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OPPORTUNITIES AND CHALLENGES OF BIOFUEL PRODUCTION FOR FOOD SECURITY AND THE ENVIRONMENT IN LATIN AMERICA AND THE CARIBBEAN

INTRODUCTION

1. As an agency dedicated to the generation, analysis and dissemination of knowledge and in response to the Kyoto Protocol, the Johannesburg Declaration of the World Summit on Sustainable Development (WSSD) and the Millennium Development Goals (MDGs), FAO has recently focused its policies and technical assistance on the sustainable promotion of biofuel production. Such policies encompass agronomy, land use, gender, technology, industry and environment.

2. FAO convened an International Bioenergy Platform (IBEP) to provide the critical linkages needed to facilitate transition towards a future of sustainable energy, combining local and global benefits and taking into account the welfare of future generations. However, further research and technical assistance are needed to maximize the opportunities from bioenergy production and to minimize the risks of compromising food security and the environment.

3. The FAO Regional Office for Latin America and the Caribbean has begun to coordinate activities with the countries of the Region to guide their bioenergy policies, through clear understanding of the food security and environmental implications and the scope of such policies. This paper outlines some of the important aspects of the discourse on the promotion of such policies, in areas of territorial development, regulation, technology and contractual relationships.

A. BACKGROUND TO BIOENERGY, FOOD SECURITY AND ENVIRONMENT

4. Bioenergy systems can be classified into three main categories: i) traditional biomass burnt directly for cooking or providing heat; ii) modern biomass-based technologies for the generation of electricity; and iii) liquid biofuels such as ethanol and biodiesel, mainly used in the transport sector[1].

5. This paper focuses mainly on liquid biofuels, as this is the segment of the bioenergy sector that has the largest and most rapid growth. There are also direct implications for food security as most of the associated crops can also be used as food.

6. However, the production of liquid biofuels can also help small farmers produce their own energy for their agricultural machinery and generate their own electricity, especially those in isolated areas. Small farmers could also benefit from better prices for their produce if they were properly incorporated into the agrofuel production chain.

7. The level of positive or negative impact of bioenergy on food security and the environment will depend on the scale and speed of change; on the type of production system applied; on the structure of commodity and energy markets; and on policy choices in agriculture, energy, environment and trade[2]. The rapid technological change that is taking place in the bioenergy sector makes it difficult to forecast the impact on food security and the environment.

8. Some countries clearly have suitable natural conditions to cover much of their energy requirement from agricultural commodities; others will have more difficulty.

9. For the former, it is essential to consider not only the objective conditions (technology, market structure, speed of change and policies), but also the need to build a solid institutional framework that can guide appropriate policies and technologies towards sustainable development of the production system.

B. DIMENSIONS OF FOOD SECURITY AND BIOFUELS

10. Expansion of the bioenergy sector could affect food security in the countries of Latin America and the Caribbean in four dimensions: availability, access, stability and utilization, with "access" the most sensitive dimension in the countries of the Region.

Availability

11. The countries of Latin America and the Caribbean possess large capacity for the production, export and import of food, so availability is not the main problem for food security. The Region has posted a relatively higher growth of agricultural production (about 0.7% each year from 1996 to 2005) and a higher proportion of food exports than the world average[3].

[1] The term "bioenergy" refers to the energy obtained from biomass which is the biodegradable fraction of products, waste and residue from agriculture (of vegetable and animal origin), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste (*Source*: Official Gazette of the European Communities, Directive2001/77/EC of the European Parliament and Council of 27 September 2001). For their part, "biofuels" are fuels derived from renewable biomass for use in internal combustion engines or for other forms of generation of energy, which can partially or totally replace fossil fuels (*Source*: Law N° 11.097 of January 2005, Brazil). In this document, liquid biofuels are essentially bioethanol (from the fermentation of sugar or starch of selected crops) and biodiesel (from the transesterification of vegetable oils).

[2] See "Assessment of the World Food Security Situation". Committee on World Food Security, CFS:2007/2, paragraph 45.

[3] FAO. 2006. “The State of Food and Agriculture 2006”.

12. However, the adequate availability of food could be threatened by biofuel production because of competition for inputs (e.g. land, water, fertilizers) and other factors that might be diverted from food production.

Access

13. This is the most sensitive dimension in Latin America and the Caribbean. It is measured by level of undernutrition, poverty and extreme poverty, and inequality. While recent reports indicate that undernutrition and extreme poverty have fallen in the Region, there are still 209 million people living in poverty (39.8% of the population); 81 million people in extreme poverty or destitution (15.4% of the population)[4]; and 52.4 million affected by undernutrition (10% of the total population)[5].

14. Biofuel programmes can represent an opportunity if these are focused on the smallholder sector with limited market access. Smallholder families would receive higher and more stable incomes from the creation of new markets and their integration into the production chain. For this happen, governments would have to establish appropriate support policies and mechanisms (financial, technological, organizational) that guaranteed and promoted the access to food of the more vulnerable sectors. A noteworthy example is Brazil's "Social Fuel Stamp" which promotes the inclusion of family farming in the biodiesel production chain, generating employment and higher income for this social group.

15. However, the rapid global expansion of agrofuels is likely to have a significant impact on agriculture in Latin America in the short term. This could trigger changes in demand, external trade and allocation of factors of production (land, water, capital) and higher prices of energy and traditional crops, thereby endangering food access of the poorest sectors.

Stability

16. Stability is the assurance that production activities and remunerative prices will be maintained over the long term. There is a risk of food instability in Latin America and the Caribbean because there is a lack of continuity in long-term policies. Stability is also linked to conservation of natural resources, but production is often unsustainable or is only rendered viable at the expense of other crops or activities[6]. Stability of food security will therefore be affected by the direction and design of biofuel policies and programmes in the Region and by their maintenance.

17. One incentive for biofuel production is the higher price of oil. However, this can impact in opposite ways[7]: *1)* higher oil prices increase agricultural costs, thus lowering production[8]; *2)* higher oil prices encourage the production of biofuels, thus raising demand for energy crops.

18. An increase in biofuel production will depend on which of these impacts prevails. In addition, the variation in impact of oil prices on agricultural production costs alters the incentives for producing individual energy crops, which can in turn affect the magnitude of transfer to other crops and thus their prices.

Utilization

19. Biofuel production could also affect the utilization dimension of food security indirectly, by reducing the availability of water for domestic uses. Some production systems require considerable quantities of water, both for production of the feedstock and for its conversion into

[4] ECLAC. 2006. Social Panorama of Latin America 2006. Economic Commission for Latin America and the Caribbean.
[5] FAO. 2006. The State of Food Insecurity in the World 2004: Monitoring progress towards the World Food Summit and Millennium Development Goals. Rome.
[6] For example, the felling of woodland to grow palm oil in parts of Asia.
[7] For more detailed discussion of these effects refer to OECD (2006) "Agricultural Market Impacts of Future Growth in the Production of Biofuels" Working Party on Agricultural Policies and Markets. OECD. Paris.
[8] The impact of an increase in oil price is not uniform as some crops are more energy intensive than others.

biofuel. The crops most commonly employed to produce ethanol and biodiesel, respectively sugar cane (*Saccharum officinarum*) and oil palm (*Elaeis guineensis*), have high water requirements (1500 to 2500 mm/year), while maize (*Zea mays*), cassava (*Manihot sculenta*), soybean (*Glycine max*), castor bean (Ricinus *communis*) and cotton (*Gossypium sp.*) are crops considered suitable for biofuels that require medium levels of water (500 to 1000 mm/year).

20. It is important to consider that some biofuel production systems make heavy use of natural resources, especially water, and could have a negative impact on food production in selected areas. Land and water quality and local genetic resources are central to safeguarding rural livelihoods and any contamination of this genetic heritage or intensive use of agrichemicals and water could undermine food security in Latin America and the Caribbean.

C. GUIDELINES FOR ACTION

21. Biofuels present both opportunities and risks for food security. Their impact will vary in space and time, depending on the evolution of market forces and technological advances. These elements will in turn be influenced by policy-decisions taken at national and international level. There is a need to develop an analytical framework that takes into account the diversity of situation and the specific needs of countries. FAO's Bioenergy and Food Security (BEFS) Project is developing an analytical framework and a methodology guide. The first target country will be Peru, with others following. The project highlights the energy potential and the implications for food security in the specific national and sub-national contexts. Field activities can then be developed to build institutional capacity and to promote sustainable bioenergy in the context of rural development.

22. It is the responsibility of governments to take the initiative in formulating this analytical framework, which will serve to maximize the opportunities and minimize the risks of biofuel production, taking into account the realities of each country.

23. Besides implications for food security and agricultural structure, biofuels also have implications for agro-industrial development and the creation of employment. The proportion of cost deriving from feedstock depends on scale of production and type of fuel and tends to be higher for small-scale production and higher for ethanol than for biodiesel. In remote rural areas where fossil fuel prices are generally higher due to transport costs, bioenergy systems may be the most economical option[9].

24. It is necessary to know the *ex-ante* position (positive or negative) of potential stakeholders (governments, other public and private actors) in the development of a policy of production and/or utilization of biofuels, regarding the different policy instruments needed for its implementation and the monitoring of the respective impacts.

25. Implementation of appropriate policies can reduce the risks that the adoption of bioenergy crops can have on food security and the environment. The potential of the bioenergy sector for reducing poverty and hunger in the world depends to a large extent on the design and correct application of policies in the following areas:

(i) Territorial development and management policies, starting with agro-ecological zoning indicating land available for bioenergy crops, a system of incentives and penalties for utilization of forests and water.

26. The production of biofuels must be directed towards sustainable territorial development. Territories with biofuel potential often comprise communities that have limited social organization, no or poor basic social or technological infrastructure, and problems entering the global market place. Overcoming these shortcomings requires expertise, logistics and technology. Territorial development policies need to adopt a comprehensive perspective of the region in question, embracing its identified production potentials and its assorted economic, political, technological, legal, cultural and environmental problems.

[9] See UN-Energy (2007). “Sustainable Bioenergy: A Framework for Decision Makers" (p. 13).

27. Territorial development based on the agricultural production of biofuels could facilitate the incorporation of developing-country small farmers into the emerging biofuel market, especially in Latin America and Africa. Territorial policies and management can guide these Regions and inform their farmers of the opportunities and risks of biofuel production, as they organize into associations and cooperatives to process and market bioenergy feedstock.

28. Liquid biofuel programmes can add value to the products of small farmers but they can also lead to a concentration of ownership, excluding the poorest farmers and driving them deeper into poverty. Special attention needs to be given to farmers who are not landowners and to the urban and rural poor who are net food purchasers, as they could suffer even greater pressure on their already limited financial resources.[10]

29. On the other hand, agro-ecological zoning or inventories of natural resources should consider the potential impacts on land that is going to be used for biofuel feedstock, especially virgin land and land with high conservation value, and the associated effects on habitat, biodiversity and quality of water, air and soil[11].

30. The first step of a territorial development policy is to identify each region's potential for biofuel production and its viability for family farming. The tacit and institutional arrangements can then be identified and strengthened to have the clear rules needed to promote entrepreneurial actions based on horizontal relationships with other workers.

(ii) Technological policies that explore all feedstock possibilities of the region and that are accessible to small farmers and oriented towards small-scale technologies, both for agriculture and for industry and end consumption.

31. The diversity of soil and climatic conditions in the Region offers a wide range of biofuel feedstock[12]. The starting point for a biofuel programme should be examination of biomass production potential by region, in order to maximize the opportunities from bioenergy production and minimize the risks of compromising food security and the environment.

32. The technological determinants of final volume of biofuel production are divided into: biomass conversion technologies; physical and chemical characteristics of feedstock; production yields per unit area (volume of biomass). Examination of these three elements will determine the optimal sources of feedstock and the most efficient technologies to be used in each case (region, country, community, etc).

33. The conversion technologies are the physical and chemical processes that turn biomass into secondary energy carriers (liquid, solid and gaseous). The technologies determine the degree of utilization of feedstock. Policies are needed that will promote (i) research and innovation, at national level, of production and processing technologies that use local resources (scientific, feedstock, organizational, financial, etc.) as well as the intraregional transfer of technologies; and (ii) efficient small-scale processing of biofuels so small farmers can benefit from the on-farm consumption of clean energy.

34. The intrinsic physical and chemical characteristics of the energy crop (content of starch, sugars, lignocellulosic matter) determines the quantity of biofuel obtained per volume of biomass and the quality (calorific value, density, lubricity, cetane number and flash point). Policies are needed to promote research and development of agricultural and forestry varieties that have a higher content of oils, sugars/starches and lignocellulosic matter for the different crops.

[10] UN-Energy (2007). (p. 28).
[11] UN-Energy (2007). (p. 50).
[12] There are two general categories of primary biomass for the production of biofuels: energy crops and waste. 1) Energy crops are divided according to their characteristics: sugar crops (sugar cane, sugar beet, etc.), starch crops (cassava, potato, cereals), oilseed crops (rapeseed, soybean, sunflower, etc., short-rotation forestry crops (willow, popular, eucalyptus), and herbacious crops (*switchgrass*, miscanthus, etc.) (Hoogwijk et al. (2005). "*Potential of biomass energy out to 2100, for four IPCC SRES land-use scenarios*". Biomass and Bioenergy 29, p. 225-257), 2) Waste is divided into: forestry, agricultural, animal droppings (dung) and solid municipal waste (organic waste, animal fats) and liquid municipal waste (used oils).

Feedstocks with higher usable energy content per volume of biomass would reduce pressure on the soil and, therefore, on food security. However, it also important to assess the potential impact of genetically modified species on fragile ecosystems.

35. Environmental regulation is also important to prevent the intensive use of fertilizers and agrochemicals that can endanger ecosystems. In places with limited rainfall, the utilization of water to irrigate energy crops should be carefully examined, with priority given to water used for food production.

36. Countries need to develop a policy of efficient utilization of waste which is a potential source of short-term feedstock because of its low cost, underutilization and abundance. Efficient crop residues currently available in Latin America and the Caribbean for the production of ethanol are bagasse, maize stalk and rice straw. Related policies should take pains to involve the family farming sector in the poorest regions.

(iii) Policies for the regulation of product and service markets that clearly set out the regulatory framework for the use of biofuels, trade rules, incentives and taxes.

37. The definition of regulatory instruments is linked to the influence and level of organization of producers in the bioenergy chain; to the relative importance of the sector; to the energy security of the country; and to the level of technology achieved (innovations, diversification and skills). However, to ensure the sustainable development of the biofuel production chain, initiatives to increase production and consumption need to be analysed within the legislative context and each country's adherence to international commitments.

38. There is a need for greater understanding of the conjunction of institutional forms that fashion, channel and, in some cases, coerce the behaviour of actors and predetermine adjustment mechanisms in biofuel markets. In Latin America and the Caribbean, the process of formulation of the regulatory framework has been approached differently, in accordance with the interests and limitations of each country. Some countries have already established their national bioenergy programme while others have only approved the enabling legislation. Hence the need for countries to exchange experiences and information so that they can understand and evaluate the different policy and programme options.

39. Regulatory policies are essential to integrate family farming into the international bioenergy market. For example, by organizing themselves into cooperatives and associations, smallholders can increase their competitiveness and enter the biofuel production chain. Environmental certification is an important control mechanism to guarantee that small farmers and large agro-industrial enterprises alike meet environmental sustainability criteria.

40. The biofuel regulatory policies most used in recent years are:

- fixing of prices of inputs, feedstock and end products;
- control of production (including quotas) and other price maintenance measures;
- marketing rules and environmental restrictions (certifications, standards, etc.);
- tax exemptions for vegetable oil plants (certificates, stamps, etc.);
- financing for the establishment of biodiesel industrial plants;
- mechanisms for the mediation of disputes between purchaser and vendor countries;
- direct and cross-subsidies;
- adoption of mixing ratios and incentive measures for transportation using biofuels;
- laws limiting the burning of cane fields; and
- laws to protect rural workers.

(iv) Policies to improve contractual relations between actors in the production chain, from primary producer to end consumer, including the incorporation of family farming and the assurance of labour rights.

41. It is important to promote rules that help improve contractual relations between the various actors (farmers, processors, distributors, service stations, etc.) involved in the agroenergy production chain in the Region.

42. Contractual relations are first subject to institutional environments and regulatory policies, regardless of the segment of the chain involved. These relations also depend on the behaviour of actors and the governance structure.

43. There is more land and production concentration where hierarchical structures predominate, significantly heightening the marginalization of family farmers. Advance in agroenergy production should not be at the expense of worsening rural labour conditions. Policies to guarantee and improve rural workers' rights are important if the ethanol and biodiesel production chains are to have positive social impacts.

44. Governance structures have positive and negative impacts on contractual relations in the production chain and must therefore be constantly fine-tuned. Discussion and comparison of these structures is strategically important for sustainable agroenergy development policies. Specific aspects can be: (a) geographical (proximity of consumer market to distributor; of supplier of feedstock to processing plant, etc.); (b) temporal (advance programming of production and supply of feedstock); (c) physical (milling capacity of a plant or harvesting capacity of machinery); (d) human resources (operating performance of harvesters and increasing demands placed on them) and (e) commercial (contractual relationship between two economic actors, such as the leasing of land); among others.

45. Policies and processes aimed at improving contractual relations need to consider the behaviour practices of stakeholders (agricultural and industrial producers; service providers; consumers; public agencies of the State, etc.). Uncertainty in the economic and institutional environments affects the bioenergy chain and permits the opportunistic actions that are inherent to the negotiation process.

46. Opportunistic actions that influence the final price of biofuel are manifold. They differ throughout the production chain (overcharging, illegal measures and forgery, etc.) and have a negative impact on the end consumer. Such actions threaten the sustainability of a regulatory and business model, especially in the case of agroenergy chains which still have to build their reputation.

47. Public policies need to consider the recent changes and concentration in the biofuel distribution structure. Further studies should produce greater efficiency of distribution systems, avoiding price increases and enhancing socio-economic outcomes.

D. FINAL CONSIDERATIONS

48. The FAO Regional Office for Latin America and the Caribbean will focus on policies based on the development of subregional bioenergy strategies. Emphasis will be placed on the potentialities and sustainability of agroenergy, supporting and assisting field programmes and projects, and preparing databases and strategies for communication and outreach on biofuels.

49. These activities will be the first steps of a work agenda that considers agroenergy structure and diversification in the countries of the Region, in terms of production, regulation, trade, technological capacity and innovation. Equally important will be consideration of the fuel consumption structure in order to avoid waste in a context of increasing energy consumption.

50. The countries are invited to discuss a Voluntary Code of Conduct for the Production and Utilization of Bioenergy. Collaboration with other international organizations will be bolstered, generating synergies to optimize the results of multidisciplinary activity. The objective will be to apply policies and good practices that can steer public and private intervention in the promotion of sustainable development and poverty reduction. This will also help prepare the regulatory ground for the formation of an international bioenergy market.