CHAPTER 3

USING THE BEFS ANALYSIS TO INFORM BIOENERGY POLICY DEVELOPMENT

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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.

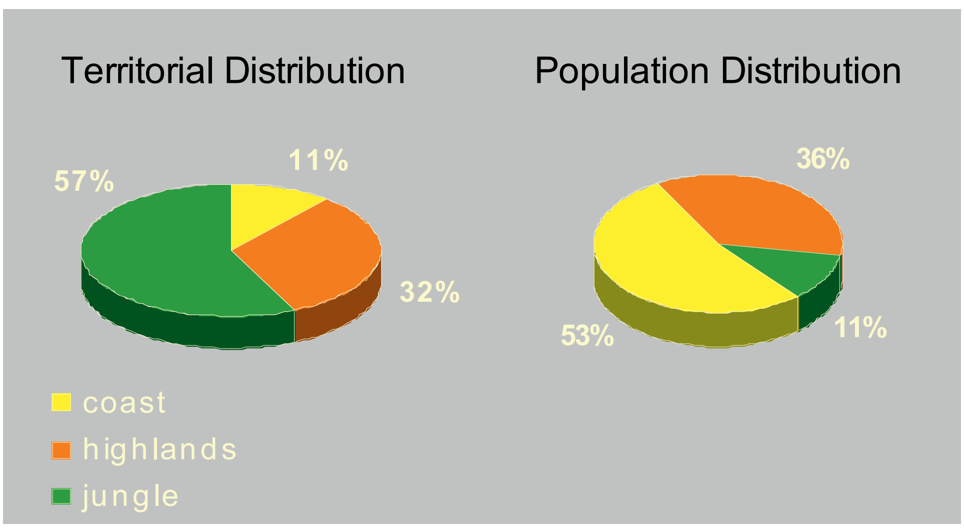
Consequently, urban-rural inequalities have widened. This is consistent with the argument that while agricultural growth is important for overall poverty reduction, it is the pattern of that growth that matters for inequality. The structure of competitive agriculture in Peru is increasingly shifting 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

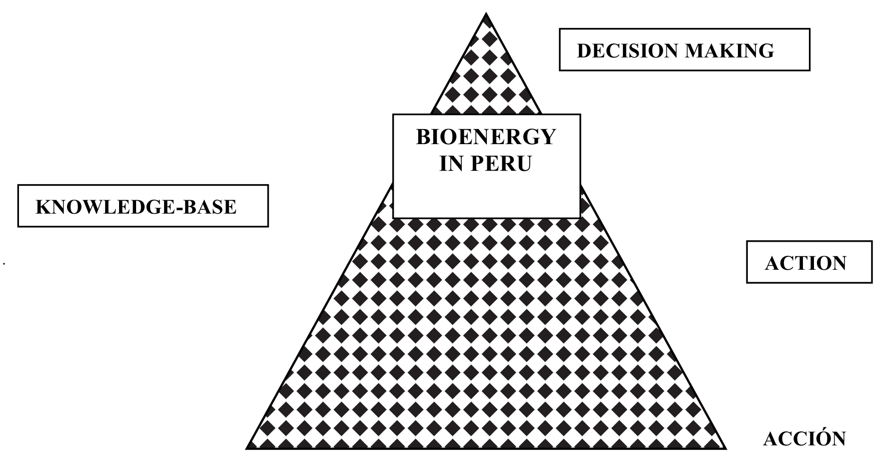
the potential for bioenergy production according to the Peruvian natural context. In addition, these assessments were relevant to validate measurement techniques on how to better approach bioenergy-related aspects.

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.

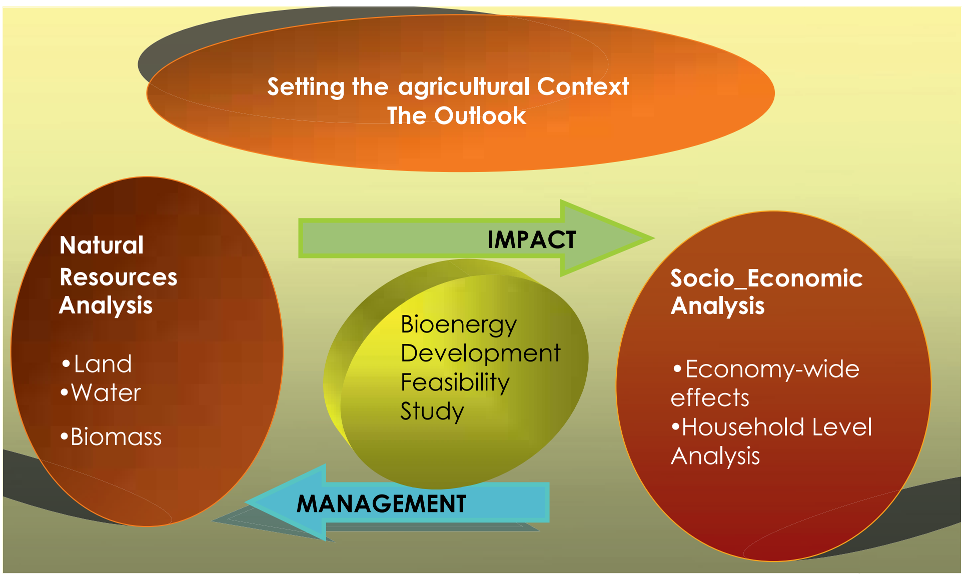
The starting point for the BEFS analysis is agriculture because this is the sector that the poor and extremely poor rely on for their livelihoods. However, the 21st century is seeing rapid changes to the sector driven by both national and international bioenergy policies within the context of promoting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



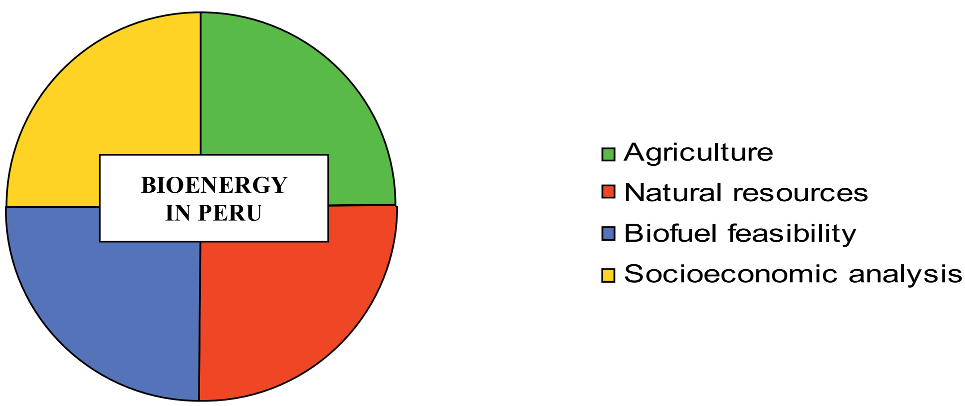
The BEFS Analytical Framework (AF) identifies the potential for bioenergy development from a natural resource perspective recognising the opportunities and pressures that changes in their use may offer to the poor. The analysis is not limited to biofuels but considers the potential of using residues 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.

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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.