytical Framework in Peru. The analysis provides an entry point into the issues surrounding bioenergy and food security. The results arising form the analysis should not be seen as definitive but they do provide strong direction in terms of identifying the policy priorities. As part of the activities under the project training is provided to build in-country capacity in the use of the BEFS tools so that the analysis may be repeated and extended to reflect the prevailing policy priorities and also to support policy adjustments as the bioenergy sector evolves.




Climate, Energy and Tenure Division (NRC) publications
Series: www.fao.org/climatechange/61878
Working papers: www.fao.org/climatechange/61879

NRC Contact: NRC-Director@fao.org

Food and Agriculture Organization of the United Nations (FAO)
www.fao.org