POLICY BRIEF:

THE CASE FOR ENERGY-SMART FOOD SYSTEMS

Key messages

- Energy poverty in many regions is a fundamental barrier to reducing hunger and ensuring that the world can produce enough food to meet future demand.
- Modernizing food and agriculture systems by increasing the use of fossil fuels, as was done in the past, may not be an affordable or sustainable option.
- The food sector accounts for around 30 percent of the world's total energy consumption and accounts for around 22 percent of total GHG emissions.
- Energy-smart food systems improve access to modern energy services, rely more on low-carbon energy systems and use energy more efficiently. They also strengthen the role of renewable energy, including bioenergy, within food systems and help support the achievement of national food security and sustainable development goals.
- Energy-smart food systems are also 'climate-smart' since they help mitigate climate change by reducing greenhouse gas emissions. They can also help rural communities adapt to climate change by increasing their reliance on local energy sources and diversifying incomes.
- Bioenergy crops, biomass residues from food production and processing and renewable energy platforms, such as wind, solar, minihydro and geothermal are possible sources of renewable energy that can be harnessed in energy-smart food systems. However, the risks and benefits must be weighed carefully.
- Greater energy efficiency in crop cultivation, irrigation and fertilizer use, as well as the storage and refrigeration, transport and distribution and preparation of food is required to make food systems energy-smart. The energy embedded in food can be saved by reducing food losses and waste.
- Energy access can be increased by deploying renewable energy technologies and by increasing energy efficiency. Integrated food energy systems (IFES) offer a range of opportunities for fulfilling the three key objectives of energy-smart food systems: greater energy efficiency, increased use of renewable energy and improved energy access.
- To achieve the transformation to energy-smart food systems, policy-makers need to coordinate policy formulation regarding energy and food among government ministries responsible for food, agriculture, energy, health, transport; economic development and the environment.
- Energy-smart food systems can only work if legal and regulatory frameworks regarding the use of land and other resources are in place before introducing renewable energy policies; a comprehensive multi-stakeholders dialogue is essential.
- There is a need to strengthen the considerable gaps in knowledge regarding the food, energy, climate nexus.
- Given the complexity and challenges involved, the shift towards energy-smart food systems will necessarily be gradual. Towards this end, FAO is proposing a multi-partner programme on climate-smart food systems for people and food to be launched in 2012.

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Right now one billion people are hungry or living under the threat of hunger. By 2030 the demand for food will increase by 50 percent (Bruisma, 2009), and it is expected that population expansion and economic growth will increase the global demand for energy and water by 40 percent (IEA, 2010, WEF, 2011). It is clear that in our efforts to build a world without hunger, we will need more energy.

Energy poverty, food security and the Millennium Development Goals

Food systems require energy, but they can also produce energy. Consequently, they have a unique role to play in alleviating 'energy poverty'. At present, almost 3 billion people have limited access to modern energy services for heating and cooking and 1.4 billion have zero or limited access to electricity. Reducing energy poverty has been recognized as the 'missing development goal'. Without access to electricity and sustainable energy sources, communities have little chance to achieve food security and no opportunities for securing productive livelihoods that can lift them out of poverty. Basic services, such as education and health care, cannot be adequately provided.

Moving beyond fossil fuels

The 'green revolution' of the 1960s and 1970s, which solved pressing food shortage problems at the time and helped ensure that food production has been able to keep pace with population growth, was made possible in part by improved plant breeding but also by an abundant supply of inexpensive fossil fuels. These fuels made it possible to manufacture and operate more farm machinery, increase the supply and application of fertilizers and pesticides, expand irrigation, refrigerate perishable goods and transport food around the world. But now there are questions about the world's reserves of fossil fuels. As concerns over fossil fuel supply have mounted, the prices of fossil fuels have become more volatile and are expected to rise. This has serious implications both for countries that benefited from the initial green revolution and for those countries that are looking to modernize their food systems along similar lines. Modernizing food and agriculture systems by increasing the use of fossil fuels as was done in the past may no longer be an affordable option. We need to rethink the role of energy when considering our options for improving food systems.

Shifting toward 'energy-smart' food systems

Although fossil fuels will continue to be used for many years, making a gradual shift to more energy-efficient food systems that make greater use of renewable energy technologies may be the most viable solution for simultaneously reducing fossil fuel dependency, improving productivity in the food sector and addressing energy-poverty in rural areas. The transformation to 'energy-smart' food systems requires:

- relying more on low-carbon energy systems and using energy more efficiently;
- strengthening the role of renewable energy, including bioenergy, to provide greater energy access for social and economic development and supporting the achievement of national food security and sustainable development goals.

Making this transformation will require a careful consideration of both:

- the direct and indirect energy **used by** food systems at each stage in the supply chain and
- the potential energy **produced by** these systems.

Reducing the dependency of food systems on fossil fuels is not just an issue that affects the future of global food production, it is important for addressing food insecurity right now. The spike in global food prices in 2008, which lead to a sharp increase in the number of hungry, was in part due to increased world energy prices. Prices for commodities,including food, tend to be linked with global energy prices, As energy prices fluctuate and trend upwards, so do food prices. A food sector that is less dependent on fossil fuels could help stabilize food prices for consumers and reduce the financial risks for food producers and others involved in the food supply chain.

Energy-smart is 'climate-smart'

At the same time as it must become more productive, agriculture must also cope with a changing climate. FAO along with other partners is promoting 'climate-smart agriculture', which:

- contributes to climate change adaptation by sustainably increasing productivity and resilience;
- mitigates climate change by reducing and/or removing greenhouse gases; and
- enhances the achievement of national food security and development goals.

Shifting to more energy-smart food systems is clearly an important step toward reaching the broader goals of climate-smart agriculture. Furthermore, making agriculture energy-smart and climate-smart are both part of a larger paradigm shift in agriculture being promoted by FAO and other partners under the term 'Save and Grow'[1]. This new paradigm recognizes that to ensure global food security we will have to do more with less. Making agriculture more productive and resilient will demand better management of natural resources, such as land, water, soil and genetic resources.

Multi-Partner Programme: "Energy-Smart Food for People and Climate"

An interdisciplinary 'nexus' approach is necessary to ensure that food, energy and climate are jointly addressed, trade-offs considered, and appropriate safeguards are put in place. These issues will not be addressed through a single initiative. Because of its importance, scope and complexity, this challenge must be met through participation of a broad constituency of interested parties. This demands a multi-partner international effort to implement energy-smart solutions in a non-fragmented and cost effective way. Within this context, FAO proposes setting up an "Energy Smart' Food for People and Climate" Multi-Partner Programme to be launched in 2012. The aim of the Programme is to address the energy dimension in relation to food security and energy poverty and should be seen as an essential component to climate-smart agriculture.

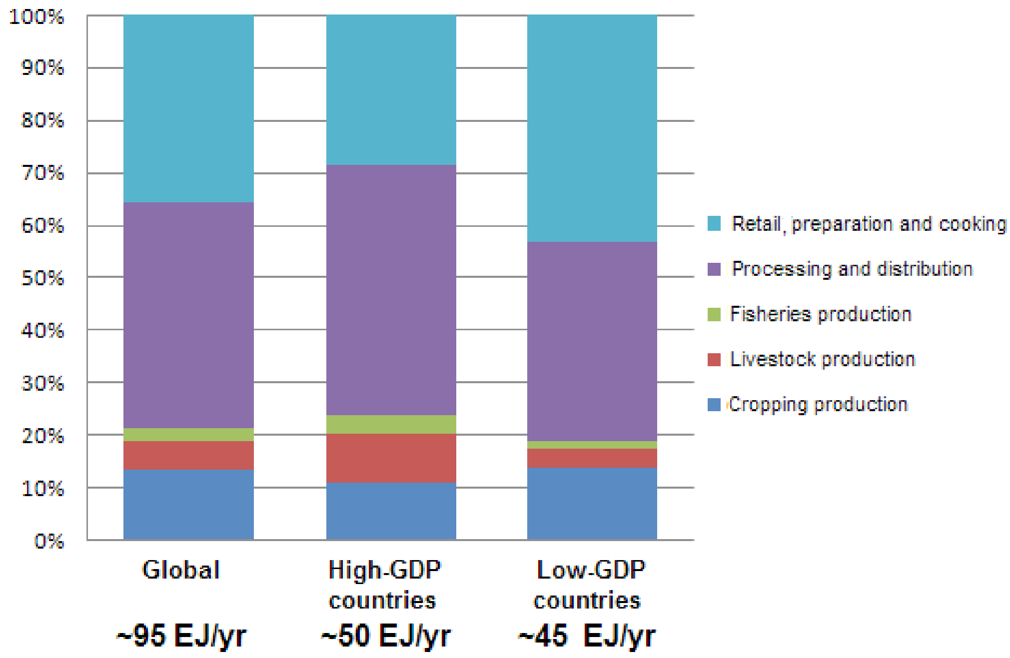
Energy consumption and GHG emissions in the food sector

The food sector accounts for around 30 percent of the world's total energy consumption (FAO, 2011a). Primary farm and fishery production[2] accounts for around one-fifth of this energy demand.

In developed countries, energy used for processing, transport and food preparation is usually around three to four times the amount used for primary production. In developing countries, the energy demand for primary production is typically around 10 percent, for food transport and processing 15 percent, and for cooking and preparation up to 75 percent.

1 FAO, 2011b

2 Primary production here includes cropping, pastoral and intensive livestock, aquaculture and fishing



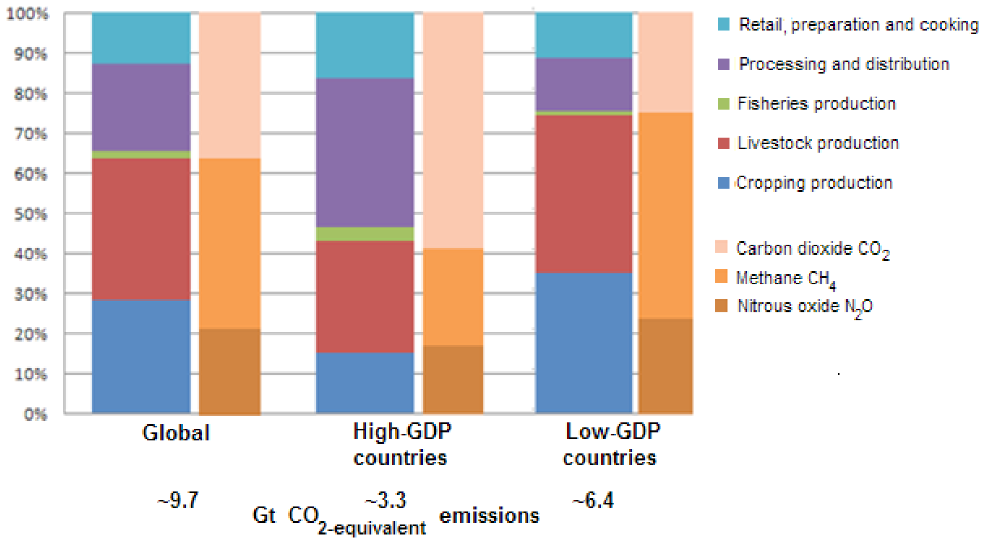
Indication of global, shares of end-use energy demands throughout the food supply chain showing total final energy for the sector and a breakdown between developed and developing countries.

Livestock production shows noticeable differences between developed and developing countries. Developing countries consume around 1 MJ of fossil fuel per MJ of animal product, while developed countries consume around 4.3 of MJ fossil fuel per MJ of animal product. Capture fishing is one of the most energy-intensive methods of food production. The global fishing fleet captures around 80-90 Mt of fish and invertebrates each year and consumes around 620 liters of fuel per tonne of catch. Small-scale enterprises produce around half of the total fish catch using a fleet consisting of about 4.3 million small vessels. Two-thirds of these vessels are powered by internal combustion engines that run on fossil fuels. The rest of these boats, mainly in Asia and Africa, use sails and oars.

The entire food chain accounts for around 22 percent of total GHG emissions, including landfill gas produced from food wastes[3]. Globally, methane from rice paddies and ruminant livestock[4] combined with nitrous oxides from nitrogenous fertilizers, soil and animal wastes have a greater impact on climate change than energy-related carbon dioxide emissions. Primary production accounts for around 14 percent of the total global GHG emissions. This is mainly from methane emissions, which in developing countries are twice as high as those from developed countries. However, when calculated on a per capita basis, emissions in developing countries are considerably lower. A greater share of carbon dioxide emissions come from developed countries. These emissions result from the use of fossil fuels to generate heat and electricity for food storage and processing, as well as for transport and distribution (IPCC, 2007a).

3 Based on Giampietro, 2002; Smil, 2008; IEA, 2010; Woods et al., 2010; GoS, 2011 and others

4 goats, sheep, cattle, deer



Global shares of GHG emissions along the food supply chain with breakdown by gas and also for developed and developing countries.

Caveat. *It should be noted the numbers in this and the previous graph are indicative only and should be interpreted with care. FAO analyses were based on the range of data available, but these data were at times unreliable, incomplete and out of date since food energy use patterns are rapidly changing. In addition, there is no standard collection methodology for food-related energy and GHG data as presented in the literature.*

Becoming energy-smart

Food security cannot be achieved without providing energy to the millions of rural communities currently living without modern energy services. That's why being energy-smart is not simply a matter of reducing energy use. Energy-smart food systems deliver energy that enables rural communities in developing countries to produce more food and enjoy the social and economic benefits that people living in the developed world take for granted. Being energy-smart also helps ensure that energy, however it may be generated, is used efficiently wherever food is produced, processed, stored, sold and consumed. Because of uncertainty about the supply and affordability of fossil fuels, harnessing renewable sources of energy to power the food sector is an energy-smart approach. A shift toward energy-smart food systems involves:

- improving access to modern energy services;
- increasing the efficiency of direct and indirect energy use so that the energy intensity of food decreases;
- using more renewable energy as a substitute for fossil fuels; and
- simultaneously enhancing food security and sustainable development.

Some key terms

Direct and indirect energy

Energy consumption in the food sector is typically disaggregated into direct or indirect energy. Direct energy is used to operate farms, fisheries, processing plants, vehicles for transport and prepare meals. Indirect energy, on the other hand, refers to the energy required to manufacture inputs such as machinery, equipment, fertilizers and pesticides.

Energy intensity

Simply monitoring the amount of energy used by a food system is not enough to determine whether it is becoming more or less energy-smart. The concept of energy intensity is proposed to measure the effective use of energy in the food chain. Energy intensity is defined as the amount of energy used per unit of food produced. Addressing the energy status of the whole food sector can help identifying options for lowering the energy intensity, reducing food losses and increasing the local use of renewable energy resources. Any attempts to reduce energy to the food sector or to generate energy from this sector that would be detrimental to productivity, processing activities, or food quality are rarely beneficial and should be avoided.

Food systems

Food systems encompass all the activities carried out during food production and all the stages of the food supply chain that connects the producers to consumers,including agriculture, fisheries and animal feed production; post-harvest operations; food storage and processing; transport and distribution; and retailing, preparation and consumption.

The spectrum of food systems is complex and diverse. Food systems range from basic subsistence smallholder farmers growing food for their own consumption to large commercial, corporate farms supplying huge supermarket chains across the world. All of these systems are dependent on energy, but they have different energy priorities and different pathways for becoming energy-smart.

Bioenergy and renewable energies in food systems

Since agriculture can be designed to maximize the production of both food as well as biomass that can be converted to energy, bioenergy has a special role to play in energy-smart food systems. As mentioned earlier, food systems require energy, but they can also provide resources to generate renewable energy. By tapping into these renewable energy resources, rural communities can produce and preserve more food and raise incomes. The renewable energy associated with food systems may also be harnessed to deliver energy services, such as lighting and communication that can improve local education and health services and raise the quality of life for individual families.

At present, renewable energy meets over 13 percent of global primary energy demand (FAO 2011, forthcoming). Bioenergy, which includes liquid and gaseous biofuels, as well as the use of solid biomass to generate energy, is already a major form of renewable energy. Bioenergy and other renewable energy platforms, such as wind, solar, mini-hydro and geothermal, may be used to help agriculture and the food sector become more self-sufficient in energy. Almost half of the bioenergy consumed comes from traditional sources of biomass and is used by rural household primarily for cooking and heating. Cleaner sources of energy would directly benefit these households. The integration of bioenergy with other renewable energies along the food chain can also provide an opportunity to generate surplus energy that can help meet household needs, improve livelihoods and support local development.

"Renewable energy can enhance access to reliable, affordable and clean modern energy services, is particularly well-suited for remote rural populations, and in many instances can provide the lowest cost option for energy access" (IPCC).

Bioenergy crops

Some crops, such as corn, cassava, sugarcane and rapeseed, are being purposely cultivated in some countries to provide biomass for conversion to liquid biofuels for transport and combined heat and power co-generation. Well-managed biofuel production could support the diversification of agricultural markets, providing economic incentives for much needed investments in capital and skills, particularly in developing countries. Energy crop management can also help maintain, and in some cases, enhance soil fertility for future food production. The mitigation of saline soils in Australia though agroforestry biomass production linked with food production is an example of the potential environmental benefits of bioenergy crop development.

'Talking rubbish'? Biomass residues for energy

Animal wastes, crop and forest residues, by-products from food processing , food wastes from retailers, households and restaurants are examples of biomass originating from different stages of the food supply chain. These biomass sources are flexible energy resources that can be:

- used on-site if and when needed to provide direct energy inputs;
- processed on-site into energy for sale elsewhere;
- sold off-site for collection and use for community heating or combined heat and power co-generation; and
- sold off-site and collected on a wider scale and in greater volumes to supply larger commercial liquid biofuel production plants.

Methods for collecting and delivering residual biomass supplies to an energy conversion plant depend on the site's location. On farms, the collection and storage of animal wastes and crop residues, such as baled cereal straw, add to the costs of delivering biomass. In food processing plants where biomass is already collected on-site as part of processing activities, costs can be relatively low. Their use as a source of energy can even save money in cases where it eliminates waste disposal costs.

Sugar mills commonly use the material left over after the sugar has been extracted from the cane (bagasse) for combined heat and power co-generation. Mauritius is already obtaining close to 40 percent of its total electricity supply from combined heat and power co-generation systems using sugarcane bagasse (Karekezi and Kithyoma, 2006). The capacity to export electricity or biomethane can be limited if the farm or processing plant is not located near the existing electricity or gas grids and connection costs are high. Also, some food processing plants operate seasonally and may not be able to provide a steady flow of energy all year. In these situations, specific contractual arrangements are required.

Renewable energy projects

Renewable energy projects, including those dealing with bioenergy, can benefit the community by pumping more income into the local economy. Some of the new revenues can be channelled toward improving public services and attracting new businesses. The initial project can generate new jobs, but long-term employment opportunities are also possible through the creation of local companies involved in refining renewable energy technologies, manufacturing components and providing related energy services. These higher wages jobs favour the development of local skills and help rural communities attract skilled workers. The costs of deploying renewable energy technologies, calculated over their lifetime, are typically higher than current average prices for electricity, heat and transport fuels. However, as more knowledge and experience is gained, the costs for renewable energy technologies are likely to decline. In many specific situations, renewable energy can be economically competitive. For example, in remote rural areas without access to the electricity grid, autonomous renewable energy systems are competitive because they allow users to avoid the high expenses involved in connecting to the grid.

Weighing the risks and benefits

Land and water are essential natural resources for all food systems. There are concerns about the impact of bioenergy development, particularly large-scale biofuel development; whether it will increase food prices and foster greater food insecurity by competing with food production for land and water, and whether it will really bring about significant reductions in GHG emissions. Potential risks and benefits need to be carefully weighed in light of country- and region-specific variables. In recent years, FAO, in collaboration with its partners, has developed a 'Support Package for Decision-Making for Sustainable Bioenergy'. The support package includes five elements, which have been developed under various FAO projects and activities[5]. FAO's work to date has shown that in some cases, if properly managed, bioenergy production can boost rural development sustainably without compromising food security. In other situations, it will not be appropriate or viable (FAO, 2010).

The amount of land required for deploying solar and wind energy technologies is usually relatively small. It has been calculated that the fraction of land needed to displace global fossil fuel use with renewable energy technologies would use around 1.5 percent of the land area currently used for agriculture (Bardi, 2004). This would have little impact on agricultural production.

Improving energy efficiency in food systems

Becoming energy-smart involves improving energy efficiency to reduce energy consumption without affecting productivity. For several decades, options for increasing energy efficiency in larger-scale food systems have expanded. However, subsistence farmers in developing countries may have few options to become more energy efficient simply because they have little or no access to energy to begin with.

Energy conservation and efficiency measures can be achieved at all stages of the food chain. These measures can bring either direct savings through technological or behavioural changes or indirect savings resulting from co-benefits derived from the adoption of agro-ecological farming practices.

Conservation agriculture

Conservation agriculture is an approach to farming that seeks to improve farm management by using crop rotations to enhance the soil nutritional status. It applies principles of soil conservation and usually incorporate zero tillage or low tillage practices. Conservation agriculture lowers the demand for inorganic nitrogen, reduces pests and minimizes soil disturbance. Reduced energy inputs are usually a co-benefit of conservation agriculture. No-till or low-till methods can reduce fuel consumption for cultivation by between 60 to 70 percent (Baker *et al., 2006)*. These methods also improve soil water retention, reduce soil erosion by incorporating crop residues into the surface and minimize soil carbon losses. Historic carbon losses through conventional cultivation are estimated to be between 40–80 Gt and are increasing by a rate of 1.6±0.8 Gt per year, mainly in the tropics (GoS, 2011).

Irrigation

The mechanical pumping of water occurs on approximately 10 percent of the world arable land area (around 300 Mha) and consumes around 0.225 EJ/yr. A significant amount of this energy is needed to power pumps (Smil, 2008). In addition, another 0.05 EJ/yr of indirect energy is required to manufacture and deliver

5 A brief description of FAO's support package for sustainable bioenergy is available here http://foris.fao.org/preview/28392-0a6fa87cdb2f3aa0d63bddb17bb2a6b8e.pdf

irrigation equipment. Irrigated agriculture contributes 40 percent of the world's food (FAO, 2002). In many part of the world, water scarcity threatens agricultural production. There is a real need to lower water intensities in food production. Increasing the efficiency of water use is also energy-smart, as it reduces the demand for pumping. Energy savings from existing irrigations systems can come from improving basic operating conditions, mending leaks and replacing worn or improperly sized pumps. Both water and energy inputs can be reduced by sowing crops to avoid anticipated periods of water deficit and by using mulch. Water management policies that promote the introduction of more efficient irrigation methods, such as precision irrigation, low-head drip irrigation, waste water recycling, are energy-smart.

Fertilizers

Energy embedded in the production of inorganic fertilizer is globally significant. Nitrogen fertilizer production alone accounts for about half of the fossil fuels used in primary production (GoS, 2011). Farmers can save indirect energy by reducing the amount of fertilizers applied through more precise applications through the use of computer-aided technologies, such as biosensors for soil fertility monitoring and trace gas detection. In developed countries, since the mid-1980s, a combination of these techniques has achieved significant reductions in fertilizer use. In the USA for example, between 1979 and 2000 fertilizer applications have been reduced by around 30 percent (Heinberg and Bromford, 2008). A shift towards organic fertilizers and the cultivation of nitrogen-fixing plants, can also reduce indirect energy inputs. This would also serve to lower GHG emissions and avoid excess nitrates being discharged into aquifers and surface waters.

Storage and refrigeration

It is estimated that food storage involves between 1-3 MJ/kg of retail food product (Smil, 2008). The food choice expectations of people living in developed countries are made possible by affordable refrigeration systems across the entire food supply chain. Introducing similar systems for developing countries will be difficult and will require large amounts of energy. Avoiding refrigeration dependence is difficult when economic development depends on exporting food to more industrialized countries. Possible solutions are bulk preservation with transport only to local markets and the use of passive evaporative-cooling technologies rather than active cooling that depends on electricity supply. When they become economically viable, stand-alone solar chillers are another potential option. Refrigerated storage can account for up to 10 percent of the total carbon footprint for some products when electricity inputs, the manufacturing of cooling equipment, and GHG emissions from lost refrigerants are taken into account (Cleland, 2010).

Transport and distribution

In 2000, over 800 Mt of global food shipments were made (Smil, 2008). Globalization in the past two decades appears to have increased the average distance travelled by food products by 25 percent. Given the fluctuating prices for fossil fuel prices, transport and distribution are particularly vulnerable components of the food chain. Locating production and handling of food closer to areas of high population density can help reduce energy consumption for transport (Heller and Keoleian, 2000). However, since long distance transport by ship or rail can be done at relatively low ratios of MJ per tonne per km, producing specific crops and animal products in locations where productivity is naturally high can lead to energy savings that compensate for the relatively little extra energy required for their transport to distant markets.

Food preparation

In developing countries where relatively little energy is used to produce food, the share of energy used in food preparation can be very high. Cooking typically consumes 5-7 MJ per kg of food. However, in developing countries it can be 10-40 MJ per kg (FAO 2011, forthcoming). Traditional biomass used for energy (fuelwood, crop residues and animal dung) is widely used in developing countries for domestic uses, particularly cooking and heating. Inefficient cooking on open fires and the associated health risks from smoke inhalation are well documented. Compared with open fires, the use of more efficient biomass cooking stoves can reduce the demand for traditional fuelwood by half (IPCC, 2011).

Food losses and waste

About one-third of the food produced is lost or wasted (Gustavsson *et al*., 2011). These losses occur at all stages of the supply chain, amounting to around 1200 Mt per year. When food is wasted, the energy used to produce the food is also wasted. Overall, the energy embedded in global annual food losses is thought to be around 38 percent of the total final energy consumed by the whole food chain. Food waste in European and North American countries is between 95 to 115 kg per capita per year. In sub-Saharan Africa, South Asia and South-East Asia where food is relatively scarce, food losses are between 6-11 kg per capita per year. These losses result from inadequate harvesting techniques, poor storage facilities, limited transportation infrastructure and ineffective packaging and market systems. Financial and technical limitations are hampering efforts to reduce these losses. Educating smallholder farmers on how to reduce food losses could be a relatively cost-effective manner for improving rural livelihoods. But significant work to change consumers' attitude is also needed, and this might prove challenging.

Energy access for livelihoods in food systems

Both renewable energies and increased energy efficiency can contribute to energy access. When bioenergy and other renewable energies are available, they can be used locally to supply much needed energy for farming and food processing, alleviate energy poverty and spur rural development. Opportunities exist for the small-scale production of biofuels to power agricultural machinery and vehicles to transport food products to the local market. For example, pure vegetable oil (oil that is extracted from plant material and use as fuel) can be used directly in diesel engines to generate electricity or to run farming equipment. However, trade-offs may need to be made between optimizing energy efficiency and keeping energy affordable for the most impoverished sections of society, especially in rural areas.

Lessons from the introduction of energy-efficient cooking stoves

Around one quarter of the 2.7 billion people who rely on traditional biomass for cooking and another 0.3 billion who rely on coal now use improved cooking stove designs (UNDP, 2009). However, not all programmes designed to introduce more energy efficient stoves have been successful. The lack of success is often due to the informal nature of the fuelwood supply chain and a poor understanding of local cultures and their cooking habits. For example, users may prefer to cook with fuelwood in the evening when it is cooler rather than cooking in the heat of the day with a solar oven. Traditional biomass cooking stoves may be less energy-efficient, less healthy and more labour-intensive than solar or biogas designs, but they are often more affordable, which is a critical factor for impoverished rural communities. The introduction of improved designs of domestic stoves has succeeded mainly when micro-finance is available for the necessary capital investments.

Increasing energy availability can help meet basic human energy needs, provide energy services to support the establishment of small and medium enterprises outside the food sector and help diversify incomes. A balance needs to be found between improving access to new energy sources and increasing the efficiency of existing energies. The decision will depend on local conditions and the economic trade-offs involved in for each option. By subsidizing the retail price paid for imported fossil fuels or by introducing measures that support the deployment of renewable energy technologies in rural areas, governments can help improve access to energy for agricultural communities.

Integrated food energy systems (IFES)

FAO's work on Integrated Food-Energy Systems (IFES) has shown that food and energy can be produced in parallel on farms to meet both energy and food needs. This can be done either through optimizing the use of land by combining energy and food crops or through the optimal use of biomass residues produced in food systems to generate energy (Bogdanski et al., 2010a). These system offer a range of opportunities for fulfilling the three key objectives of energy-smart food systems: greater energy efficiency, increased use of renewable energy and improved energy access. Several types of IFES follow a landscape approach that support sustainable crop intensification and improve energy efficiency in primary production. The IFES framework can also provide a balance between large scale businesses seeking to maximize profit and long-term mixed farming systems. Such a framework can also be used to develop of regional-scale energy and food production systems. In certain cases, IFES can be implemented without costly capital investment.

Policies towards more energy-smart food systems

Policy-makers need to adopt a long-term view to make the needed paradigm shift to energy-smart food systems. But just because this shift will not be accomplished in the short term does not mean that we can afford to wait. The key question at hand is not, 'If or when we should we begin the transition to energy-smart food systems?', but rather 'How can we get started and make gradual but steady progress?' Political will needs to be mobilized to ensure that key decisions on investment and policies are taken and implemented effectively. FAO is prepared to take a leading role and assist member countries to address the energy-food-climate nexus. This is why FAO recommends the establishment of a multi-partner programme on 'Energy-smart food for people and climate'. Such a programme would make an important contribution to the recently launched UN initiative 'Sustainable Energy for All' and to the achievement of a 'Green Economy', which will be promoted at Rio+20.

Recognizing shared goals

The options for making food systems more energy-smart are intertwined with other development goals. Creating a greater understanding of these mutually supportive relationships can contribute to more co-ordinated policy formulation among government ministries responsible for food, agriculture, energy, health, transport, economic development and the environment. This multi-sectoral cooperation can advance a holistic landscape approach to energy-smart food systems that link agricultural production and natural resource management with poverty reduction through improved product supply chains.

Building multi-stakeholder dialogue

Existing policy frameworks and national energy policies in developing countries often do not respond to the energy needs and capacities of impoverished communities. Questions related to energy access - Is the energy affordable? Is the technology adaptable? - need to be addressed when developing new policies. From the social perspective, co-benefits, such as heightened security of water supplies, healthier landscapes and greater biodiversity should be also considered in any policy decisions.

Land tenure issues also require careful consideration, particularly for bioenergy production. In recent years there has been a growing interest in large-scale land acquisition for securing a future supply of food and for biofuel production (*Cotula, et al.*, 2010). This development has raised concerns about land tenure security, as the most vulnerable segment of the population depend on land and other natural resources for their livelihood and food security. The move toward energy-smart food systems cannot be accomplished without substantive multi-stakeholder dialogue on options for energy production and consumption and the policies and institutional arrangements needed to achieve the desired results.

Establishing public-private partnerships

Public-private partnerships will be essential to establish energy-smart food systems that can reduce the food sector's dependency on fossil fuels. Investors may need incentives to start business ventures to deliver energy services to rural communities with very limited ability to pay for them. Governments may need to offer subsidies or other financial incentives, such as offering long-term contracts to renewable energy producers based on the cost of generation. Public sector support should also be used for transferring appropriate energy technologies to communities where it is needed and for research and development into local energy technologies. Policies on tariffs and risks should be clearly laid out.

Maintaining flexibility

It is also important to realize that a flexible approach is necessary to suit specific situations. Having a mix of policy designs and implementation approaches flexible enough to accommodate the evolution of technologies, markets and other factors can help overcome barriers to renewable energy deployment.

Following the right policy sequence

Policy sequencing is also critical. Legal and regulatory frameworks regarding the use of land and other resources, the connection and integration to electricity grids, and the allocation of permits and rights, should be in place before introducing renewable energy policies.

Ensuring financial benefits

Over the last several decades, some governments have implemented policies to manage the demand for energy and improve energy efficiency in food supply chain. These policies tend to be set within a broader constellation of policies designed to reduce energy use in the transportation and industrial sectors and encourage more energy-efficient behaviour at home. At present, primary producers are likely to adopt energy savings measures only when significant financial benefits are evident. For example, fishermen are highly motivated to reduce fuel consumption for the immediate economic savings it generates.

Reducing food losses and waste

Less food waste means more energy is saved. The European Landfill Directive, which outlines obligations for reducing organic wastes in landfills, is an example of a policy that reduces food waste and reduces GHG emissions.

Changing traditional dietary patterns so that they become more energy-smart requires powerful and widespread public awareness campaigns. However, promoting a shift to a diet with less energy-intensive foods is unlikely to gain much support, unless efforts to make this change are linked to achieving national health objectives. For example, establishing financial incentives or taxes that encourage people to eat more fresh produce and to reduce their intake of animal fats could be part of national efforts to reduce heart disease and obesity. Retailers can help consumers become more energy-smart by placing labels on food packaging that display the energy used in the production, processing, packaging and distribution of the product. This is complex undertaking and would require international standards for measuring energy consumption at each stage of the food chain.

Addressing knowledge gaps

One of the key steps that need to be taken is to address gaps in our knowledge about the status of energy use and energy production in food systems. Developing effective policies and programmes will require more accurate data from a variety of fields. This will demand significant increases in public investment in research and development for energy. Private sector investments in research and development in the food chain, directed primarily to large-scale systems, have been driven by the need to respond to the globalization of food commodity markets and the desire to maximize profits. Small-scale systems in developing countries have been neglected.

The time needed to develop new energy-smart food systems so that they are competitive with conventional systems is often under-estimated. Analysis of the timelines for creating new pathways for delivering energy-smart systems, establishing appropriate safety nets and adopting effective transition measures would provide policymakers, institutions, financiers and other stakeholders with a better understanding of how to proceed.

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This brief summarizes the key findings and supportive information comprise in a forth coming detailed FAO issues paper, Energy-Smart Food for People and Climate, prepared by Ralph E.H. Simms.

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