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ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER

ENVIRONMENT CLIMATE CHANGE [BIOENERGY] MONITORING AND ASSESSMENT

Making Integrated Food-Energy Systems Work for People and Climate

An Overview



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Making Integrated Food-Energy Systems Work for People and Climate

An Overview

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FOREWORD

A safe integration of food and energy production may be one of the best ways to improve national food and energy security and simultaneously reduce poverty in a climate smart way. This study on Integrated Food-Energy Systems (IFES) draws some lessons on constraints to scale up IFES and opportunities to overcome them from examples from Africa, Asia and Latin America as well as from some developed countries.

Farming systems that combine food and energy crops present numerous benefits to poor rural communities. For example, poor farmers can use the left-overs from rice crop to produce bioenergy or in an agroforestry system they can use the debris of trees used to grow crops like fruits, coconuts or coffee beans for cooking. Other types of food and energy systems use by-products from livestock for biogas and compost production. Yet others combine biofuel crops and livestock on the same land.

With these integrated systems farmers can save money because they don't have to buy costly fossil fuel for their energy needs, nor chemical fertilizer if they use the slurry from biogas production. They can then use the savings to buy necessary inputs to increase agricultural productivity such as improved seeds - an important factor given that a significant increase in food production in the next decades will mainly have to come from yield increases. All this increases their resilience, hence their capacity to adapt to climate change.

At the same time, integrating food and energy production particularly, through the use of by-products, can also be an effective approach to mitigate climate change, especially indirect land use change (iLUC). Implementing IFES leads to increased land and water productivity, therefore reducing greenhouse gas emissions and increasing food security. Moreover by combining food and energy production, IFES reduce the need to convert land to produce energy, in addition to land already used to agriculture. This further reduces the risks associated with land conversion – hence that of additional GHG emissions.

This document presents a comprehensive overview of different options which make the various benefits of IFES materialize while addressing risks and constraints associated with current bioenergy productions schemes.

Promoting the advantages of IFES and improving the policy and institutional environment for such systems should become a priority. FAO is well placed to coordinate these efforts by providing knowledge and technical support for IFES through a programme aimed at promoting IFES. Enhancing IFES practices will contribute to the progress towards achieving the Millennium Development Goals (MDGs), including MDG 1 to reduce poverty and hunger and MDG 7 on sustainable natural resource management.

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EXECUTIVE SUMMARY

Background

Reducing "Energy Poverty" is increasingly acknowledged as the "Missing Development Goal". This is because access to electricity and modern energy sources is a basic requirement to achieve and sustain decent and sustainable living standards. It is essential for lighting, heating and cooking, as well as for education, modern health treatment and productive activities, hence food security and rural development. Yet three billion people – about half of the world's population - rely on unsustainable biomass-based energy sources to meet their basic energy needs for cooking and heating, and 1.6 billion people lack access to electricity.

Small-scale farmers are globally the largest farmer group and of key importance to local and national food security in developing countries. Therefore safely integrating, intensifying and thus increasing food and energy production for this large group of producers may have the best prospect to improve both local (rural) and national food and energy security and reduce poverty and environmental impact at the same time.

While biomass has been – and continues to be – the primary energy source for the rural poor in developing countries, it has also been of special interest in the Organisation for Economic Co-operation and Development (OECD) countries in recent years, mainly due to the production of liquid biofuels for transport. This has caused strong controversy, mainly regarding the potential risk that the production of biofuels may pose to food security of the rural poor in developing countries, but also regarding issues related to global climate change.

IFES as a Solution to Climate-Smart Agricultural Development

Integrated Food Energy Systems (IFES) aim at addressing these issues by simultaneously producing food and energy, as a possible way to achieve the energy component of sustainable crop intensification through the ecosystem approach. This can be achieved in two ways: Type 1 IFES combine the production of food and biomass for energy generation on the *same land*, through multiple-cropping systems, or systems mixing annual and perennial crop species, i.e. agroforestry systems. Either system can be combined with livestock and/or fish production. Type 2 IFES seek to maximize synergies between food crops, livestock, fish production and sources of renewable energy. This is achieved by the adoption of agro-industrial technology (such as gasification or anaerobic digestion) that allows maximum utilization of all by-products, and encourages recycling and economic utilization of residues. In many situations, the production of renewable energy can feasibly go well beyond bioenergy alone. Other locally available (non-biological) renewables can be incorporated such as solar thermal, PV, geothermal, wind and water power.

IFES can function at various scales and configurations, from small-scale systems that operate at the village or household level mainly for the purpose of self-sufficiency, to large-scale systems adjusted for industrial operations, but involving and benefiting small-scale farmers.

The main driver for implementing IFES in *developing countries* is the need for food and energy security - the basic requirement for poverty reduction and rural development. In developed countries, the growing interest in IFES is backed by the general trend towards increased resource efficiency, especially in land use, and the need to risks related to reduce direct and indirect land use change through biofuel developments. This particularly links to the challenges posed by climate change and climate variability. IFES can help to adapt to, and mitigate, the consequences of a changing climate, and reduce dependence of agricultural development on fossil fuels.

Barriers and Development Needs

The concept of IFES as such, is not new. *Simple* integration of food and energy production at both small and large scales has shown many successful results. However, there are fewer successful examples of the more *complex* and resource-efficient systems. Examples of long-term implementation and uptake exist for simpler systems like biogas, but are also relatively scarce for more complex IFES operations.

This paper draws on an extensive review of literature and the findings of an FAO technical consultation held in July 2010 on "How to make integrated food-energy systems work for both small-scale farmers and rural communities in a climate-friendly way" which aimed to identify what hinders the uptake of IFES, in particular, and to find some key solutions that could help realize their benefits on a wide scale.

Barriers to the implementation and wide-scale dissemination are manifold, and concern various aspects at both farm and beyond farm level:

- The complexity of some IFES requires high levels of *knowledge* and skills. *Technical support* is essential, but not always available.
- *The technology* used needs to be reliable and economical. Ensuring good quality of the conversion device is crucial for the success of IFES, and has often been overlooked in systems aimed at being rapidly scaled up, e.g. some large-scale biogas programmes in the past.
- *Financing* is mostly related to the investment required for the energy conversion equipment. Very often, the better they are from an energy and GHG point of view, the more expensive they are. This is often not affordable for individual small-scale farmers, and *access to financing mechanisms* such as micro-credit schemes is not always given.
- The increased *workload* often experienced with IFES makes the systems less attractive to farmers. Where multiple crops are grown on one piece of land, as in Type 1 IFES, or where there is a diverse array of inter-connected crops and livestock, as in Type 2 IFES, there tends to be less scope for specialization and mechanization, and therefore IFES often require significant manual input.
- *Competition between different uses of residues* refers to the fact that the use of residues for energy production should not negatively affect their use for soil fertility and protection and/or for feeding animals. *Trade-offs* in the use of resources (land,

water and nutrients) are becoming increasingly hard to balance, as competition for biomass for food, feed, fertilizer and fuel increases.

- *Access to markets* for agricultural and/or energy products is often a key factor to ensure economic viability of the IFES, since most of the time IFES operators earn the bulk of their revenues from the sale of their agricultural products. However, adequate access to markets and product competitiveness should not always be assumed.
- *Access to information-communication and learning mechanisms* regarding the above-mentioned factors is as important a production factor as "classic" land, labour and capital. Difference in levels of access to information is a well-known power factor in rural development.
- *Politics*, i.e. how things really work and are decided at local level, might influence the above-mentioned factors. *Few gov*ernment *policies* encourage all aspects covered by IFES, and some sectoral technical support policies even play against the *replicat*ion and scaling up of IFES, especially more complex ones. Possible ways to overcome these barriers are: (i) agricultural - through sustainable farming practices that reduce residue competition; (ii) institutional arrangements; and (iii) policy options that support the development and scaling-up of IFES initiatives.

Agricultural Solutions

The use of soil residues for energy production might, in some cases, interfere with the need to maintain and enhance soil quality, or with other residue uses such as animal feed provision. To be used in a sustainable way, residue must only be removed when it does not hamper soil quality. In some regions the combination of crop, management practice, soil, and climate, work together to produce more than is needed to maintain soil health. In this case, excess residues could potentially be used for conversion to biomass energy. However, it is important to discern in what systems residue harvest for energy purposes is possible, or even beneficial, and at what rates. This is particularly true for tropical and sub-tropical climates where the soil organic carbon pool is below the critical level.

In some cases, trade-offs can be found, for instance, when too much crop residue can create problems (e.g. diseases, fires in dry areas) or residues substituted with alternative sources for soil protection and livestock feed (e.g. cover crops). In others, win-win solutions are possible, such as biogas and use of its by-product as compost, or using soil amendments such as biochar produced from residues. However, literature that addresses the trade-offs between competing uses of crop residues is relatively scant. Given the importance and the complexity of the topic, it certainly warrants more research and development in the coming years.

Institutional Solutions

Institutional arrangements that support the scaling-up of IFES concern two different issues, i.e. the workload and financial constraints. Often both types of issues are addressed through the division of labour and costs, when individuals specialize and work together, rather than individually, to implement all the components of IFES. The obvious way to achieve this is to let farmers handle what they do best – farming, including the supply of residues from their farming activity – while having other operators handle the energy component of IFES. A further division of labour through area-wide integration is advocated in the case of integrated crop-livestock systems, i.e. where crops and livestock do not have to be operationally integrated (within the same management unit) to have functional integration (e.g. feed-manure). Integration can be achieved through supplies from different farmers, all with their specialized contributions and comparative advantages. By dividing labour and allowing specialization, the efficiency of complex IFES can be increased and more easily managed. Such a system requires co-ordination and often collective action, which may come from different institutional structures, such as farmer cooperatives, social businesses or companies that wish to market or process the produce, as is often the case, for example, with outgrower schemes.

Knowledge management and supporting services in the case of *simple* IFES are usually provided through vertical integration of the supply chain, which also allows for labour division, with private sector companies or cooperatives entering into contracts with small-scale farmers (contract farming). Farmers supply the feedstock, while the company or cooperative guarantees the purchase and provides support in the input supply side of the value chain. Tenant farming and sharecropping, whereby small holders farm the land belonging to companies, is another type of agribusiness-smallholder partnership which often includes provision of technical services and sometimes inputs to the farmer.

More efficient but also more *complex* and knowledge-intensive IFES do not lend themselves easily to vertical integration. They require knowledge management and support systems that combine better articulation of demand and managing the institutional responses to the demands in a pluralistic way. Developments in agriculture and rural development and their related new policy requirements (such as those related to the MDGs), increasingly require that organizations involved in agricultural and rural development take the role of coherent, competent and engaged service providers, which can act as counterpart to the better-articulated demands on farmer's part. In other words a combination of "demand-side approaches" and "supply-side approaches" seems the best way forward. Such systems often rely on local-level learning systems, such as the farmer-field school and the success-case replication approach.

In many countries there are formal mechanisms set up to provide credit to small-scale farmers and entrepreneurs in rural areas. Small-scale farmer organizations such as cooperatives, can help increase access to micro-credit for small-scale producers where rural banks are reluctant to engage. Some simple IFES systems, such as those using biogas, are good candidates for carbon finance, given the significant potential they hold to reduce GHG emissions, and are relatively simple to monitor.

Policy Solutions

Institutional arrangements require *policy instruments* to support their implementation. Policies relevant to IFES concern both their agricultural and energy components. Those related to the agricultural component concern the need to increase productivity to meet future global food and energy needs. Policy measures to promote this concern research and development and technology adoption (e.g. input subsidies, tax incentives, and technical and financial support). But agricultural policies also need to promote environmental conservation and social equity. The former can be achieved through a combination of market based measures following the "provider gets-polluter pays principle" and regulations such as zoning. Policies regarding more environmentally-oriented agriculture, for instance, through the ecosystem approach to agricultural intensification promoted by FAO, face serious challenges. These constraints include: the lack of institutional coordination of concerned government bodies; inadequate links with research; a focus on commodity agriculture and lack of incentives to reward ecosystem stewardship and low carbon agriculture; subsidies to chemical fertilizers; and lack of support to measures favourable to small-scale producer involvement in the local food supply chain.

Land tenure security is an essential component of social equity, as are investments in agriculture. The critical factor is that the State must be able to guarantee, in practice, the rights accorded to all land users by law. Only then can investors – big and small, entrepreneurs and communities – make financial and longer-term plans with the confidence that the parameters shaping their long-term vision will not change. There are ways to address this challenge, and these are being developed and discussed in some recent major international initiatives.

Policy instruments, in support of the energy component of IFES and more broadly renewable energy (RE), are manifold. Two areas of support stand out:

- The promotion of renewable energy markets through quotas/mandates and/or feed-in tariffs. However, these are probably not the most appropriate instruments to promote RE development for small-scale farmers and rural communities in developing countries. The former tend to favour large and centralized plants and to concentrate development in best-endowed areas, while the latter require a grid to feed into, and tend to favour relatively wealthy households which are already grid connected. They are also more relevant to the operations and maintenance phase of RE initiatives, whereas a lot of the challenges in rural areas of developing countries lie at the start-up phase.
- Financial incentives in the form of grants, subsidies, micro-credits, carbon finance or tax breaks. Effective financing mechanisms should fill an existing investment gap, increase private sector involvement and awareness and have the ability to be phased out over time, leaving a long-term private sector financing solution in place. The most effective finance mechanisms do not distort the market, but rather help to build it into a financially viable alternative to conventional energy. A major reason for the success of recent RE financing schemes stems from the fact that they have focused on the main actors of RE development – entrepreneurs and end users – to provide incentives, so that, instead of 'dropping' RE projects on completion, these actors have an interest in their continued success.

Other policy instruments regarding RE include support to infrastructure development, standards, capacity-building and stakeholder involvement. Subsidies are an important aspect of energy policies. Energy markets should factor in all types of societal costs (economic, social and environmental). It often makes sense to establish time limits or "sunset clauses" in subsidy schemes right from the outset, and mechanisms to regularly assess the appropriateness of reforming subsidies.

IFES vary in types and sizes. They do not develop spontaneously in a vacuum. Solutions to their constraints evolve according to local circumstances, scale and the stage of development time. Therefore, any support mechanism must be predictable, long-term and consistent, with clear government intent. It must be simple, transparent, appropriate, flexible, credible and enforceable.

Policy-makers and supporting partners (donors, private sector, farmers, etc.) need to be convinced about the benefits of promoting and implementing IFES. A first step in that direction is the development of a critical mass of tangible arguments, to be obtained through documenting IFES experiences and showing concrete examples of successful IFES. In parallel, decision support tools (DSTs), could be developed to help policy-makers and investors in IFES to make the right choices, both at strategic and project levels. Rigorous evidence and decision-making support can lead to political willingness to introduce the policies and institutional changes needed to replicate and scale up successful IFES.

Future Work

Concrete actions related to the above-mentioned sequence were proposed during the FAO Technical Consultation on IFES in July 2010. These include:

- FAO playing the role of international information platform and repository of knowledge *related to IFES*. To start with, FAO could set up an IFES website within its bioenergy website, and develop a very simple Newsletter to be circulated to the participants of the July 2010 meeting, but also other likely interested individuals and organizations.
- Promotion of simple IFES systems, e.g. through the collection and dissemination of information related to the scaling up of successful large-scale simple biogas programmes (e.g. from China, Viet Nam and Nepal), including policy and institutional aspects. This information would be placed on FAO's IFES website, and shared with FAO's decentralized offices.
- Documentation of cases, and more particularly, more complex IFES. A starting point would be the development of a rapid assessment methodology regarding IFES, starting at farm level. This would then allow for comparative assessments of different types of IFES, but also of IFES with and without the energy component (e.g. integrated crop-livestock systems with or without biogas).

Work on unresolved issues. Three topics stand out: (i) the IFES assessment methodology mentioned above; (ii) residue competition; and (iii) links between IFES and land use changes caused by liquid biofuel development (both direct and indirect land use changes).

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