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The role of bioenergy in a climate-changing world

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ABSTRACT

Bioenergy has been under intense scrutiny over the last ten years with significant research efforts in many countries taking place to define and measure sustainable practices. We describe here the main challenges and policy issues and provide policy recommendations for scaling up sustainable bioenergy approaches globally. The 2016 Intended Nationally Determined Contributions (INDCs defined under the UN Framework Convention on Climate Change) (UNFCCC) Conference of the Parties (COP21) will not reach global Greenhouse Gas (GHG) emission targets of 2 °C. Sustainable biomass production can make a significant contribution. Substantive evidence exists that many bioenergy cropping systems can bring multiple benefits and off-set environmental problems associated with fossil fuels usage as well as intensive food production and urbanization. We provide evidence that there are many approaches to land use for bioenergy expansion that do not lead to competition for food or other needs. We should focus on how to manage these approaches on a synergistic basis and how to reduce tradeoffs at landscape scales.

Priorities include successful synergies between bioenergy and food security (integrated resource management designed to improve both food security and access to bioenergy), investments in technology, rural extension, and innovations that build capacity and infrastructure, promotion of stable prices to incentivize local production and use of double cropping and flex crops (plants grown for both food and non-food markets) that provide food and energy as well as other services.

The sustainable production of biomass requires appropriate policies to secure long-term support to improve crop productivity and also to ensure environmental as well as economic and social benefits of bioenergy cropping systems. Continuous support for cropping, infrastructure, agricultural management and related policies is needed to foster positive synergies between food crops and bioenergy production.

In comparison to fossil fuels, biofuels have many positive environmental benefits. Potential negative effects caused by land-use change and agriculture intensification can be mitigated by agroecological zoning, best management practices, the use of eco-hydrology and biodiversity-friendly concepts at field, watershed and landscape scales.

Global climate and environmental changes related to the use of fossil fuels and inequitable development make it unethical not to pursue more equitable energy development that includes bioenergy. To achieve sustainable development, competitiveness and costs of bioenergy production need to be addressed in a manner that considers not only economic gains but also development of local knowledge and social and environmental benefits.

1. Introduction

Over the past two years, 137 experts from 24 countries and 82 institutions have collaborated to analyze a range of issues related to the sustainability of bioenergy production and use. The resulting assessment *Bioenergy & Sustainability: Bridging the Gaps* (Souza et al., 2015a) was launched at a symposium at the World Bank on September 28, 2015, in Washington DC, USA. During the symposium, authors highlighted key findings and discussed opportunities and challenges for sustainable energy in developing regions as well as the role of bioenergy in the 2030 and 2050 time horizons. The symposium brought together invited representatives from a range of research institutions, government and non-government agencies and key staff from the World Bank. The report was coordinated by scientists linked to the research programs of the São Paulo Research Foundation (FAPESP) on Bioenergy (BIOEN), Global Climate Change (RPGCC), and

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Box 1. Some bioenergy policy-relevant issues.

- Is bioenergy really needed, and why?
- Is there enough land to produce bioenergy without jeopardizing food security?
- Can bioenergy be deployed at the scales needed without inducing unintended land-use changes?
- Can we deliver enough biomass, and how?
- Is bioenergy efficient?
- What are the bioenergy impacts for the environment?
- Under what conditions does bioenergy reduce greenhouse gas emissions?
- What happens to food production, biodiversity, water and soils in multi-functional landscapes?
- What evidence is there that sufficient land and resources are available?
- Under what circumstances can bioenergy enhance food security?
- How can biofuels compete with low fossil fuel prices?
- What needs to happen in financing and commercialization schemes?
- What research needs to be conducted to fill in the gaps in understanding how bioenergy contributes with maximum benefits?

Biodiversity (BIOTA) and was supported by FAPESP and the Scientific Committee on Problems of the Environment (SCOPE), an international non- governmental organization. We summarize discussions on policy, challenges and recommendations for scaling up sustainable bioenergy approaches globally (Souza et al., 2015b). Since most of the bioenergy is derived from plant biomass, the scientific knowledge about its production and supply chains needs to be appropriately disseminated to inform policy making. Box 1 lists some of the aspects discussed by policy makers and scientists at the World Bank meeting in 2015.

2. Meeting energy security sustainably

Energy consumption patterns in OECD and non-OECD countries show that most increase in energy use will take place in developing countries. Because there is a direct relationship between energy consumption and economic activity, increased consumption brings opportunities for human development, better education levels and improved public health (Dale and Ong, 2012). With the advent of global trade as practiced in the last 15 years where lowest cost of products was practiced for economic benefits without accounting how damaging to the environment this would be, more critical analysis are looking at the sustainable production and consumption patterns that are beneficial all around and that consider the comparative advantage of nations. For instance, in the case of biomass and bioenergy, developing countries that have adequate land and water may be more suitable to produce bioenergy (Chum et al., 2015). Moreover, increasing energy demand for development in non-OECD countries makes it critical that they have access to sustainable energy sources. Otherwise, they will be pushed to use fossil energy and thereby compromise global efforts to reduce emissions of greenhouse gases (GHG).

Fortunately, several alternatives exist to increase the share of renewables in the energy matrix including various bioenergy options (Foust et al., 2015), and developing countries' investments in renewables surpassed those of developed countries in 2015 (REN21, 2016) representing 19.2% of the share of global final energy consumption. Bioenergy initiatives exist in several countries in the world that contribute to a significant share of their energy matrix providing liquid biofuels, bioelectricity, biogas and heat (Fig. 1). Provided that good management practices are followed and efficient systems are used, bioenergy can have several added benefits besides energy security, including food security, climate security and sustainable development (Osseweijer et al., 2015; Nogueira et al., 2015; Kline et al., 2016), and we now know that based on the 2016 INDCs (Rogelj et al., 2016) even the global GHG reduction targets of 2 °C will not be reached without bioenergy. Sustainable biomass production can make a significant contribution to climate change mitigation while also providing diversification of energy resources in the long term. Major global GHG mitigation scenarios show that a primary energy use average contribution of 25% from bioenergy is possible e.g. International Energy Agency (2011); Global Energy Assessment (2011); IPCC et al., 2014; OECD/IEA (2011) as well as Greenpeace, and the World Wildlife Fund. In the AR5 (IPCC et al., 2014) and the IPCC Synthesis Report (IPCC et al., 2015), bioenergy coupled with carbon capture and storage (CCS) have a major role to play, principally if nations did not start levelling emissions by 2030, very likely with the current pledges

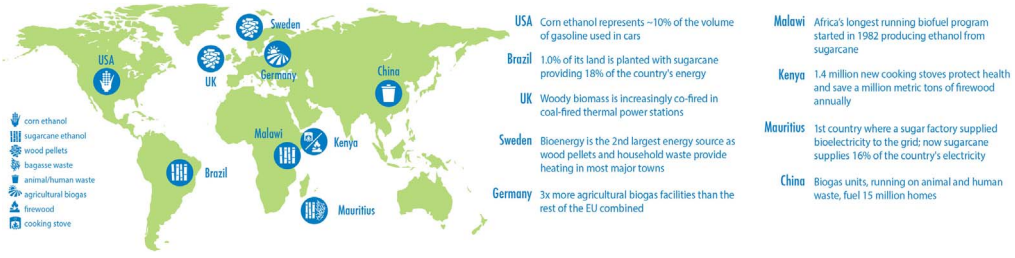

Fig. 1. Examples of biofuels, bioelectricity, biogas and heat from biomass that are increasingly contributing to energy supply around the world. See also the shares of biomass in total final energy consumption and in final energy consumption by end-use sector (REN21, 2016).
Source: FAPESP-SCOPE Bioenergy & Sustainability Policy Brief (Souza et al., 2015c).