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Meeting the Growing Demand for Food and Bioenergy in the 21st Century: Synergies through Efficient Waste Management

By

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Introduction

There is a universal need for safe, affordable and reliable source of energy. Advances towards more sustainable energy supply by decoupling resources use from economic growth is on top of the agenda in many countries, hence renewable energies are given priority. Bioenergy potential varies across geographical regions around the world. However, as a general trend, the growing demand for bioenergy meets an increasingly land-intensive food consumption pattern.

Identification and shaping of research pathways towards sustainable food systems within the ‘Future Earth’ programme was one central aim of the Post-doctoral Networking Conference on ‘Food Futures’ held in April 2013 under the auspices of the International Council for Science (ICSU), the German Research Foundation (DFG) and the International Social Science Council (ISSC). This commentary builds on the analysis and presentation made at the conference. Although bioenergy was not an explicit topic during the meeting, it is evident that consideration of both the synergistic and competitive relationships between energy demands and food security is essential when looking at creation of future food systems.

Generally, the bioenergy systems hold potential to contribute to sustainable progress in developing and developed nations if the interrelations with food supply and management of resources are well understood. This is set in a context of rising populations, increasing economic development, climate change, and resource utilisation strategies. With view to future-orientated frameworks, it needs to be highlighted that biomass has a unique status as the most basic material for human subsistence and the majority of poor rural communities rely heavily on it for their energy needs. In an economic perspective biomass significantly stands out from other material groups as it has been identified to be a resource of high economic inelasticity which is largely driven by population and not by economic development [1]. Utilisation of biomass as a commercial energy carrier bears the risk inducing a closer coupling of biomass use and economic wealth, which might further increase global inequality [1].

This commentary argues that the need for bioenergy and food can reinforce each other both in developed and in developing countries through efficient and sustainable waste management strategies. The article highlights prospects and challenges of implementing efficient waste management in order to ensure food and biofuel security. Besides, it argues for the formulation of sustainable policy and regulatory framework, which underscores the link between sustainable bioenergy and food security strategies. The study advocates for a comprehensive bioenergy policy and country-specific strategies for promoting investments in biofuel and food security research along with consideration of sustainable waste management synergies.

Waste Management and Food-Bioenergy Synergies

Assessment of global bioenergy potential is subject to a variety of studies. Bioenergy systems have the potential to interfere with food security in three ways: (1) diversion of food crops to energy use, (2) creation of competition for land, labour and capital between energy and food crops, and (3) increasing the prices for food through the increased demand of food crops [2]. When looking at possible alleviation of competing scenarios for food and bioenergy, two key options can be identified: efficient valorisation of organic waste streams, and cultivation of high-yield non-food crops suitable for application on degraded or marginal land. In both options, the beneficial effects on soil quality, either resulting during cultivation of the chosen crops or by application of bioenergy production residues to land, are additional positive factors in long-term sustainability assessment.

The range of estimates for biomass potential is extremely wide, and biomass from the field or forest rarely distinguishes between those grown on good quality soil and on marginal land. Generally, the potential for residues and wastes are assessed to be within a smaller range than energy crop potential. However, in recent years, residues have attracted less attention in scientific studies. The implication is that residues are likely underestimated, while energy crop potential for biomass generation is likely overestimated [3]. Making potential arable lands more available is not likely to play a dominant role in increasing future food production, and might among others be limited by supply of fossil energy, and availability of water resources and nutrients. Meanwhile, the utilisation of inedible fractions such as agricultural residues and organic wastes holds a better prospect to quantify potential in scenarios of an agriculture challenged to provide us with both food and fuel [4].

The application of organic waste for food production and bioenergy is essential in view of the mounting challenges of climate change, fertiliser and energy shortages facing low and middle-income countries, especially those in sub-Saharan Africa. Organic waste management strategies can be instrumental in "closing the rural-urban nutrient cycles and improve the poor African soil structures in a very sustainable manner" [5]. On the other hand, a large-scale and sustainable biogas generation from organic waste would reduce the present dependence on foreign, unsustainable and expensive sources of energy.

Food waste is a potential source for bioenergy generation, so its diversion from landfill by establishing source-segregation and valorisation schemes needs high attention. Further priority must be given to the prevention of food waste – a topic of high complexity along the whole food supply chain. Around one third of all globally grown food is lost [6], and approximately a half of this could be prevented by efficient implementation of already available technologies and instruments [7]. Climatic change with altered scales of temperature and rainfall, along with potentially adapting activity patterns of aerial and soil-borne pathogens, is expected to increase food losses [8]. Food wastage does not only threaten food security by reducing the amount of food available for consumption, but also represents a loss of embedded energy and other resources. At the same time, wasted food occupies land, which otherwise would have been available for energy crop production. In low-income countries, a high proportion of food waste occurs in post-harvest stages due to managerial and technical limitations (e.g. lack of storage facilities), while in industrialized countries, food waste is mainly related to consumer behaviour and lack of coordination between different actors, and consequently, prevails at later stages of the supply-chain [9].

Food losses were already a topic when the FAO (Food and Agriculture Organization) was established in the 1940th. However, initial reduction programmes with a purely technical focus were poorly adopted, which towards the end of the century led to the understanding that technology does have an essential role to play but is by itself insufficient for solving the problems, and hence needs to be combined with additional instruments (compare [6]).

Policy and Institutional Initiatives

Increasing need for food and energy security coupled with the need for climate change mitigation underscore the imperative for integrated and coherent policies that can stimulate sustainable growth and benefit the poor [2]. Applicable policies are essential for the effective and sustainable utilisation of water and agricultural waste for bioenergy production, food and environmental security. Thus, the segregation and reuse of organic waste streams as renewable resources in food and energy value chain can be enabled or handicapped by policy initiatives [10]. Ensuring food and sustainable energy security entails multi-sectoral, collective, and trans-boundary policy actions for effective multi-level governance [11]. To this effect, different and complex policy measures are needed to avoid the food-energy trade-off: governments must ensure that bioenergy options are developed sustainably without compromising food security.

One major role of governments is to create awareness of the social economic and environmental imperatives of waste management/reuse. Often times, sustainable food and energy policies are portrayed by some commercial interests as depressing to the economy, and in some cases, as ‘job killers.’ Therefore, it is crucial for governments to ensure that the public understands the environmental, economic and social benefits of food and energy security through national institutional networks. The first step in this direction is to set a minimum volume or share of the environmental sustainability mandate for waste-based bioenergy and fertilizer production [10]. Producers of waste-based bioenergy and fertilizers would be required to comply by these mandates while their products would be subject to national certification. National-specific mandates for food-energy sustainability would encourage the blending of organic wastes to traditional energy sources and fertilizer for farming. In addition, mandates of this character will create the market for waste-based farm fertilizers and bioenergy and attract investment to the sector. While sustainability mandates have become part of bioenergy policy framework in many European Union (EU) and North American countries, they are yet to take roots in the low- and middle-income countries in Africa, Asia and Latin America.

Equally important is the use of tax incentives. Governments, particularly those in low and middle-income countries should grant tax incentives to local and foreign companies and organizations that possess commercially viable technologies for waste management practices that are gainful to food and bioenergy production. Tax incentives could be in form of tax exemptions. Such policy will encourage investment and development of technological infrastructure in the area of waste management for bioenergy and food production. Tax relief measures will also attract local and foreign direct investments and technology transfers to boost the exploitation of bioenergy and food security opportunities through environmentally friendly waste management strategies. Arguably, the multiplier effect of such investments in sustainable bioenergy and food production processes will increase employment for rural and urban households thereby creating new and sustainable market opportunities for small-scale farmers and the poor, who may have a comparative advantage in certain aspects of the production chain.

Another efficient policy instrument to stimulate and promote waste-based bioenergy and food security is government grants or direct payments to both large and small-scale farmers who are actively engaged in waste-based farming methods. In the same vein, government subsidies should be extended to new companies engaged in waste-based bioenergy production. Obtaining government payments and subsidies can be made conditional to compliance to sustainability standards outlined above. Additional tax tools can be devised to encourage minimum organic waste utilization for agricultural and agro-allied industrial production, value-added and location of such industries and facilities in rural and economically disadvantaged areas.

Global bioenergy production is driven by incentives that favour domestic production and indirectly restrict international trade. Such measures include mandates, subsidies, tax incentives and tariffs [12], which discourage trading transactions in bioenergy and food commodities across countries. Many countries, particularly the developed ones, have structured different measures and schemes to support local bioenergy production. The result is that domestic producers are protected from foreign competition thereby granting them a competitive advantage at the international level [13]. For instance, in 2006, the governments of the EU, the USA and Canada provided a total of 11 Billion USD as direct support to the bioenergy industry [14]. Therefore, given the political sensitivity of the issues involved, the World Trade Organization (WTO) needs to devise acceptable and unambiguous standards for internationally traded bioenergy commodities in line with its subsidy rules and regulations.

The choice and suitability of each of the above policy instruments for the stimulation and promotion of waste-based bioenergy and food industry is to be carefully considered and determined by each country based on its socio-economic dynamics. However, the implementation of the above policy recommendations requires high administrative capacities, which is lacking in many developing countries. Thus, despite the elegance of these policy instruments, their successful implementation entails long-term financial commitments by governments [10]. This is where many developing countries need to rethink the opportunity costs involved. In addition, countries need to reconsider existing policies of subsidies that create impediments for national transitions to an efficient and sustainable food-energy system. The viability and long-term sustainability of these policy instruments in each country depend largely on factors such as the financial buoyancy of the economy and the administrative capacity of the government to enforce such policies effectively for the benefit of waste-based bioenergy and food industries.

Painstaking and balanced crafting of policy frameworks are needed in order to ensure that pro-industry policies are equally accompanied by strong elements that target to socio-economic empowerment of the rural poor (as pointed out e.g. in [15]).

Perspectives

To meet the needs of the 21st century, creation of sustainable food systems has to be aligned with goals of reduced use of non-renewable energy, resilient ecosystems, social justice and economic development. Especially when looking at the limited resource of land availability, it is essential that food and bioenergy enter into new dialogues in order to identify common grounds and synergetic connections. Current research within the field addresses either food or bioenergy issues, while other studies discuss competition between both. The goal must be to establish integrated research, followed by transformative processes of change, in order to build a climate-friendly and socially equitable food-energy system that embraces a holistic understanding of its embedded complexity, and the changing challenges caused by its inevitable exposition to climate change, social and political transformations, as well as economic developments.

Against the background of interrelations of food and bioenergy issues, the significant potential held by efficient waste management deserves higher attention. In this context, policy instruments are crucial in order to influence food and energy production from sourcing and collection to processing and marketing of food and bioenergy from waste products. All scenarios for the provision of long-term reliable ecosystem services, including the expansion of urban populations, are heavily linked to a resilient agricultural system capable of coping with increased energy demand and international trade. Thus, looking at value creation and losses along the whole food supply chain is a central theme towards more efficient systems.

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Authors declare that there are no financial or competing interests.

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