NL Agency
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Sustainable Biomass

Combining bioenergy production and food security

>> Focus on energy and climate change

NL Agency

Combining bioenergy production and food security

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LEI Wageningen UR
LEI develops economic expertise in the field of food, agriculture and the natural environment. The research within the department of International Trade and Agricultural Policy shows the economic impact of policy change on agricultural markets, rural development, food security and the biobased economy.

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Index

Executive summary

Introduction
This report analyses whether and how bioenergy can be produced within the context of food insecurity. With this study, the NL Agency aims to contribute to Dutch Development Cooperation policy on food security by showing in which way producing and using biomass for energy does not compete with food security, but contributes to it.

The recent rise in bioenergy use, in particular biofuels, is driven by concerns over energy security, climate change and rising fossil fuel prices. Several leading studies expect that the global bioenergy market will further expand in the future. This requires changes in the way food is produced, stored, processed, distributed, and accessed, and also a rethinking of how biomass is used for bioenergy.

Food security has four dimensions:

1. *Availability* of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid). Available land and food production play an important role.
2. *Access* by individuals to adequate resources for acquiring appropriate foods for a nutritious diet. Land, income and consumer prices play an important role
3. *Utilisation*: Utilisation of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. Income and local consumer food prices play an important role.
4. *Stability*: To be food secure, a population, household or individual must have access to adequate food at all times. Macro-economic conditions play an important role in stability.

The effect of bioenergy production on food security through these variables is sometimes positive (e.g. on food access through producer prices and household income), sometimes negative (on food availability through food production, food trade or food access through consumer prices) and sometimes goes either way (on utilisation and stability dimensions through macro-economic variables). As a result, generic claims stating that bioenergy production is a risk to food security or benefits food security should be treated with caution. Such claims often reflect a partial view on the issues at hand.

The Dutch government has set the following goals for food security in Dutch Development Cooperation policy:

1. Increased sustainable food production.
2. Improved access to food of sufficient quality.
3. Improved functioning of markets.
4. Improved investment climate.

We assess to what extent biomass production for biofuels is consistent with each of the goals of food security policy of the Netherlands.

Increased sustainable food production

Energy crops can be produced in ways that minimize further claims on agricultural land. There are at least four promising avenues to achieve this.

Increased efficiency in land use

The need to expand the cultivated area can be reduced by increasing the yields of energy and food crops. Alternatively, energy and food production are integrated on the same plot in mixed cropping, livestock and/or agroforestry systems. In addition, there is empirical evidence that bioenergy investments can stimulate productivity growth of *food* crops.

To the extent that an expansion of bioenergy production does make new claims on agricultural land, there is a need to increase the efficiency of agricultural land outside bioenergy systems. There are various examples of ways in which the efficiency of land use for bioenergy and food production can be increased. These also show, however, that this effect is not "automatic" but that intentional activities that increase food crop production need to be developed, such as improved crop varieties, irrigation, increased use of fertilisers, possibly combined with training of farmers or provision of inputs.

Crop production on abandoned or degraded lands

An expansion of bioenergy production on abandoned or degraded land may control and limit the impacts of land use change. Marginal or degraded lands are typically characterised by lack of water, low soil fertility or high temperatures. There are bioenergy crops that are able to tolerate these environmental conditions, where food crops might fail. These energy crops may offer the opportunity to put land, which presently yields few economic benefits, to productive use.

There are a few examples that show this can, indeed, be achieved. There are, however, several caveats that need to be taken into account. Before deciding to use degraded lands, two steps should be taken:

1. An assessment needs to be made what the degraded areas are and how they are used, to avoid competition with other uses of degraded land. The Low Indirect Impact Biofuel (LIIB) methodology and the Responsible Cultivation of Areas (RCA) may be useful tools for identifying plots of land.
2. When using degraded lands, a prognosis should be made of the expected yields. A cost-benefit analysis is required to assess whether the investment on degraded lands will be profitable. In general, there is limited bioenergy investment on degraded land, presumably for lack of sufficient return to investment.

Producing bioenergy from wastes or residues

When agricultural waste streams and residues are used for bioenergy production, this can save land otherwise needed to produce bioenergy crops. In addition, by transforming waste into bioenergy, value can be added to a food crop or other biomass, adding to the earning potential in the rural economy.

There are numerous ways in which wastes and residues are used to produce bioenergy (e.g. bagasse for energy from sugar production, biogas from manure). Many of these technologies are available in more developed economies. There is scope for cost-efficient technologies that are specifically targeted at low-income countries, where technologies should be easy to maintain and cheap to use. Using residues and waste should not conflict with important alternative uses such as for fertilising soils and/or feeding animals. The decision on the use of residues and waste should be supported by a careful assessment.

At policy level, investment needs for technologies that can process waste and residues may require support, particularly in Africa and other developing regions. This support may be in the form of subsidies, tax reductions or soft loans for investing in such technologies, but may also be directed at research and development into cost-efficient technologies that are affordable for low-income countries.

Production of co-products

Co-products such as press cakes of biofuel production are often used as livestock feed. This prevents, to a certain extent, the use of land and water resources for feed production, and makes resources available for food production.

There are various good examples of how co-products support the business case of bioenergy or food production, because they usually have high added value. At the same time, market drivers determine whether co-products generate the most value as feed or as industrial or energy feedstock. Therefore, price fluctuations on a range of markets bring a level of uncertainty in the investment decision for bioenergy.

Investments should be made in the production or process facilities for co-production. Producing co-products may also help the business case because they usually have high added value. However, investments in co-products should be weighed against the profitability of selling co-products. Several questions should be asked before investing to assess profitability:

1. What is the demand for that particular co-product?
2. What price will it fetch?
3. What are the alternatives and their prices?
4. Will a large supply of co-products influence prices and therefore profitability?

Improved access to food of sufficient quality

Bioenergy should be produced in ways that improve livelihoods and people’s access to food of sufficient quality. We see three elements that contribute to this goal.

Land rights

Expanding bioenergy production is likely to lead to greater competition for access to land and water. Greater competition may result in rising land rents and a redistribution of income from land leasers towards land owners. This competition poses a threat to various people dependent on land and water resources for their livelihoods, such as farmers, pastoralists, fishermen and forest dwellers. In many developing countries these people live in areas that have no formal land tenure rights. Therefore, proper land tenure policies are crucial for food security.

When land is acquired through sale or lease, there should be fair and equal representation of the communities affected in the terms of compensation: land tenure issues are often complex, and what constitutes a fair compensation is not always clear.

Tools that can be used to ensure land rights are dealt with correctly are the FAO’s *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security* or the *Principles for Responsible Agricultural Investment that Respects Rights, Livelihoods and Resources Voluntary Guidelines* (RAI). These schemes encourage the periodical review of agreements, making sure that they are understood by all and that indigenous people and other vulnerable groups be provided with information and support so they can participate effectively. In this sense, the process of reviewing enables learning, especially on the impact on food security.

National and local governments should clarify legal land acquisition procedures (through sale or lease), increase transparency of such deals and enforce the laws. This may be achieved by encouraging the use of the FAO's Voluntary Guidelines or the RAI.

Consumer prices

One of the effects of bioenergy production that has received much attention has been its alleged contribution to high food prices and thus negatively affecting food security. Policies that set mandatory targets for bioenergy in fuel consumption (such as by the EU) have thus been criticised for pushing up food prices. It should be noted, however, that high international prices do not always translate automatically to high local prices.

Bioenergy production is an additional source of demand for agricultural commodities, and as such, it may in part cause higher price levels. The production of bioenergy reinforces the link between oil and agricultural markets. The main concern about the influence of increased use of biomass for energy is the effect of high food prices on vulnerable households who are net consumers.

There are two ways to counter this concern. First, by reducing the effect of bioenergy on food prices, which is best addressed by a dismantling of government policy aimed at target shares of bioenergy in energy consumption beyond levels compatible with market forces. Partial measures in this direction include making mandatory targets for bioenergy more flexible and reducing trade restrictions on bioenergy in the global market . Second, by reducing the effect of high food prices on vulnerable groups, e.g. through social safety-nets.

Household income

Bioenergy production may have a positive impact on the household income of small-scale producers and therefore on food security. First (A), bioenergy production provides additional employment opportunities that allows them to generate income with which they can purchase food. Usually this involves relatively large-scale bioenergy production and processing. Second (B), bioenergy production may also provide income to farmers who grow bioenergy crops as a cash crop. This may involve small-scale, local bioenergy production, but also relatively large-scale production with outgrowers. Additional income from bioenergy may be used to increase the efficiency of food production.

(a) The literature shows that biomass production for bioenergy may indeed lead to higher employment. To ensure that higher employment leads to food security the following could be pursued:

- Hire local workers to ensure local food security effects. Invest in training if necessary;
- Ensure the workers receive at least the minimum wage and provide for good working conditions, especially for women.

Due to ongoing shifts towards more mechanised production of bioenergy in various developing countries, many low-skilled workers run the risk of losing their job. The redundant workers may need to be retrained and offered support in finding different work by governments, in combination with the private sector and NGOs.

(b) The literature also shows that producing bioenergy crops may provide farmers with cash income with which they can purchase food. Sourcing from local farmers may therefore be a feasible option to increase local food security. However, in order to provide farmers with sufficient income, several conditions should be met. Above all, the bioenergy crop should be economically attractive, which usually means providing farmers with a stable and secure market outlet and a competitive price.

Bioenergy crops, such as sugarcane or oil palm, are often high volume, low value crops and therefore more suitable for large-scale commercial production than for smallholder farming. Such crops may be suitable for smallholders in outgrower schemes, if the company provides inputs and secures a market and smallholders provide their land and labour. The high yields per ha make these crops especially suitable for smallholders who have relatively low land and labour resources

When farmers only have one supplier to sell bioenergy crops to, there is a risk of lock-in. When this supplier, for whatever reason, disappears, the farmers lose their outlet and source of income. At a local policy level, multiple marketing outlets should therefore be promoted. For smallholders who produce a marketable surplus, it will often be attractive to plant food crops such as cassava, soybean or maize that can also be used for biofuels. This provides them with multiple outlets that would be missed in the case of specific biofuel crops such as jatropha or castor that have only a biofuel outlet.

In most parts of the world, local food markets function properly. However, in those, usually remote, parts of the world where they do not, investments should be made to lift the most important constraints, for instance by investing in roads.

Improved functioning of markets

When the functioning of markets is improved, bioenergy markets may work better for small farms, small firms and low-skilled workers. We identify three ways in which markets can contribute to a stable income and thus stable access to food security: inclusion into value chains, increased opportunities of small to medium scale enterprises (SMEs) and local value adding. Well-functioning markets play an essential role in these.

Inclusion of small-scale producers and low-skilled labourers in modern biomass value chains

There are various ways to include small-scale producers and low-skilled labourers into the biomass value chains, differing by whether the land is held by smallholders or agribusiness and whether the production is led by smallholders or agribusiness.

Within the bioenergy chain, the agro-industry usually retains a lead role. When agribusiness firms control land, production process or both, they should offer smallholders contracts that provide a secure marketing outlet. This could involve:

1. Offering a stable price. This may be achieved by sharing price risk, in which the risk of price fluctuations are shared between farmers and contracting firms;
2. Offer long term perspective for supply. Contracts may be short-term (e.g. annual), which may benefit both farmers and firms because it introduces flexibility. Firms may signal a longer term perspective by investing in the relationship with farmers, which may benefit the firm also, by securing a stable supply. The investment may consist of training, supplying inputs etc.

When smallholders control the production process and the land, they should have access to well-functioning supply chains or markets, because smallholders lack the means to provide for these (such as building infrastructure). Therefore, governments at national and local level, together with the private sector, should invest in processing facilities, transport and infrastructure.

Creating additional employment and income by increasing opportunities for small to medium enterprises (SMEs) in biomass value chains

Bioenergy production may lead to additional demand for services or production, which could be provided by other SMEs. We could find little information on the role of SMEs in biomass value chains. The main reason for this is probably that the value chain is usually short. Typically, farmers sell directly to bioenergy companies, which leaves little room for other actors in the chain, such as service providers.

Local, small-scale value adding by local processing

Local, small-scale value adding may increase food security, by creating employment in the processing industry, as well as providing income to skilled people in countries where skilled jobs are scarce.

There are several successful examples of how bioenergy production firms have invested in local processing to generate local value adding. These examples show that local value adding often comes with an orientation towards outlets on the local or domestic market.

Governments in collaboration with the private sector, should create an enabling environment that will stimulate investments in local, small-scale value adding, such as local processing plants. Especially in Sub-Saharan Africa there is relatively little local processing and value adding. Harnessing foreign investment may be an effective strategy to achieve this in Africa, as the Mali Biocarburant example shows, which was facilitated by Dutch investors. Dutch policy from their side, can also stimulate local small-scale value adding by providing start-up capital for investors.

Improved investment climate

An improved investment climate helps to ensure that bioenergy investments may generate spin-offs that contribute to agricultural development and the rural economy.

Bioenergy production may in principle generate growth linkages to the rest of the economy through investment in processing capacity, infrastructure (such as roads) and employment. Through these growth linkages it may contribute to the stability dimensions of food security, as well as to food access.

However, achieving these growth linkages requires strict control and governance of the proposed biomass investment. It is important to ensure that the investment strengthens the rural economy and that local communities benefit from the additional economic activity and employment. We identify three issues that can facilitate this:

Enabling government policies need to be in place to ensure biomass production for bioenergy benefit rural communities.

When national governments develop policy frameworks to improve their bioenergy markets, energy infrastructure and stimulate bioenergy technologies, they should also target policies towards creating benefits for local livelihoods and food security. There are various examples how supporting policies implemented by governments have achieved this, such as providing tax reductions or other incentives to biofuel producers when smallholders are engaged.

Foreign assistance may also provide support to government policies, in the form of capacity development of agencies involved in bioenergy investments. Another example is devising procedures and criteria that will improve transparency of decision-making and improve the assessment of which investments should be approved. For instance, a criterion could be the involvement of smallholders.

Investments in biomass production for bioenergy may have spill-over effects that benefit food production

Very little information is available on actual investments in infrastructure by bioenergy companies, and therefore we could not find sufficient information about the spill-over effects of these investments. This does not mean that these investments have not been made. There is anecdotal evidence that in Latin America and many Asian countries for instance, large-scale investments in processing facilities and infrastructure have been made.

Governments may promote positive spill-over or multiplier effects of investments in biofuel production by creating leverage to deliver rural services or by holding firms accountable. However, most of these effects are indirect and are achieved through a well-functioning economy.

Farmers' organisations may play an important role in this.

In general, the role of farmers' organisations is increasingly recognised as being pivotal. By pooling and protecting the interests of the farmers, and negotiating on their behalf with bioenergy companies, farmers' organisations may contribute to protecting the livelihoods and therefore food security of farmers.

At project level, therefore, it may be useful to explore the possibilities to collaborate with farmers' organisations. The farmers' organisation may help in contacting and contracting large numbers of farmers, and ensure that the terms in the contract are fair. If a well-functioning farmers' organisation is missing, an NGO may assume a role in initiating and training farmer organisations while temporarily acting on their behalf.

At policy level, farmers' organisations should be recognised and supported, especially when they implement activities that protect the farmers' interests (see above).

Use certification schemes and available guidelines to address food security in bioenergy production

Certification schemes

Certification schemes help to ensure that bioenergy production does not harm the different dimensions of food security. In addition, certification schemes may outline best practices in management. Such Best Management Practices (BMP) can help farmers achieve higher yields as well as higher incomes, both which contribute to an improved food security status.

There are numerous certification schemes. The Roundtable on Sustainable Biofuels (RSB) incorporates food security in the most comprehensive manner, with clear criteria. Therefore, for projects wishing to have their produce certified, and audited explicitly on food security, the use of RSB guidelines may be most useful.

Other certification schemes, that incorporate food security less comprehensively, may also be useful tools to ensure bioenergy production does not harm the different dimensions of food security. Even when food security impacts are not mentioned explicitly in guidelines, food security issues may arise through for instance mandated local consultation as well as impact assessment and mitigation processes. Certification schemes may also outline Best Management Practices (BMP). For instance, the Roundtables include requirements for BMP, which may be used for food security purposes.

Other tools

Certification schemes are not the only way to ensure bioenergy is produced with a focus on food security. There are also other tools available to assess and monitor the links with food security. These may be simpler to apply, less costly but yet robust.

For instance, the FAO Support to Decision-Making for Sustainable Bioenergy: Bioenergy and Food Security (BEFS) is a comprehensive toolkit, which aims to support policy makers, investors and producers in making bioenergy development sustainable.

At a policy level, the Global Bioenergy Partnership (GBEP) is a useful tool because it focuses on bioenergy policy development. The Global Bioenergy Partnership (GBEP) aims to promote the wider production and use of modern bioenergy, particularly in the developing world where traditional use of biomass is prevalent.

1 Introduction

1.1 Context

The recent rise in bioenergy use, in particular biofuels, is driven by concerns over energy security, climate change and rising fossil fuel prices. Several leading studies expect that the global bioenergy market will further expand in the future. At the same time, new technologies such as shale gas might be a fundamental game changer for the energy sector, and lead to a revision of the policies that have driven much of the expansion of bioenergy use. What is certain, however, is that population and consumption growth will increase global demand for biomass. This requires changes in the way food is produced, stored, processed, distributed, and accessed, and also a rethinking of how biomass is used for bioenergy.

Production of biofuels, specifically, has been heavily supported by policy measures (such as subsidies, mandates and tariffs for imports) that targeted a few domestic-based feedstock: maize, rapeseed, soybeans (Elbehri, Segerstedt, and Liu 2013). The food crisis of 2007-08 led to a debate over food-versus-fuel competition, raising concerns about biofuels competing with food security (Sagar and Kartha 2007). Projected future demand for food and biomass depends on a number of factors:

- Population growth and change in population concentration over decades is subject to general macroeconomic and sociocultural developments (Ames et al. 2001);
- Food prices and biomass prices developments are uncertain in the long run, mainly because (i) climate change will cause more volatility in harvests and productivity, (ii) farmer supply response, innovation and technological change cannot be predicted precisely, (iii) the level of market integration and other institutional developments will affect global prices and competition (see e.g. Turral, Burke, and Faurès 2011).
- The consumption of meat, dairy, vegetables and other high-value foods is more responsive to price change than the consumption of basic foods (staples). The FAO & OECD Outlook for 2021 estimates that world meat consumption will continue to grow at one of the highest rates among major agricultural commodities (OECD & FAO 2012). Meeting food demand by 2050 will require roughly a 60% increase in output from the world's cropland and a 70% increase in the output of meat and dairy (Alexandratos and Bruinsma 2012).

Biofuel and bioenergy use could give a further push to the global demand for biomass. Van Ittersum (2011) suggests that agricultural output will need to triple between 2010 and 2050, if global biomass will deliver 10 per cent of global energy use by 2050. For biofuels only, Achterbosch et al. (2012) indicate that, in volume terms, the demand for feedstock would be largest in China and US. A threefold challenge faces the world (Godfray et al. 2010):

1. Match the rapidly changing demand for food from a larger and more affluent population to its supply.
2. Do so in ways that are environmentally and socially sustainable.
3. Ensure that the world's poorest people are no longer hungry.

This requires changes in the way food is produced, stored, processed, distributed, and accessed, but also rethinking the way biomass is used for bioenergy.

1.2 Objectives

In 2010, the Dutch government declared food security as one of the key priorities of development cooperation policy. This year, the Netherlands Programme Sustainable Biomass reaches its projected finalisation. Questions have been raised whether the promotion of sustainable biomass production and biomass imports into the Netherlands is consistent with the policy to improve food security. With this study, the NL Agency aims to contribute to the following goal:

- Contribute to the Dutch Development Cooperation policy on food security by showing in which way producing and using biomass for energy does not compete with food security, but contributes to it.

And the following sub-goals:

- To provide guidance to certification programmes for sustainable biomass specifically for the criterion "competition with food security".
- To contribute to the public debate on this theme.
- To advise policy.

This report examines the relations between biomass and food security with particular attention to energy use of biomass. Based on a literature review, it aims to answer the question whether and how biomass production for bioenergy can be combined with food security objectives.

The Dutch government has set the following goals for food security in Dutch Development Cooperation policy (Ministerie van Buitenlandse Zaken 2012; Ministerie van Buitenlandse Zaken 2011)[1]:

1. Increased sustainable food production.
2. Improved access to food of sufficient quality.
3. Improved functioning of markets.
4. Improved investment climate.

We assess to what extent biomass production for biofuels is consistent with each of the goals of food security policy of the Netherlands.

1.3 Methodology

This report is largely based on a literature review. The above-mentioned four goals of Dutch Development Cooperation policy are used to guide the literature review. For each goal, we assess to what extent biomass production for bioenergy is consistent with that goal in contributing to food security.

An earlier memorandum by NL Agency (Internal Memorandum NL Agency 2011) already laid out several arguments that linked food security and biomass production for bioenergy, within the context of the Dutch Development Cooperation policy. This internal document linked the results from the pilot projects in the subsidy schemes from the Netherlands Programmes for Sustainable Biomass to the food security objectives. We build on these arguments in this report, but looked for practical experiences documented in literature sources for a scientific foundation.

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[1] On the website of the Ministry of Foreign Affairs five goals are mentioned:

1. Increasing sustainable food production;
2. Let local producers profit from international and regional trade;
3. More people should get nutritious food;
4. Food must be more easily traded and transported;
5. Improve climate for local and foreign agricultural entrepreneurs.

http://www.rijksoverheid.nl/onderwerpen/ontwikkelingssamenwerking/voedselzekerheid Accessed in February 2013

The literature review was targeted at reviewing specific literature, combining the topics biomass production for biofuels, food security and the specific goal of the Dutch Development Cooperation.

We scope and provide practical examples of how biomass production for biofuels and food security can be combined. The practical examples are derived from literature with case studies. This means that besides scientific literature, also reports from non-scientific institutions, such as NGOs are used. In addition, field experience from the authors of this report are used.

These examples are discussed with respect to what extent their experience can be generalised. We do this in sections labelled "Critical points".

The examples and critical comments are subsequently integrated into recommendations The report addresses two different levels: (i) the level of projects for biomass production for bioenergy (micro level), and (ii) the level of policies on biomass production for bioenergy (macro level).

1.4 Structure of the report

Chapter 1 introduces the study, while chapter 2 introduces the two main concepts discussed in this report, i.e. biomass production for biofuels and food security. Chapter 2 also introduces the framework we use to assess the links between biomass production for biofuels, food security and the goals of Dutch Development Cooperation policies to improve food security. Chapters 3 to 6 discusses to what extent biomass production for biofuels is consistent with the four goals of Dutch Development Cooperation in contributing to food security. Chapter 7 discusses the role of certification as a tool to combine the four goals of Dutch Development Cooperation, biomass production for biofuels and food security. Chapter 8 develops the conclusions.

2 Definitions and framework: links between biomass production for bioenergy and food security

In this chapter, we introduce the two main concepts discussed in this report: (i) biomass production for biofuels and (ii) food security. We also introduce the framework with which we can assess the links between biomass production for biofuels, food security and the goals of Dutch Development Cooperation to improve food security.

2.1 Biomass and biofuels

Biomass (feedstock) comprises any organic matter of either plant or animal origin constituting a renewable energy source. Biomass energy or *bioenergy is* the stored solar energy, carbon and hydrogen – captured initially through photosynthesis into chemical bonds – that is available on demand within that organic matter (Macqueen and Korhaliller 2011).

Biomass differs from other renewable energy resources in that it can be a substitute for all fossil-fuel based products, using a wide range of technologies to convert the range of resources into heat, electricity and liquid fuels. It can be used directly in traditional ways for heating and cooking, or indirectly using modern conversion technologies (IEA 2008).

The term *biofuel* is referred to liquid, gas and solid fuels and blending components predominantly produced from biomass feedstocks (USDA ERS 2009). Biofuels include various types[2]:

- Bioethanol is a petrol additive/substitute and is produced from maize, wheat, sugar cane, cassava or beets.
- *Biodiesel* is produced from oil seeds.
- *Biogas* can be produced from the organic fraction of almost any form of biomass, including sewage sludge, animal wastes and industrial effluents, through anaerobic digestion into methane and carbon dioxide mixture (Demirbas 2008)[3].

First generation biofuels (bioethanol, biodiesel), are produced from agricultural feedstock such as maize, sugarcane, sugar beet, wheat, cassava, potato, rapeseed and soybean, sunflower and palm oil. Currently, some 65% of EU vegetable oil, 50% of Brazilian sugar cane, and 37% of US maize production are used as feedstock for biofuel production. The main biofuel producers in the world are Brazil, the USA and the EU, other significant players are Thailand (ethanol and biodiesel), Argentina and Indonesia (biodiesel). Also countries with a high potential in sugar cane and/or vegetable oil production like India, Columbia, Philippines and Malaysia are increasingly producing biofuels (OECD & FAO 2012).

The so-called *second-generation biofuels* technologies are more efficient and have the potential to use waste residues and use of abandoned land. Second generation biofuels are those biofuels produced from cellulose, hemicellulose or lignin. They can either be blended with petroleum-based fuels combusted in existing internal combustion engines, and distributed through existing

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[2] We do not include biomethanol, bio-synthetic gas (bio-syngas), bio-oil, bio-char, Fischer-Tropsch liquids, and biohydrogen here.

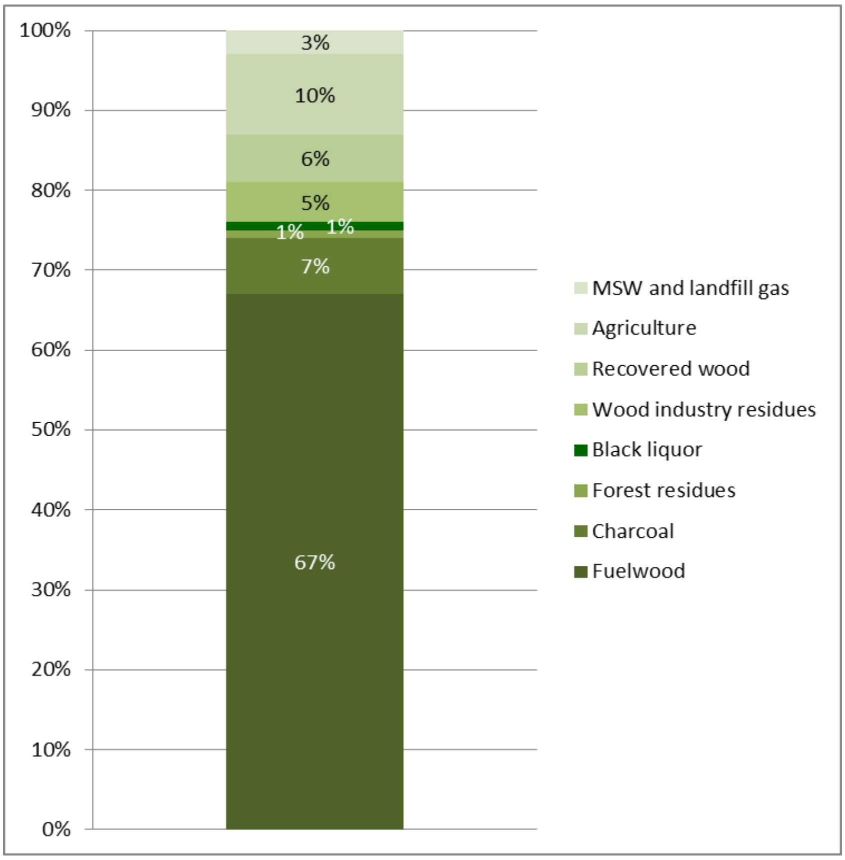
[3] Demirbas (ibid) discusses also other biofuels such as bio-char and biohydrogen. We refer to the article of Demirbas for further explanations.

infrastructure or can be used in slightly adapted vehicles with internal combustion engines (e.g. vehicles for DME). Examples of second generation biofuels are cellulosic ethanol and Fischer-Tropsch fuels. Despite its promise, research-and-development activities on second-generation biofuels so far have been undertaken only in a number of developed countries and in some large emerging economies, and they are not yet produced commercially (Eisentraut 2010).

Figure 1 shows the different types of biomass used for energy. Wood in general makes up almost 90% of biomass used for fuel. Over 70% consists of charcoal and fuel wood, which are usually used by rural household and traded in small-scale or informal markets. Besides generating heat and electricity, woody biomass can also be used for biofuels. In many cases, the technology for converting woody biomass into energy has been established for decades, but because the price of woody biomass energy has not been competitive with traditional fossil fuels, bioenergy production from woody biomass has not been widely adopted. Exceptions are those that are low cost to procure, such as wood in municipal solid waste, milling residues, and some timber harvesting residues (White 2010).

Our study focuses only on biomass feedstock that has a relation to food security via land use for agriculture and to a lesser extent for agro-forestry. It does not focus on for instance small-scale wood gathering for e.g. fuel wood stoves.

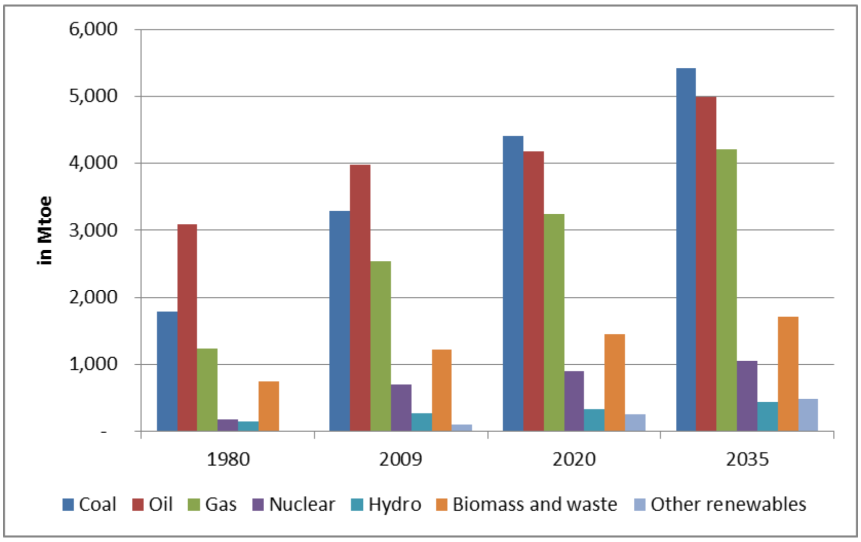
Figure 1: composition of biomass used for energy by type of biomass.



(Source: Bauen et al. 2009)

Most of the biomass consumed in 2030 will still come from agricultural and forest residues. A growing share will come from purpose-grown energy crops, mainly for making biofuels as well as energy from waste (Figure 2). Especially the use of biomass in modern applications, such as biofuels and power generation, is increasing rapidly, while the use of traditional biomass in e. g. cooking stoves in poor households in less developed parts of the world grows at a much slower pace (IEA 2008).

Figure 2: World primary energy demand by fuel 1980-2035 (under current policies scenario)

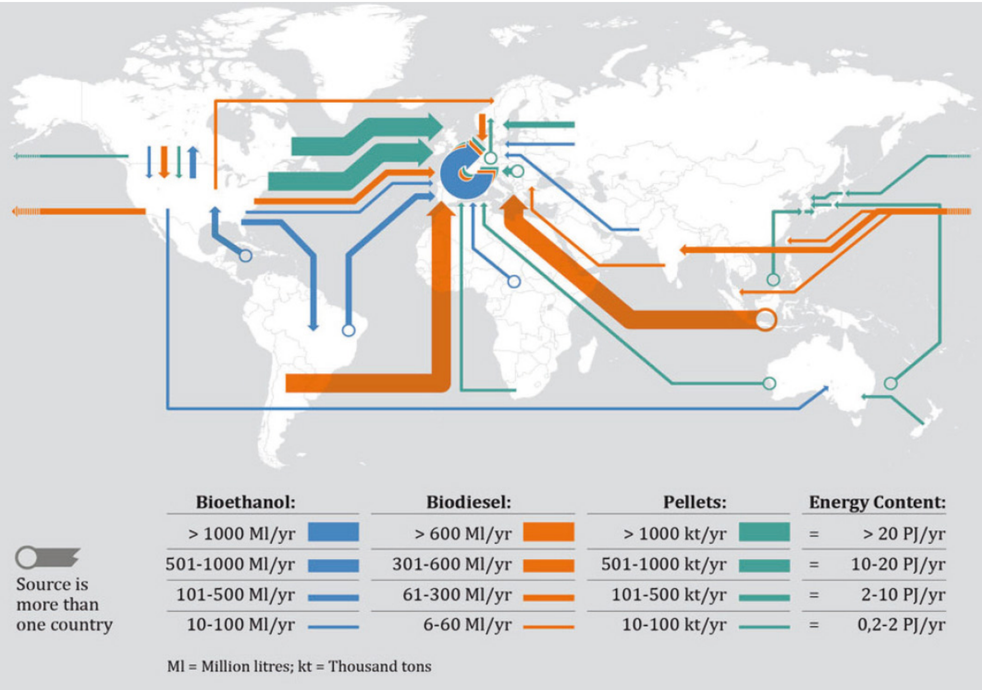


(Source: IEA 2011)

The growing use of biomass for heat, electricity, and transport fuels has resulted in increasing international trade of biomass fuels to supplement local supply. Ren21 (2012) reports that wood pellets, biodiesel, and ethanol are the main fuels traded internationally. Others include methane, fuel wood, charcoal, and agricultural residues. The leading global markets for biomass energy are diverse and vary depending on fuel type (see Figure 3).

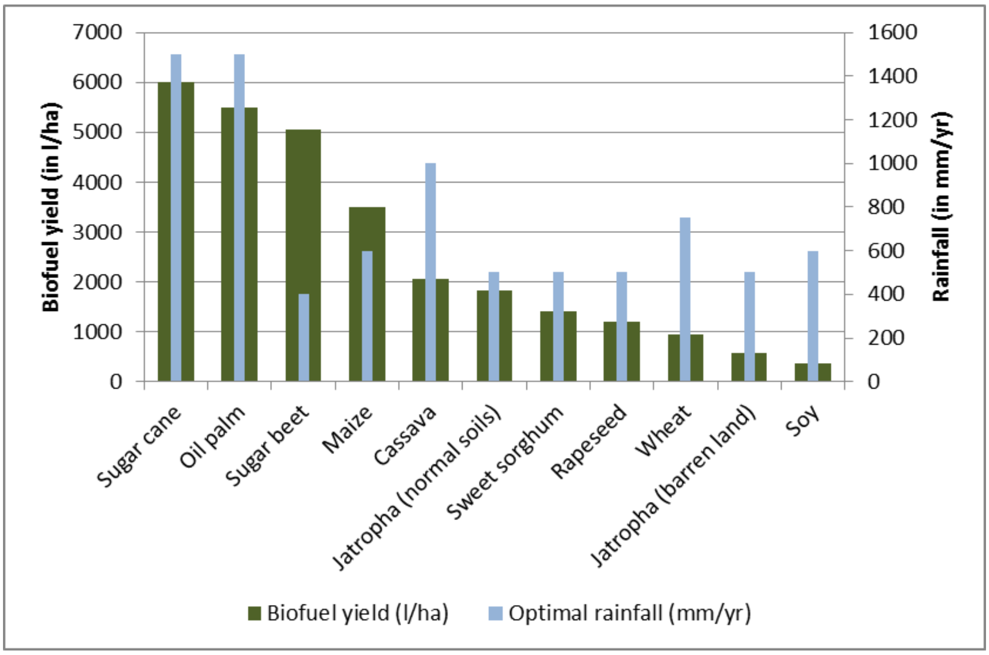
Figure 4 shows the main agricultural biofuel feedstocks with their yields and rainfall requirements. Sugar cane & beet and oil palm have the highest yields per hectare. The figure does not show the second generation energy crops (e.g. poplar, willows, alfalfa, switchgrass, miscanthus or even wood or crop residues) which offer great promise as energy feedstock. These second-generation energy crops have yet to be fully commercialised, and the dates for doing so have been pushed back many times (Elbehri, Segerstedt, and Liu 2013).

Figure 3: Net Trade Streams of Wood Pellets, Biodiesel, and Ethanol, 2011.



(Source: Ren21 2012)

Figure 4: Biofuel feedstocks yields, and optimal rainfall



(Source: Elbehri, Segerstedt, and Liu 2013).

2.2 Food security

The widely accepted definition of food security was formulated during the World Food Summit of 1996: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit 1996; see also FAO 2006).

The FAO (2006) outlines four dimensions of food security:

3. *Availability*: The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid).
4. *Access*: Access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet. Entitlements are defined as the set of all commodity bundles over which a person can establish command given the legal, political, economic and social arrangements of the community in which they live (including traditional rights such as access to common resources).
5. *Utilisation*: Utilisation of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. This brings out the importance of non-food inputs in food security.
6. *Stability*: To be food secure, a population, household or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e. g. seasonal food insecurity). The concept of stability can therefore refer to both the availability and access dimensions of food security.

2.3 EU policies

The Renewable Energy Directive (RED) established mandates for the use of renewable energy in the European Union (European Commission 2013a). This included a mandatory target for European Member States which specifies that 10% of energy in land transport should be from renewable sources by 2020. This renewable energy may consist of various types, such as hydrogen, electricity, or bioenergy. For bioenergy, the Directive includes sustainability criteria (see the Fuel Quality Directive), which set a minimum threshold on the direct emissions savings from biofuels.

Council of 23 April 2009 on the promotion of the use of energy from renewable sources (European Commission 2009) mentions the effect of biofuel production on food prices several times.

Article 17 (Sustainability criteria for biofuels and bioliquids) promises that "The Commission shall, every two years, report to the European Parliament and the Council on the impact on social sustainability in the Community and in third countries of increased demand for biofuel, on the impact of Community biofuel policy on the availability of foodstuffs at affordable prices, in particular for people living in developing countries, and wider development issues".

In Article 23 (Monitoring and reporting by the Commission), The Commission states that it "shall also monitor the commodity price changes associated with the use of biomass for energy and any associated positive and negative effects on food security

On 27 March 2013, the first report was published on the progress in the promotion and use of renewable energy, and to monitor and report on measures taken to respect the EU biofuel sustainability criteria and impact of the EU biofuel consumption on sustainability in the EU and the main third countries of supply (European Commission 2013b), together with an accompanying report (European Commission 2013c). In these reports, food security per se is not mentioned, although the report does analyse the effect of bioenergy on food prices. The European Commission finds that (European Commission 2013b, 12):

> "(...) grain use for bioethanol production constituted 3% of total cereal use in 2010/2011 and is estimated to have minor (1%-2%) price effect on the global cereals market. EU biodiesel consumption is greater, and the estimated price effect on food oil crops (rapeseed, soybean, palm oil) for 2008 and 2010 was 4%18. It also appears that biofuel demand is more price sensitive than the food market and so demand declines more in response to rising prices"

In October 2012, the EC issued a proposal for amending the ambition levels regarding biofuel use, motivated by a precautionary approach to displacement of cropland for food by energy crops. The key element in the proposal (COM(2012) 595 final) is that the "share of energy from biofuels produced from cereal and other starch rich crops, sugars and oil crops shall be no more than 5%, the estimated share at the end of 2011, of the final consumption of energy in transport in 2020."

2.4 Connecting Dutch development cooperation, food security and biomass for bio-energy

Bioenergy and food security are connected at several levels. A framework of economic drivers shows that biofuel production affects producer prices, food production, food trade, consumer prices, household income, food basket and nutrient consumption (Figure 5). The effect is sometimes positive (producer prices and household income), sometimes negative (food production, food trade and consumer prices) and sometimes it can go either way (utilisation and stability dimensions).

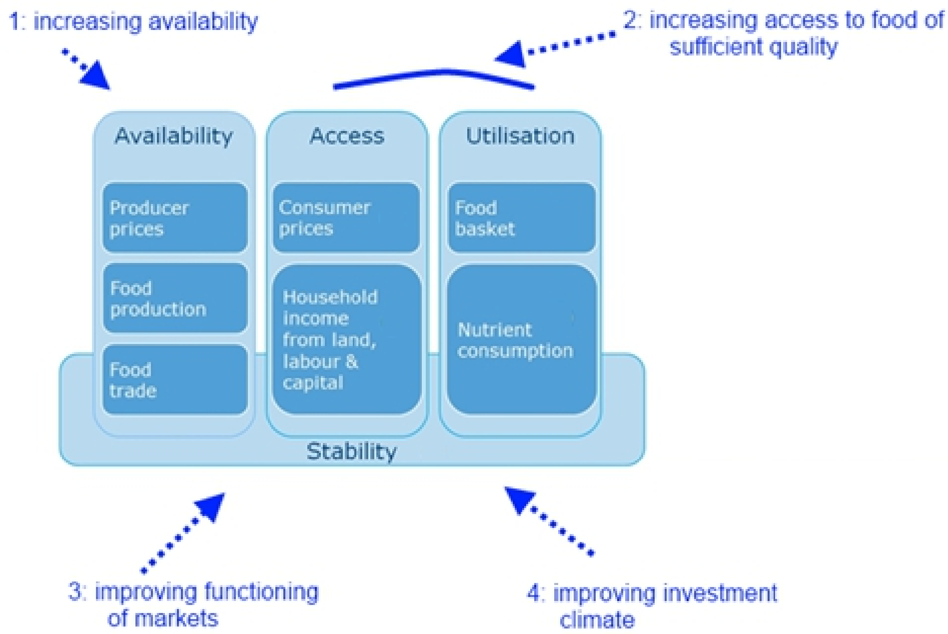
The Dutch government has set the following goals for food security in development cooperation (Ministerie van Buitenlandse Zaken 2012; Ministerie van Buitenlandse Zaken 2011)[4]:

1. Increasing sustainable food production.
2. Increasing access to food of sufficient quality.
3. Improving functioning of markets.
4. Improving investment climate.

The four policy goals impact on the different dimensions of food security. Figure 5 shows where the different goals link up with the four dimensions. Improving functioning of markets and improving investment climate will, of course, also have an effect on the availability, access and utilisation dimensions. However, we will argue below that these two goals are especially important to safeguard the stability of food security.

[4] On the website five goals are mentioned; see previous footnote

Figure 5: Possible impacts of biofuels on the four dimensions of food security



(Source: Shutes et al. 2013)

There are several documents that describe how bioenergy production affects the different dimensions of food security, see Achterbosch et al. (2012) or the FAO BEFS project (FAO 2010). This section provides a simplified overview of the links between food security and bioenergy production, in connection to the food security goals of Dutch development cooperation (see Figure 5).

The production of biomass for bioenergy affects the goal of **increasing sustainable food production** (*availability dimension* of food security) in several ways. First, through land: if agricultural land is used for the production of biomass for bioenergy, it is no longer available for food production, and thus in principle, it negatively affects food production. Second, biomass production can have a positive effect on farm-gate producer prices: when food production decreases, food prices may rise. To the extent that rising consumer prices are transmitted to the farm level, rising prices, in turn, may lead certain producers to grow more food, until a new equilibrium is found. A likely complication is that bioenergy production also affects the demand of farm inputs such as land, water and fertiliser. Shortfalls in domestic food production could require increases in food imports expenses, and thus negatively affect food trade.

Improving **access to food of sufficient quality** encompasses two dimensions of food security: access and utilisation. The access dimension relates to food prices and income, but also to access to land and other natural resources, which are used to generate income or food. Prices play a role in that food may be available, but too expensive for poor households to purchase in sufficient quantities. Any additional income generated by bioenergy production raises the purchasing power of the household, and also results in a lower share of food in household expenditures.

The *utilisation dimension* refers to what kind of food people consume; quality in terms of nutrition is an important aspect. This also relates to prices and income, but other factors, such as education, knowledge about nutrition etc., are important as well. We focus on prices and income, as other factors such as education do not have a clear link to biomass for bioenergy production.

Finally, the *stability dimension* refers to the fact that a population, household or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks.

An improvement in the **functioning of markets** will lead to more stability. Markets are closely related to prices and income as well. Markets determine food and biofuel prices, and consequently household incomes. In this report, however, we focus on how markets can contribute to a stable income of households, allowing them to have a stable access to food and good quality nutrition. We identify three ways in which households can achieve this: inclusion into value chains, opportunities of small to medium enterprises (SMEs) and local value adding.

Biofuel developments may contribute to an overall improved macroeconomic performance and living standards because biofuels production may generate growth linkages (i.e., multiplier or spill-over effects) to the rest of the economy. **Improving the investment climate** is crucial: achieving these growth linkages requires strict control and governance of the proposed biomass investment; only then, the stability dimension of food security can be addressed. It is important to ensure that the investment strengthens the rural economy and that local population benefits from additional economic activity and employment. We identify four issues that can facilitate this. First, investments in biomass production for bioenergy may have spill-over effects that benefit food production. Second, enabling government policies need to be in place to ensure biomass production for bioenergy benefit rural communities. Also farmers' organisations may play an important role in this. Finally, land tenure rules need to be place to ensure that rural communities continue to have *access to land* for their livelihoods.

3 Policy objective no 1: Increase sustainable food production

The production of biomass for bioenergy May affect the availability dimension of food security in several ways. First, through land: if land is used for the production of biomass for bioenergy, it may no longer be available for food production, and thus in principle, it negatively affects food production. Biomass production can have a positive effect on producer prices: when food production decreases, food prices will increase. This, in turn, may lead producers to grow more food and less biomass for energy, until a new equilibrium is found. Shortfalls in domestic food production could require increases in food imports expenses, and thus negatively affect food trade.

In the discussion on the competition for land between biomass production for bioenergy and food production, two types of land use change (or LUC) are usually distinguished (Dehue, Cornelissen, and Peters 2011; Laborde 2011; Lange and Delzeit 2012):

1. Direct land use change (DLUC) is the conversion of land that was not used for crop production before, into land used for a particular bioenergy feedstock production. Direct land use change can be observed and measured and attributed to the party that caused them
2. Indirect land use change (ILUC) is an external effect of the promotion of biofuels. The effect is caused by changes in prices for agricultural products on the world or regional market. When bioenergy feedstocks are increasingly planted on areas used for agricultural products, there is a reduction of food and feed supply on the world market. If the demand for food remains on the same level and does not decline, prices for food rise due to the reduced supply. These higher prices create an incentive to convert formerly unused areas for food production since the conversion of these areas becomes profitable at higher prices. This is the ILUC effect of the bioenergy feedstock production. Several studies that use economic models have tried to measure the ILUC effect.

There are various options to minimise the effects of direct and indirect land use change. First, by intensifying land use or by integrating food and energy production. Second, by using abandoned or degraded lands for bioenergy production. Third, by using wastes and residues and finally by co-producing bioenergy with another product. Such sustainable, Integrated Food-Energy Systems (IFES) have the potential to reduce the impacts and competition arising from bioenergy production on food security (Bogdanski and Ismail 2012; Bogdanski et al. 2010).

It is possible to cultivate energy crops while maintaining land use of food production completely or partly, through sustainable integrated agricultural and (agro) forestry management systems or by producing bioenergy from waste.

The production of valuable co-products or residues of bioenergy mitigate land use change. Land that would be used to produce these residues is saved. There are several examples of wastes and residues used for bioenergy production.

3.1 Increased efficiency in land use

Ways to combine bioenergy production and food security

The need to expand the cultivated area can be reduced by increasing the yields of energy and food crops. Alternatively, energy and food production are integrated on the same plot in mixed cropping, livestock and/or agroforestry systems. In addition, there is empirical evidence that bioenergy investments can stimulate productivity growth of *food* crops (e.g. Batidzerai, Faaij, and Smeets 2006; IPCC 2011; van der Hilst 2012). For instance, factories that have plantations and outgrowers to guarantee their feedstock supply should also provide agronomic assistance to their small-scale or low-income suppliers, helping them to improve their productivity from bioenergy and food crops.

To the extent that an expansion of bioenergy production does make new claims on agricultural land, there is a need to increase the efficiency of agricultural land outside bioenergy systems. Intensifying livestock systems or reducing food waste are such entry points for increasing land use efficiency (see 3.3).

In addition, *indirect* yield increasing effects of bioenergy production may be achieved. Although these effects may be difficult to show or monitor in practice, modelling analyses, such as by the MAGNET model, show that a significant part of the additional demand for oil bearing crops for biodiesel production can be met by increased productivity (Achterbosch et al. 2012).

Examples

1. In Brazil for instance, sugarcane expansion leads to attractive land lease options for medium scale farmers who can use the annual revenues from leasing part of their land to pay for investments needed to intensify production on the remaining hectares. The BaldeCheio programme provided technical assistance, allowing dairy farmers managed to increase milk production threefold. This outcompeted the revenues of sugarcane or soybean production per ha (Novo 2012).
2. Another example is the production of ethanol from sugar cane in São Paulo, Brazil, which has become more efficient due to learning-by-doing through the national ProÁlcool programme (Van den Wall Bake et al. 2009).
3. In Indonesia and Malaysia, palm oil producers have contracts with smallholder that include support in the form of seedlings, fertilisers, pesticides, and access to technical assistance or credit all aiming at oil palm production (Wild Asia 2012).
4. BP has invested heavily in production of biofuel from sugar cane in Brazil (BP 2012). Increasing crop yields is important for optimising economic performance of biofuel production. Increasing yield may be total biomass yield or increasing yield of the desired component in the biomass e.g. oil content in seeds.

5. Yield increases were also realised in Mali Biocarburant project due to targeted investments in food crops (Verkuijl 2012); see Box 1. Mali Biocarburant provides the opportunity to invest in improved food production.
6. Another example from Africa is the joint venture CleanStar Mozambique started in 2011 by Biotech firm Novozymes and CleanStar Ventures. CleanStar Mozambique works with subsistence farmers to increase production of cassava, legumes and cereals using simple sustainable farming methods such as crop rotation and agroforestry. CleanStar's processing division purchases the farmers' surplus cassava production and processes it into an ethanol cooking fuel. The legumes and cereal are processed into packaged foods at its integrated food and energy processing facility. The firm sells this cooking fuel, along with affordable cookstoves in Mozambique (WWF 2012)
7. Ismail (2012) provides several examples of multiple cropping systems, for instance one in Kyrgyzstan where poplar species were planted for timber and fuel wood with strips planted with lucerne and a grass, both for use as feed.
8. Ismail and Colangeli (2012) provide an example of bioenergy feedstock production (palm oil), in Malaysia. Under this project, the input for livestock rearing is kept low by implementing rotational cattle grazing on natural vegetation and undergrowth, supplemented by palm oil leaves in the case of forage shortage. At the same time, manure from livestock is used as fertiliser in the plantations.

Box 1: Mali Biocarburant Foundation

Mali Biocarburant SA (MBSA) is a private company with smallholders as shareholders. The smallholders produce biofuel to supplement their income while respecting the environment. MBSA has created Koulikoro Biocarburant SA and Faso Biocarburant that locally produces and sells biofuels.

MBSA aims to improve the value chain for biofuels by supporting small holders in all their farming activities in the following way:

- Intensify and diversify agricultural production systems (improved varieties, crop rotation, water harvesting techniques, fertility management etc.);
- Assist farmers to prepare documents and negotiate credit for agricultural inputs;
- Improve access to markets by supporting cooperatives to contract the sale of surplus cereals;
- Add value to pro poor carbon credits;
- Acquire knowledge and stimulate innovation by organizing farmers around farmer field schools for learning by doing experiments (horticulture and cereals);
- Linking farmers to research organisations, agricultural credit banks, seed and input suppliers, markets etc.

(Source: Verkuijl 2012)

Critical points

In general, achieving increased yields of food crops is hampered by numerous constraints, such as lack of inputs (seeds, fertiliser, agrochemicals), lack of investment potential of farmers to buy inputs, lack of economic feasible use of inputs, lack of credits, lack of stable markets, lack of infrastructure to access input-output markets, lack of farmer organisations to facilitate transactions, or lack of technical assistance. In addition, many small-scale farmers may have good reason for not aiming at potential or maximum yields. Instead, they aim at optimal yields given price ratios between inputs and yields. They also take into account the risks involved in using credit in agriculture in climates with erratic rainfall or numerous pest and diseases (e.g. Koning et al. 2008), and may invest less because of these risks.

The present yield gaps[5] observed in many parts of the world can be thus explained by variety of reasons. Closing yield gaps will only be achieved at a very slow rate (Lobell, Cassman, and Field 2009; Fischer, Byerlee, and Edmeades 2009). The constraints mentioned above cannot always be lifted by investment in biomass for bioenergy alone.

There might also be a perverse effect: if intensification increases profitability per hectare, more land might be cultivated. In the oil palm case for instance, farmers who have a higher productivity level can hire labour from additional profits and are able to increase cultivated land.

Finally, it seems that targeted investments to increase yields outside the bioenergy production area are often not made (Wild Asia 2012).

Recommendations

Project level

The examples show that there are various ways to increase efficiency in land use of bioenergy crops, which leads to less land needed for bioenergy crops and therefore possibly more land availability for food crops. There are, however also various ways in which the production of bioenergy crops may lead to increased efficiency in food crop production. The examples also show, however, that this effect is not "automatic" but that to achieve this, intentional activities to focus on increasing food crop production need to be developed, such as training of farmers in crop production or supplying inputs.

3.2 Crop production on abandoned or degraded lands

Ways to combine bioenergy production and food security

Expanding production on abandoned or degraded land may control and limit the impacts of land use change. The USA estimated that between 16 and 21 million ha of marginal non-cropped land would be suitable and available for the production of bioenergy crops, especially for perennial cellulosic crops (Swinton et al. 2011). Brazil also claims to have more than 30 million hectares of degraded land available for oil palm production (César and Batalha 2013) and has claimed for a long time that sugarcane was only replacing degraded land (Novo et al. 2010).

Marginal or degraded lands are typically characterised by lack of water, low soil fertility or high temperatures. Bioenergy crops that can tolerate these environmental conditions, where food crops might fail, may offer the opportunity to put to productive use land that presently yields few economic benefits. Crops such as cassava, castor, sweet sorghum, jatropha and

[5] The yield gap measures the "gap" between what yield is potentially possible (given certain conditions) and what yield is actually obtained

pongamia are potential candidates, as are tree crops that tolerate dry conditions, such as eucalyptus (FAO 2008).

Examples

1. Energy crops less susceptible to soil degradation compared to food crops could consist of perennial energy crops (e.g. poplar, willow, eucalyptus). Nijsen et al. (2012) estimated that the yield of perennial energy crops is 5.3–16.3% less sensitive for degradation compared to annual food crops, which equals 0.3–1.1%-points lower yield reduction for light degradation, 1.6–3.0%, 4.5–8.2% and 11.0–16.3%-point for moderate, strong and extreme degradation, respectively.
2. Several authors have argued that cultivation of perennial energy crops could increase the carbon sequestered in degraded soils, increase the quality of these soils and improve wildlife habitat and restore natural ecosystem functions (Volk et al. 2004; Zegada-Lizarazu et al. 2010).
3. Nijsen et al. (2012) estimate that the yield of annual crops can increase by 5% per year of energy cropping. These results suggest that LUC effects can be reduced by giving priority to the use of non-degraded, high productive soils to food production and degraded, low productive soils to bioenergy production, potentially at the expense of economic viability of bioenergy production.
4. In the case of oil palm in Indonesia, degraded peat lands often regarded as the most preferable option for area expansion. Several NGOs (e.g. Fairhurst and MacLaughlin 2009 on behalf of WWF) but also for instance Unilever advocate to expand oil palm cultivation in degraded peat lands to protect the standing peat forest and save greenhouse gas emissions.
5. In Brazil, the government has decided to work with industry in developing several million hectares of degraded land for biodiesel feedstock production (IPS 2010). An agro-ecological survey identified 31. 8 million hectares of abandoned and degraded agricultural areas suitable for oil palm production (César and Batalha 2013). The government authorised plantations on 4.3 million hectares. So far, the Brazilian government has stated that bioenergy production does not compete with food because it takes place in degraded pasture land (Novo et al. 2010; De Aruda, Slingerland, and Giller 2013). However, data on soil degradation are partially uncertain and scarce (Miranda 2001).
6. In August 2004, the state of Uttarakhand in India launched a biodiesel programme with the aims of creating employment and rehabilitating degraded forest land. It planned to cultivate Jatropha on 200,000 ha of village forest land until 2012. Altenburg et al. (2009) report that about 10,000 ha have been planted through the “joint forest management” approach. India strongly promotes joint forest management programmes in order to combine the benefits of afforestation and income generation for lower casts and tribal people.
7. There are several case-studies that use the Low Indirect Impact Biofuels (LIIB) methodology, which can be used to produce biofuels without displacing other provisioning services and hence avoiding indirect environmental and social impacts. Part of this involves identifying areas and/or production models that can be used for environmentally and socially responsible energy crop cultivation, without ILUC effects (causing displacement effects that could affect the market prices for commodities

and land, thus potentially affecting global land use change and food security) (NL Agency 2012a)[6].

Critical points

The current production of first-generation bioenergy crops is based on conventional food crops and only a few successful examples can be found of bioenergy productions systems based on degraded areas.

Competition over degraded areas

It is important to note that globally, the majority of degraded lands overlays with pastoral land (43%); followed by cropland (25%), other land use (21%) and forest area (10%) (Nijsen et al. 2012). Especially light and moderately degraded areas are currently used for agricultural purposes. As a result of the increased demand for food and feed, there may be also competition for land in degraded areas.

High returns on investments needed

Investors and farmers aim for attractive returns on investments. Crops need water, nutrients, good soil texture and absence of limiting factors such as salinity, toxicities and severe climatic conditions (frost) for optimal growth, which are lacking in degraded and marginal soils. Furthermore, many degraded and marginal lands are in remote areas, leading to costly transport of inputs and yields. Finally, new crops need investments in technology and incur risks, requiring high yields per hectare in order to deliver a competitive return on investment.

Expansion of bioenergy crops onto non-agricultural land would entail similar risks and start-up costs. The US policy to promote cellulosic crops on idle or marginal lands would therefore require extremely high prices of bioenergy crop to persuade farmers (Swinton et al. 2011). The incentives that would be needed to convince farmers or investors to bring these lands under cultivation are uncertain. Swinton et al. (2011) investigated the willingness of farmers to start cultivating these idle, marginal, lands in USA with bioenergy crops. Their findings show that despite an increase in crop prices of 64% between 2006 and 2009, only 2% additional, formerly non-cropped, land was cultivated. Unlike currently cultivated crops, biomass crops lack familiar markets and proven production technologies. The sunk costs of investments in unfamiliar perennial crops combined with uncertainty about their future profitability have been shown to prevent farmers from converting land from an annual food crop into a perennial bioenergy crop.

The study by Schut et al, (2010) shows, for instance, that bioenergy investors in Mozambique selected fertile soils in densely populated areas with infrastructure in place. This location provided high yields, sufficient labour to work on the plantations and infrastructure to transport the feedstock for export at low costs The objective of the Mozambican government to attract investments in bioenergy towards remote rural areas hits on market forces. A comparative study by German et al. (2011) also finds that none of the investigated bioenergy investments in Brazil, Ghana, Malaysia, Indonesia, Mexico, were directed towards degraded lands.

A case study by de Aruda et al. (2013) provides evidence that sugarcane production in Brazil has taken over prime cropland, replacing soybean and maize in Goias state. In addition, Novo et al. (2010; 2012) show that

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[6] See for more information the LIIB website http://liib-draft.catalyzecommunications.com/

historically, sugarcane production is favoured over milk and meat production and therefore has replaced these food producing activities.

Recommendations

Project level

Bioenergy could, in theory, be cultivated on degraded lands so that more fertile lands are available for food production. There are a few examples that show this can, indeed be done. There are, however, several caveats that need to be taken into account. Before deciding to use degraded lands two steps must be made:

1. An assessment needs to be made what the degraded areas are and how they are used, to avoid competition with other uses of degraded land. The LIIB Methodology may be a useful tool for this. The Responsible Cultivation of Areas (RCA) may be another useful tool for identifying areas (Ecofys 2010).
2. When using degraded lands, a prognosis should be made of the expected yields that can be used in a cost-benefit analysis to assess whether using degraded lands will be profitable.

3.3 Producing bioenergy from wastes or residues

Ways to combine bioenergy production and food security

When agricultural waste streams or by-products are used for bioenergy production this can save land otherwise needed to produce bioenergy crops (Petersen 2008). Waste in the food chain is high, on an average ca. 25% of food ends up in the garbage bin, and even 30-40% if post-harvest losses are included (Godfray et al. 2010; Hall et al. 2009; Smil 2000). In developing countries, post-harvest losses are particularly important whereas in developed countries, home and municipal waste is the major cause of food waste. Reducing losses in the chain is an effective strategy to increase food availability (Parfitt, Barthel, and Macnaughton 2010). In addition, by transforming waste into bioenergy, value can be added to a food crop or other biomass, adding to the earning potential in the rural economy.

Examples

1. Especially ethanol production may result in several residues including crop residues, stillage, evaporator condensate, condensed solubles, spent cake and/or distillers grains, depending on the feedstock and process design. These have a high potential for methane production and can also be converted to biogas[7] (University of Florida 2013).
2. Sagar and Kartha (2007) discuss the use of biogas in developing countries. Biogas digesters have been used in developing countries for over a century as a way of providing energy, especially in rural areas. For instance, China promoted biogas plants already in the 1930s to reduce the consumption of kerosene. But also in recent years, programs in a number of developing countries have disseminated biogas digesters. In many developing countries, biogas produced from domestic scale digesters is used for cooking and to a smaller extent for water heating and lighting. In 2011, China and India had the largest numbers of domestic digesters in the

[7] Biogas is a combustible gas composed primarily of methane and carbon dioxide, derived from the anaerobic digestion of biomass, generally manure, agricultural waste, or other biomass feedstock. It delivers energy with no net emission of carbon dioxide because the feedstock generally will be renewably harvested, although there may be leakage of methane.

world, with 43 million and 4.4 million domestic biogas digesters, respectively. Nepal and Vietnam also have digesters in significant numbers, while several other countries in Asia and Africa have initiated digester programmes (Ren21 2012).

3. An important advantage of the use of biogas digesters in farming households is that the digestate still contains the nutrients from the feedstock which can be used to fertilise the land. An example of cassava in Mozambique shows how a biogas digester can increase crop production per hectare due to the use of digestate as fertiliser on the land, apart from many other advantages such as labour saving for women and decrease of respiratory diseases due to healthier cooking methods (Zvinavashe et al. 2011).
4. For Colombia, it has been shown that including anaerobic digestion in bioenergy production of sugarcane, oil palm, cassava or panela cane saves water and prevent the loss of nutrients. This will lead to more energy production from the same amount of biomass and due to this efficiency increase, the same amount of energy production will require less land (Pabon Pereira 2009).
5. Also in Europe, biogas digesters are popular, especially for livestock farms in the Netherlands, Germany and Belgium that need a way to dispose of their excess manure. With increasing fossil fuel prices, it becomes more attractive to produce one’s own energy, and because disposing manure is costly, these costs can be reduced by transforming it into energy. The digestate can be sold as fertiliser (Van Bruggen 2011), whereas selling slurry as fertiliser is rather costly due to its low quality and high water content. One constraint is that the digester needs additional feedstock, for instance in the form of maize to create a sufficiently high energy output of the digestion process to make the production of energy economically feasible. At current costs, a subsidy scheme is required to increase the spread of this technology.
6. Oil palm mills have started to use residues for the production of steam and electricity for their factories (UNEP 2013). This also applies to the sugarcane example mentioned above. Ethanol or palm oil as bioenergy for the European market requires that it is produced with low GHG emissions (confirmed during field visits to sugarcane factories in Brazil and oil palm mills in Indonesia by Slingerland in 2012). In the future, the value of residues such as bagasse or solid oil palm waste may increase and instead of using it as a cheap energy source, it may be used as a substrate for more valuable products (Pandey et al. 2000).
7. Biomass from various sources such as urban wood waste collection, forest thinning, logging slash, and agricultural residue may be used to produce torrefied briquettes, which is a biomass fuel-like wood (see HM3 Energy 2013 for an explanation). In Mozambique a DBM project[8] has started to produce and torrefied biomass from biomass residues (Gnoth 2012).
8. Rice husks, which are otherwise left in the fields after rice is harvested, may be used to generate electricity. There are examples of this in the Philippines (Interco 2005). In China, rice husks are used for power generation through gasification (Leda Greenpower 2010).
9. Agro-production parks are an example of how in the design phase, the use of residues is optimised. In agro-production parks, companies cluster together so that they can use each other’s residues or waste in an efficient

[8] Global Sustainable Biomass Fund (‘Duurzame Biomassa Mondiaal’, or DBM fund)

way with low transport requirements. For instance, greenhouses can benefit from by-product of CO_2 production from factories and residential houses can profit from the co-product of excess heat from greenhouses or factories. There are many examples of potential benefits and a number of Dutch companies already have several agreements for exchanges of residues (P. J. A. M. Smeets 2010).

Critical points

Although biogas has become quite established in developed countries, Latin America and in Asia (such as in India and China), our literature review shows that in Sub-Saharan Africa it is still in its infancy, limited to pilot projects in various projects. To become mainstream, more investments are needed.

In addition, in many developing countries waste and residues are often already re-used for fertilising the soils and/or feeding livestock. Using such wastes and residues for bioenergy production may conflict with those uses. In particular, residues and wastes are used in peri-urban agriculture (Cofie et al. 2010). Other examples are the use of empty fruit bunches, crushed kernels and fibres for composting or mulching in oilpalm plantations (Prasertsan and Prasertsan 1996; UNEP 2013). Recently, oilpalm plantations have started using these for the production of steam and electricity in oil palm mills (see above). The reasons to use the residues differently are profitability (substituting high oil prices) and access to European markets (certification).

It is not always possible to re-use residues. Residues of crops used for biodiesel such as castor and jatropha are toxic and cannot be used as livestock feed without further expensive processing (Lestari 2012).

Recommendations

Project level

Using agricultural residues and waste (such as manure) for bioenergy production is a feasible option because it does not compete with resources dedicated to food production. Therefore:

1. more needs to be invested in developing technologies that can process waste and residues in a cost-efficient manner, specifically targeted at low-income countries where technologies should be easy to maintain and cheap to use
2. using residues and waste should not conflict with alternative uses such as for fertilising soils and/or feeding animals. A careful assessment should therefore be made of the existing uses of residues and waste.

Policy level

The investment needs for technologies that can process waste and residues may require support at a policy level, particularly in in developing countries (Sub-Saharan Africa). This support may be in the form of subsidies, tax reductions or soft loans for investing in such technologies, but may also be directed at research and development into cost-efficient technologies that are affordable for low-income countries.

3.4 Production of co-products

Co-products are products that are produced as an end product besides bioenergy. Co-products such as press cakes of biofuel production are often used as livestock feed. This prevents, to a certain extent, the use of land and water resources for feed production, and makes resources available for food production. A distinction with waste or residues may also be made in terms of value, where co-products typically have more value than waste or residues.

Ways to combine bioenergy production and food security

When co-products such as livestock feed, are produced, these may substitute other livestock feed production, which would have needed resources such as land and water. Co-products such as press cakes of biofuel production are often used as livestock feed. Resources are no longer required to produce livestock feed, and may be used for food production (Dehue, Cornelissen, and Peters 2011). It has been estimated that these reduce the LUC effects of biofuels by 55-100% (Croezen and Brouwer 2008; Ros, van den Born, and Noteboom 2010)

Examples

1. Satyanarayana (2010) provides several examples that are being implemented in Brazil, for instance the use of cashew press cake and bagasse for livestock feed.
2. During the process of manufacture of sugar, a sugar mill produces several wastes us as molasses, bagasse, filter press cake, waste water, bagasse ash. Of the above, molasses and bagasse have become valuable co-products of the sugar industry. Sugarcane companies used to sell their residues as livestock feed (molasses) and to the paper factories (bagasse) (for instance in Thailand; Prasertsan and Prasertsan 1996). Nowadays, companies everywhere prefer to use the molasses to produce ethanol and the bagasse as energy source in the factory, thereby reducing their GHG emissions (UNEP 2013).
3. DDGS (Dried Distillers Grains with Solubles) is a co-product of the ethanol production process, and a high nutrient feed valued by the livestock industry. When ethanol plants make ethanol, they use only starch from corn and grain sorghum. The remaining nutrients - protein, fiber and oil - are the co-products used to create livestock feed (see for an example Kansas Ethanol 2013).

Critical points

Distinguishing between main products, residues, co- or by-products is not straightforward. In Brazil, soybean meal for livestock feed has been the main driver for soybean expansion for a long time. Recently, some of the use of soybean oil shifted from human consumption into biodiesel production (Watanabe, Bijman, and Slingerland 2012). Similarly, sugarcane can be used to produce sugar or ethanol. Depending on the world market price, ethanol is the main or the co-product. With high sugar prices, the ethanol prices rise as well and may no longer be able to compete with fossil fuel prices. This affects consumption of bioethanol in the domestic market, where consumers can choose between ethanol and fossil fuel due to their flex-fuel cars. High sugar prices lead to low demand and hence low production of ethanol. In places where blending with ethanol is obligatory, all fuel prices will change with ethanol prices and the market for ethanol will be maintained.

In areas where there is rapid expansion of ethanol production, there could be a saturation of the livestock feed market with associated by-products such as DDGS; a third of the grain that goes into ethanol production comes out as DDGS. This may affect the sale value of this by-product (University of Florida 2013).

Recommendations

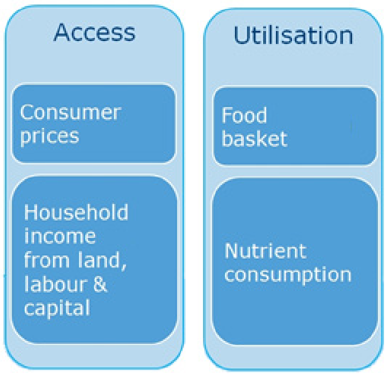
Project level

Aiming for co-products in bioenergy products is a feasible option to combine biomass production with food security, because co-products may be used as livestock feed. Investments should be made in the production or process facilities for co-production. Producing co-products may also help the business case because they usually have high added value.

However, investments in co-products should be weighed against the profitability of selling co-products. Several questions should be asked before investing to assess profitability:

1. What is the demand for that particular co-product?
2. What price will it fetch?
3. What are the alternatives and their prices?
4. Will a large supply of co-products influence prices and therefore profitability?

4 Policy objective no. 2: Improved access to food of sufficient quality



Improving access to food of sufficient quality encompasses two dimensions of food security: access and utilisation. The access dimension relates to prices and income, and other entitlements such as land and other natural resources relevant to food security. Prices and income play a role because food may be available, but too expensive for poor households to purchase in sufficient quantities. Access to land, and related land rights are important entitlements that determine whether households have access to food.

The utilisation dimension refers to what kind of food people consume; quality in terms of nutrition is an important aspect. This also relates to prices and income, but other factors, such as education, knowledge about nutrition etc., are important as well. In this section, we focus on prices and income, as other factors such as education do not have a clear link to biomass for bioenergy production.

4.1 Land rights

Expanding bioenergy production is likely to lead to greater competition for access to land and water. This competition poses a threat to various people dependent on land and water resources for their livelihoods, such as farmers, pastoralists, fishermen and forest dwellers. In many developing countries these people live in area without formal land tenure rights. Therefore, land tenure policies are important (Elbehri, Segerstedt, and Liu 2013).

Ways to combine bioenergy production and food security

Proper land tenure policies are crucial to safeguard the livelihoods of people who depend on land and water resources for their livelihoods, but do not have formal or well protected land tenure rights. This applies especially to women. Assessing land tenure issues in terms of their impact on food security, it seems as if private land ownership has the best guarantee for fair pricing of land and income to local populations. With private land ownership, farmers have full control over their own land, although some forms of communal land ownership also allow for fair decision-making. An additional benefit of private land ownership is that often it is accompanied by a well-functioning land market, which may provide information on the value and price of land

Examples

1. In Brazil, land ownership is private, enabling farmers to sell or lease their land to sugarcane factories. Those who sell might decide to start farming

again in another place where land is still cheap[9]. Others may prefer to lease to obtain a stable income while farming on a smaller part of their land area (Novo, 2012). As soon as it has become known that a sugarcane company will be established in an area, land prices tend to increase. Land leases depend on a fixed amount plus a share of the annual yield, sugar content and sugar price in the world market. This enables land leasers to share in the profits from their lands.

2. German et al. (2011) summarised 7 articles on bioenergy investments and their impacts, contrasting impacts in cases with land ownership and cases with communal land user rights. They report on the positive outcomes of voluntary land transactions between landowners and land buyers in both Mexico and Brazil.
3. A tool that can be used to ensure land rights are dealt with correctly are the FAO's Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (or FAO Voluntary Guidelines) (CFS 2012).
4. The Principles for Responsible Agricultural Investment that Respects Rights, Livelihoods and Resources (RAI) may be another useful tool to ensure land rights are dealt with properly. The RAI was established by FAO, IFAD, UNCTAD and the World Bank Group. It includes effects on food availability, access, utilisation or stability of land investments on local and directly affected populations (FAO/ IFAD/UNCTAD/World Bank 2010).

Critical points

Companies, local elites and government authorities who have a shared interest in the investment in a particular locality are often successful in persuading local communities to consent in agreements that are not in the best interest of those communities. In some cases, they are able to evict people from their land (Oxfam-Novib 2011). Benefits to local communities are usually framed in terms of job opportunities, economic development and community services such as hospitals, schools, roads and water points as compensation. Farmers are put under pressure to take a decision quickly by the companies, threatening to go somewhere else instead. Farmers may not always realise what the offer is or what it will cost them. In addition, when it turns out that some within the community will benefit more than others, e.g. in terms of employment, problems will be created after the agreement is signed.

Especially in Sub-Saharan Africa, compensation for individual farmers who have lost their land is usually low or completely absent. Often companies obtain long-term land user rights (50-99 years), while farmers only receive a one-off payment as compensation (Smaller and Mann 2009). In many Sub-Saharan African countries, land tenure issues are complex. All land officially belongs to the government and farmers or communities only have user rights. In some countries, user rights are well described, can be legalised by title deeds and are respected. In other countries, user rights can become non-existent when government decides another destination for the land.

Originally, land tenure issues were managed through customary laws by community authorities (such as village chiefs) and subject to community consent. Many parts of Sub-Saharan Africa are communal lands that provide community members with fuel wood, grazing area or are part of a shifting cultivation system with long fallow periods between cultivation periods. In these circumstances, governments tend to allow investors to negotiate directly

[9] This may lead to ILUC e.g. close to the Amazonia

with the communities about land use and compensation. Unfortunately, not all communities have strong bargaining power.

Also in Asia, land tenure issues may be difficult, which the case of Indonesian oil palm cultivation illustrates. To establish plantations in former forest lands, only permission by the government is needed as it officially owns all forest land. Many forests provide livelihoods to people living in the forest or in its vicinity and compensation for the loss of these services is usually lacking. There are other arrangements by which farmers provide their own land or community land (e. g. 10 ha), getting back a smaller piece of land (e. g. 2 ha) after 4 years, while the company keeps the remaining land as its nucleus plantation and as compensation for planting the returned land. Farmers have low bargaining power leading to many land conflicts about the initial agreements on compensation between companies and farmers.

In their summary of 7 articles on bioenergy investments and their impacts, German et al. (2011) describe a variety of cases in Ghana, Zambia, Indonesia and Malaysia that show several instances of unsatisfactory compensations, lack of negotiation power of the land users and lack of community consultation by village heads or tribal chiefs, in cases of communal land user rights. By contrast, German et al. reported on positive outcomes of voluntary land transactions between landowners and land buyers Mexico and Brazil.

A particularly difficult issue is what happens to land after a bioenergy plantations goes bankrupt after leasing land for a long term (see e.g. Obidzinski et al. 2012; van Eijck, Smeets, and Faaij 2012). In Mozambique, the government has started to search for new investors for the tracts of lands of bankrupt plantations, instead of redistributing the land to the people that had user rights before. It is unclear whether farmers can negotiate with the new company or whether they lost all their rights when dealing with the former company. In other countries, such as Ghana and Ethiopia where several companies have gone bankrupt, it is unclear what will happen to the land. In Indonesia, many jatropha plantations were established on community lands or farmers' fields. When a plantation goes bankrupt, trees are often uprooted to be converted back to farmers' fields, while land that is not urgently needed is left to become overgrown.

Recommendations

Project level

When land is acquired, there should be fair and equal representation of the communities affected in the terms of compensation. Land tenure issues are extremely important when acquiring land through sale or lease, as land is directly linked to local people's livelihoods. Land tenure issues are often complex, and what constitutes a fair compensation is not always clear.

Tools that can be used to ensure land rights are dealt with correctly are the FAO's Voluntary Guidelines or the RAI. These encourage periodically reviewing agreements, making sure that they are understood by all and that indigenous people and other vulnerable groups should be provided with information and support so they can participate effectively. In this sense, the process of reviewing enables learning, especially on the impact on food security.

Policy level

National and local governments should clarify legal land acquisition procedures (through sale or lease), increase transparency of such deals and enforce the laws. This may be achieved by encouraging the use of the FAO's Voluntary Guidelines or the RAI.

4.2 Consumer food prices

One of the effects of bioenergy production that has received much attention has been its alleged contribution to high food prices. Internationally, agricultural prices peaked in 2011, exceeding levels reached in the 2007-08 food price crisis. Food prices increased 92% in nominal terms and 57% in real terms from December 2005 to January 2012[10]. Policies that set mandatory targets for bioenergy (such as in the EU, see 2.3) have been criticised for pushing up food prices.

It should be noted that high international prices do not always automatically translate to high local prices; the price transmission mechanisms are complex, in which local circumstances and government policies play a role (D. Headey and Fan 2010). The effects of local bioenergy production on local food prices has not been investigated thoroughly. In addition, recent research has pointed out that the high food prices of 2008 apparently did not lead to a large increase in world hunger (D. D. Headey 2013)

Internationally, bioenergy production is considered to be an additional source of demand for agricultural commodities, and as such, it may in part cause higher price levels. Meijerink et al. (2011) and Smeets et al. (2012) provide an extensive discussion.

The production of bioenergy also reinforces the link between oil and agricultural markets. Oil prices affect agriculture commodity prices by influencing the cost of production and by the additional demand for crops for bioenergy production (Solano Hermosilla, Silvis, and Woltjer 2010). A large energy market creates both a floor price for agriculture as well as ceiling price (Schmidhuber 2006). If demand from the energy sector is large and/or elastic and agricultural feedstocks are competitive in the energy market, a floor price effect for agricultural products results. The output price effect creates incentives to produce more rather than less. Energy prices also set an upper boundary for agricultural prices. In the long run, agricultural prices will not rise faster than energy prices, because if they do, agricultural feedstocks price themselves out of the energy market.

Ways to combine bioenergy production and food security

The main concern about the influence of increased use of biomass for energy is the effect of high food prices on vulnerable households who are net consumers. There are two ways to counter this concern. First, by reducing the effect of bioenergy on food prices. Second, by reducing the effect of high food prices on vulnerable groups.

Examples

1. Making mandates more flexible

Although demand in the EU has not been very elastic due to the fixed biofuel blend mandate, the carry-over principle makes it more elastic. Carry-over means that fuel blenders and other parties required to meet the blend mandate are allowed to shift portions of their mandate compliance cross time by trading and saving 'biotickets' (Netherlands) and 'Renewable Transport Fuel Certificates' (UK), for example. Use of biotickets and similar certificates thus introduces flexibility in the system with respect to time. There are also other flexibility-increasing regulations that can be introduced. Examples are elimination of trade restrictions on biofuels and their feedstocks, reduction or elimination of mandates when a chosen market variable (e. g. agricultural

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[10] See FAO Food Price Index. Available on http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/. Accessed January 2012

commodity prices) exceeds a given threshold, or government intervention through purchase of call options on agricultural commodities from biofuels producers (Smeets et al. 2012).

2. Shield vulnerable groups from price increases or ensure a stable food supply

Incorporating more flexibility in the system is one way to reduce the influence of biofuels on food prices. However, another approach is to directly shield vulnerable groups from price increases or ensure a stable food supply. A short-term solution is to develop emergency food reserves systems. A more long-term solution is to scale up 'social safety nets' such as mother and child nutrition programmes and school meals programmes (WFP 2011). Such safety nets are not related to biomass production per se.

Critical points

In the EU, biofuel production has so far only been mandate driven[11] and therefore demand in the EU for biofuels has not been very elastic. The diverse mix of feedstocks used for biofuels in the EU increases links between different agricultural markets. Increased integration of agricultural commodity markets results in spillover of volatility between markets.

Recommendations

Policy level

There are two ways to counter the concern over the influence of bioenergy production on consumer prices. First, by reducing the effect of bioenergy on food prices, which is best addressed by a dismantling of government policy aimed at target shares of bioenergy in energy consumption beyond levels compatible with market forces. Partial measures in this direction include making mandatory targets for bioenergy more flexible and reducing trade restrictions on bioenergy in the global market .

Second, by reducing the effect of high food prices on vulnerable groups, e.g. through social safety-nets. Emergency food reserves systems should be developed to shield food insecure population that suffer from the effects of increased food prices, resulting from increased biofuel production.

4.3 Household income

We distinguish two types of income generation through bioenergy production. First (A), bioenergy production may provide additional employment, which allows them to generate income with which they can purchase food. Usually this involves relatively large-scale bioenergy production and processing. Second (B), bioenergy production may also provide income to small-scale producers (small-scale farmers) who grow bioenergy crops as a cash crop. This may involve small-scale, local bioenergy production, but also relatively large-scale production with outgrowers. See 5.1 for more information on how small-scale producers may be included.

[11] On 17 October 2012, the Commission published a proposal to limit the use of food-based biofuels to meet the 10% renewable energy target of the Renewable Energy Directive to 5%. This will reduce the impact of the mandate on prices. http://ec.europa.eu/energy/renewables/targets_en.htm Accessed 25 February 2013

4.3.1 A. Income from employment in bioenergy sector

Ways to combine bioenergy production and food security

Investments in bioenergy crops could create additional employment and thus lead to income sources. This way, people employed in the production of bioenergy could improve their purchasing power and hence their access to food (see e.g. Vel 2011).

Examples

1. Bioenergy production is relatively labour intensive and therefore can generate more employment per unit of energy than conventional fuels and more employment per unit investment than in the industrial, petrochemical or hydropower sector (UN Energy 2007). Lynd and Woods (2011) estimate that in Brazil biomass production has lifted 10% of the Brazilian population out of poverty during the last decade.
2. Dufy (2008), citing the Worldwatch Institute and FAO, estimates that in Brazil, direct employment associated with sugarcane bioethanol production ranges from 500,000 and 1 million with indirect employment in the order of 6 million.
3. Arndt et al. (2011) calculate that ethanol production from a sugarcane plantation in Mozambique would need 17 ha and 7 workers for the production of 100,000 litre of ethanol, whereas an outgrower scheme would use 34 ha and 76 workers to produce the same volume. Hence, from an employment perspective, outgrower schemes are more appealing for Mozambique. They draw a similar conclusion for cassava outgrower schemes in Tanzania[12].

Critical points

The number of promised jobs may be lower in reality

In general, Schut et al. (2010) warn that in more recent bioenergy plantations (for sugarcane, oil palm or jatropha), the amount of employment promised is often much higher than the amount actually employed (see also Da Vià 2011 for example in Sierra Leone).

Low skilled labour with poor labour conditions

Several authors have pointed at the fact that often, the jobs created are for low skilled labour with poor labour conditions.

An example are the jobs in the sugar plantations in Brazil. This labour was mainly performed by migrants from other states, who were offered temporary jobs without any labour rights. People living in the vicinity of sugarcane plantations were not willing to do these unhealthy jobs for low wages (Rocha, Marziale, and Hong 2010). Many NGOs have called these practices slavery (see for example Ribas Chaddad 2010). After international exposure, the government of Brazil promised to increase controls (Trindade and Costa 2009). Much of the manual labour has been replaced by the process of increased mechanisation (see below). Through the RenovAção initiative, which is a DBM[13] project, Solidaridad is training sugarcane cutters to do different work (Solidaridad 2012).

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[12] It must be noted that strictly speaking, these jobs cannot be counted as additional because there will be displacement of labour from non-biofuel sectors, both for plantation workers and for smallholders. This effect is larger in Tanzania where more labour is currently engaged in cash crop production for export.

[13] Global Sustainable Biomass Fund ('Duurzame Biomassa Mondiaal', or DBM fund)

Oil palm plantation are reported to have serious problems finding workers and even smallholders are found to hire workers. Also here, NGOs have pointed out that the labour conditions of workers are often unhealthy and unsafe and that workers receive low wages, which all jeopardises their food security. Workers tend to be poor migrants because the people in the vicinity of the plantations tend to find the jobs too heavy and wages too low (Oxfam-Novib 2008; Wulandari 2008; Situmorang 2011).

Burden on women

The gender dimension of labour is an important point. A gender division seems to exist in employing women in the nurseries because this work requires much attention. By contrast, men are more generally employed in physically hard labour such land clearing, planting and weeding. Yet women are also employed for the latter tasks. A case study in Bilene, Mozambique, showed that women were satisfied with the employment opportunities offered by the jatropha plantation as it was their only way to get an income. Nonetheless, the study also showed that their paid job interfered with labour input in their food production. They decreased the cultivated land area and complained about labour constraints in peak periods. A negotiation with the plantation manager allowed for adjustments in labour hours solving part of the mentioned competition (Mota 2009).

Many low-skilled jobs versus a few high skilled migrant jobs

Technological progress means that bioenergy production is becoming less labour intensive. Sugarcane, for instance, will only be harvested mechanically in near future, starting in Brazil. In the State of São Paulo, which produces approximately 60% of Brazil's sugarcane, almost 70% of the sugarcane is now being harvested mechanically (Solidaridad 2012). There are various reasons for this change. One of the reasons was to avoid the undesirable release in GHG emissions caused by burning of leaves during manual harvesting. This negatively influences the GHG balance required to sell ethanol as a climate change mitigating bio-energy source. A second reason was the increasing difficulties in finding labourers. The activities involved are harsh and rather unhealthy. Mechanical harvesting has meant that more skilled labourers are required as it includes operating highly sophisticated machinery. This has left many unskilled workers without employment. The conversion from manual to mechanical harvesting in Brazil is accompanied by job training and job relocation programmes (for instance by Solidaridad, see above).

Lynd and Woods (2011) argue therefore that the impact of bioenergy on income generation depends on the technology employed and how the bioenergy supply chain is integrated into agricultural, social and economic systems. To date, modern bioenergy supply chains are practically absent in Sub-Saharan Africa; there are no bioenergy clusters established like in Brazil (see also 5.1).

Local versus migrant employment

In addition, in less developed countries often unskilled labour is locally recruited while skilled labour is recruited abroad. For instance, in Mozambique, many South Africans were recruited for the skilled jobs, such as management and tractor driving, whereas Mozambican villagers did the manual jobs, such as clearing of the land and the planting of the crops (personal observations in sugarcane firm in Dombe, Manica province).

German et al, (2011) summarises seven papers on impacts of bioenergy projects. This study confirms that skilled labour is usually hired from outside, but it also finds that unskilled labour is provided by migrants who are willing to work under unhealthy labour conditions against low salaries. In Ghana only 4% of households that lost land to bioenergy producers, secured employment. In

Indonesia, the majority of the plantation workers came from other provinces, whereas in Malaysia (Sabah),the workers came from other countries such as Indonesia.

Recommendations

Project level

The literature shows that biomass production for bioenergy can indeed lead to higher employment. To ensure that higher employment leads to food security the following could be pursued:

1. Hire local workers to ensure local food security effects. Invest in training if necessary
2. Ensure the workers receive at least the minimum wage and provide for good working conditions, especially for women.

Policy level

Because there is a shift to more mechanised production, many low-skilled workers run the risk of losing their job. Unskilled workers may be retrained and offered support in finding different work by governments in combination with the private sector and NGOS. A good example is the Solidaridad example described above.

4.3.2 B. Income from energy crops as cash crops

Ways to combine bioenergy production and food security

Bioenergy crops are, by definition, "cash crops" and as such, they can provide farmers with cash income with which they can purchase food. The production of energy crops is in this sense no different than other non-edible cash crops such as coffee, cotton or tea.

Cash crops are generally more interesting for farmers and companies when they have more than one marketing outlet. Sugarcane is not only popular because of its large yield per ha but also because of its flexibility to react to world market prices of sugar and ethanol allowing the company to shift its production accordingly. Similarly oil palm is a high yielding crop with multiple outlets including cooking oil, soap and biofuels, allowing a shift in outlets when prices change. The same reasoning applies to farmers.

Cash crops that also have valuable co-products are even more profitable (see 3.4)

Examples

1. Small-scale bioenergy initiatives may generate income and other benefits in a number of ways, as illustrated by a study by Practical Action Consulting (PAC 2009), commissioned by FAO and DFID. This study analysed 15 case studies of small-scale bioenergy initiatives in Asia, Latin America and Africa. They find that the small-scale bioenergy initiatives increased income. In addition, small-scale bioenergy initiatives can bring additional livelihoods opportunities to rural areas. Through job and productive activity creation, financial capital is increased. Through the development of producer groups, co-operatives and rural market systems social capital is enhanced. These gains are supported by, and in turn support, increases in human capital in rural areas through skills creation and improved energy service availability.
2. This, in turn, has been shown more generally with respect to retaining more skilled and able individuals along with professionals such as teachers and health care practitioners. Creating viable choices for these individuals to stay in rural areas through a combination of improved revenue

opportunities and living conditions within villages is an important contributor to rural development. The cases examined in the PAC study offer optimism that appropriately implemented Small-Scale Bioenergy Initiatives can contribute to this outcome, although more empirical evidence is needed.

3. In addition, for smallholders, producing energy crops can have additional value when production is aimed at local energy production, as is the case for many NGO-led initiatives on jatropha (Dufey 2008; HIVOS 2012; PAC 2009). In Mozambique and Brazil, small-scale family farmers were only willing to introduce energy crops when these yielded more than the currently produced cash crops, cotton and sesame in Mozambique (Baruzzi 2009) and vegetables and fruits in Montes Claros in Brazil (Dal Belo Leite et al. 2013).
4. Farmers in Chapada Gaucia Brazil preferred soybean because of its oil, biodiesel and feed market (Dal Belo Leite et al. 2013). Farmers in Montes Claros Brazil preferred any oil crop that could also be used as livestock feed when the biodiesel market would become unattractive (Dal Belo Leite et al. 2013).

Critical points

High volume, low value bioenergy crops such as sugarcane or oil palm may be unsuitable for small-scale farmers

High volume, low value bioenergy crops such as sugarcane or oil palm are more suitable for large-scale commercial production than for smallholders (Dufey 2008; Elbehri, Segerstedt, and Liu 2013). Increasing economies of scale and land concentration have usually meant that benefits, of for instance sugarcane bioethanol production, for small land owners have so far been limited while large farmers and industrialists have benefited more from the expansion of the industry (Peskett et al. 2007).

High volume perennial crops, such as sugarcane or oil palm outgrower schemes, may be suitable for smallholders if the company provides inputs and secures a market and smallholders provide their land and labour. The high yields per ha make these corps suitable for smallholders that have relatively low land and labour endowments.

Unstable employment opportunities

For jatropha, a number of models have been tried, including plantation with outgrower schemes (NL Agency 2010; Nielsen and de Jongh 2009). However, many of the jatropha initiatives have not succeeded in becoming economically viable. This has led to a high turnover of managers. Some plantations have started to temporarily cultivate other crops while trying to produce jatropha in an economically efficient manner. Failures of plantations are a set-back for workers that either leased their land to a plantation or migrated from elsewhere: their income is no longer secured. These examples show that the production for bioenergy for rural labour opportunities might be risky.

Well-functioning food markets

An important condition for farmers to be able to spend income earned from bioenergy cash crops is that food markets should be functioning properly. It is well-known that when food markets are thin and isolated, because of high transport costs and low agricultural productivity, farmers may be confronted with food prices that are volatile and highly correlated with their own agricultural output. When basic staples constitute a large share of total consumption and have low income elasticity, farmers will protect themselves against such food price risk by producing more food themselves (Fafchamps 1992).

Recommendations

Project level

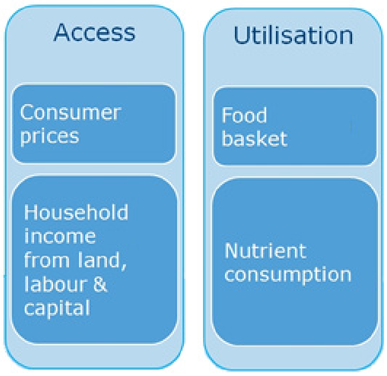
Bioenergy crops may provide farmers with cash income with which they can purchase food. Sourcing from local farmers may therefore be a feasible option to increase local food security. However, in order to provide farmers with sufficient income, several conditions should be met. Above all, the bioenergy crop should be economically attractive, which usually means providing farmers with a stable and secure market outlet and a competitive price

Policy level

When farmers only have the option to sell the bioenergy crops to only one supplier, there is the risk of lock-in. When this supplier, for whatever reason, disappears, the farmers lose their outlet and thus source of income. At a local policy level, multiple marketing outlets should be promoted. This means that for smallholders it will be more attractive to invest in additional production of food crops (such as cassava, soybean, maize), which can also be used for biofuels rather than investing in specific biofuel crops (such as jatropha or castor) that have only a biofuel outlet.

In most parts of the world, local food markets function properly. However, in those, usually remote parts of the world where they do not, investments should be made to lift the most important constraints, such as investing in roads.

5 Policy objective no. 3: Improved functioning of markets

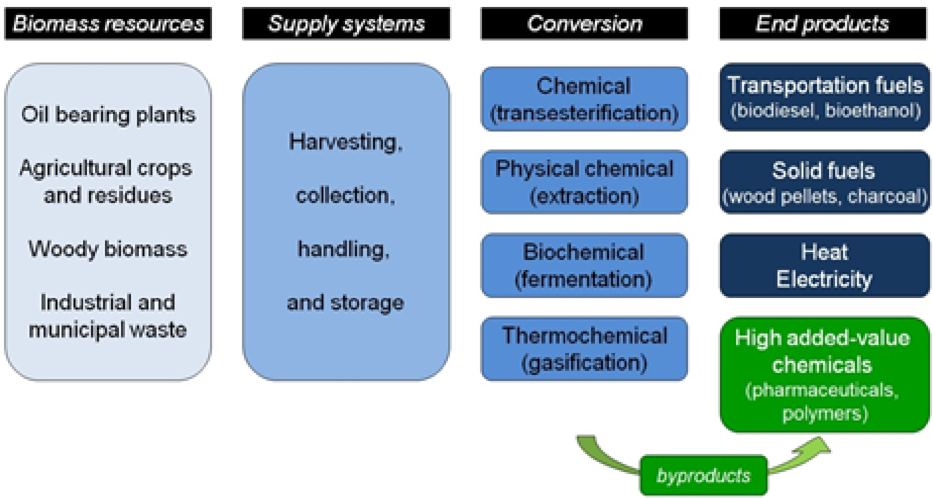


We identify three ways in which markets can contribute to a *stable* income and thus a stable access to food security: inclusion into value chains, increase opportunities of small to medium scale enterprises (SMEs) and local value adding. Well-functioning markets play an essential role in these. The functioning of markets is also closely related to prices and income, of course, which are discussed in chapter 4.

5.1 Inclusion of small-scale producers and low-skilled labourers in modern biomass value chains

The biomass value chain begins with growing, harvesting and collecting biomass, followed by its processing and ultimately, the end products are delivered to customers nationally or internationally (Figure 6).

Figure 6: Bioenergy value chain.



(Source: UNIDO 2007).

Small-scale producers and low-skilled labourers are typically often to be found in the first stages of the value chain. Incorporating small-scale producers into the value chain will provide them with more stable income generation opportunities. The potential for value to be created and retained for small-scale producers in rural areas is enhanced when bioenergy are developed for local and sub-regional markets with small-scale production, rather than for large-scale commercial production for national or global markets. The pattern of ownership is also an important determinant (Woods 2006).

There are various options to include smallholders into biomass production, even when this is large-scale (Dufey, Vermeulen, and Vorley 2007). Vermeulen and Goad (2006) identify three options for arrangements for smallholder palm oil production, which may also be used for other biomass production arrangements regarding perennials. See for instance Wolde-Georgis and Glantz (2010), who identify three bioenergy development strategies: (1) contract plantations of bioenergy crops by small farmers for sale to bioenergy refineries; (2) bioenergy crops grown side by side with food crops by small farmers and processed at the local village level; and (3) bioenergy production on large plantations directly linked and managed by bioenergy refineries. Except, the large-scale plantations create a vertically integrated production chain that bypasses smallholder farmers. They may, however, provide employment opportunities (discussed in 4.2).

Vermeulen and Cotula (2010) provide a more general framework to identify different business models. The different types are distinguished by who own land and who leads production. When land is owned by agribusiness and production is also led by agribusiness, there are no smallholders involved, but employment opportunities do arise (shaded area in Figure 7. These are discussed in 4.2.1. We discuss the different options below.

Figure 7: General framework to identify different business models to incorporate smallholders in biomass value chains

Land held by: **Production led by:**	**Smallholders or community**	**Agribusiness**
Smallholders	Contract farming – ranging from informal purchase agreements through to highly specified schemes	Tenant farming and sharecropping
Agribusiness	Contract farming/Outgrower schemes Management contracts Joint ventures	Labour arrangements predominantly – though can include opportunities for contractors and service providers

(Source: Vermeulen and Cotula 2010)

Ways to combine bioenergy production and food security

(a) Production led by smallholders, land held by smallholders

Contract farming involves pre-agreed supply agreements between farmers and buyers. The agreements usually specify the purchase price, or how it will relate to prevailing market prices, and may also include terms on delivery dates, volumes and quality. In many cases the buyer, which is generally an agri-processing company, commits to supply upfront inputs, such as credit, seed, fertilisers, pesticides and technical advice, all of which may be charged against the final purchase price. In summary, there is a wide range of contract farming deals, from informal verbal purchase agreements through to highly specified outgrower schemes around large estates. The agreements may result in a more stable income stream for small-scale bioenergy producers, especially when these agreements are for a longer terms. Because both production and land are under control of smallholders, they retain a certain amount of independence and flexibility.

Examples

1. Independent smallholders who cultivate palm oil without direct assistance from government or private companies sell their crop to local mills either directly or through traders. In Malaysia, independent growers are proliferating as independent mills multiply and Federal Land Development Authority (FELDA) schemes mature towards less regulation and subsidy (Vermeulen and Goad 2006).
5. In Kenya and Ethiopia, there are examples of farmers that cultivate bioenergy crops by entering into contractual supply agreements with refineries. This strategy might benefit farmers who produce feedstock for bioenergy, especially in marginal areas where traditional export crops such as coffee and cocoa are absent (Wolde-Georgis and Glantz 2010).
6. In the State of Karnataka India, oil expelling industry is well-established and the demand for oilseeds has risen considerably during the past few years. While in 2002 the price of Pongamia seeds was about 4 Rs./kg, the price has since risen to about 15-17 Rs./kg. Still, most farmers in Karnataka cultivate Pongamia or Jatropha not as a cash crop but as boundary plantation or on unfertile soils. Collection of the seeds takes place as an additional activity on the farms, and the produce is then sold – via middlemen – to the many existing oil-expelling enterprises (Altenburg et al. 2009).

(b) Land held by agribusiness, production led by smallholders

Tenant farming and sharecropping are versions of management contracts in which individual farmers, for example smallholders, work the land of larger scale agribusinesses or other farmers. In tenant farming the usual arrangement is a fixed rental fee while in sharecropping the landowner and sharecropper split the crop (or its proceeds) along a pre-agreed percentage.

Examples

1. In Indonesia, oil palm production companies can acquire land from farmers (either their crop land and/or part of their communal forest land) to plant it with oil palm seedlings, manages the land for four years and then give only part back to the farmers keeping the rest for the nucleus estate of the company. Farmers pay back for the investments, but have lost part of their land (Vermeulen and Goad 2006).

(c) Production led by agribusiness, land held by smallholders

Management contracts refer to the variety of arrangements under which a farmer or farm management company work agricultural land belonging to someone else. Management contracts may take the form of a lease or tenancy, but carry the connotation of stewardship, of managing the land on behalf of the owner. To provide incentives for the farm management, the contract often entails some form of profit-sharing rather than a fixed fee.

Joint ventures entail co-ownership of a business venture by two independent market actors, such as an agribusiness and a farmers' organisation. A joint venture involves sharing of financial risks and benefits and, in most but not all cases, decision-making authority in proportion to the equity share.

Examples

1. Examples are nucleus-plasma (PIR) in Indonesia. The Government of Indonesia has introduced several cooperative programs of plantation development which involve main plantation companies called nucleus and individual farmers called plasma farmers. The nucleus assists the plasma farmers to develop and manage their plantation up to a point at which the plasma plantation is ready to be transferred to the plasma farmers (PWC 2010)
2. There are a variety of land resettlement and rehabilitation schemes in Malaysia (RISDA, FELCRA, FELDA) (see RSPO 2011). The land deals are crucial for these agreements. Sometimes the farmers receive additional formerly forested land from the government, this land is planted with palm oil seedlings and managed by the government or by a company paid to do so, and after four years when the trees start producing the farmers get a share of this land and have to start paying back the investments from the revenues of the harvests. Whether farmers will get additional assistance is uncertain and also the investment potential of these farmers is rather low as they also have to pay back the installation and management costs
7. Another example is the palm oil value chain in Honduras (Fromm 2007). Here 11 extractors (eight of which are privately owned) are the central figures in the chain. Most producer associations or cooperatives produce under contract to the extractors. The leading firms (Hondupalma and Coapalma) define what is being produced. The producers have contracts that secure an income in over the contract period. Both lead firms have plantations but they also source from associated and independent producers.
8. In Brazil, sugarcane binds many smallholders to their factory by leasing their land (Novo 2012). Larger farmers can cultivate sugarcane by themselves and sell their produce to the factory.
9. Collective landowner schemes are another option for local communities who hold land title or recognised customary land rights. These are land leases or joint ventures, whereby local landowners rent out use rights of their land to a plantation company, or collect a share of profits based on the equity value of their land. This is not strictly a smallholder model, but can be an attractive alternative for local landowners. The mini-estate or Konsep Baru in Malaysia (Sabah and Sarawak) and Lease-lease-back schemes in Papua New Guinea are current models (Vermeulen and Goad 2006).
10. In Mozambique, sugarcane production is organised through a nucleus estate outgrowers model with different levels of farmer participation in sugarcane production (Jelsma, Bolding, and Slingerland 2010).
11. In India, the British company D1 Oils plc. – in a joint venture with BP in Chhattisgarh and with Mohan Breweries in Tamil Nadu – is one of the most important actors promoting contract farming in the biodiesel sector in India. In Chhattisgarh, D1-BP Fuel Crops developed an approach based on so-called Jatropha Interest Groups (JIGs). JIGs consist of 5-20 small, marginal and semi-medium farmers that grow Jatropha as boundary plantation or on small parts of their land. Each JIG cultivates an area of about four to ten ha and signs a buy-back memorandum of understanding with the company. D1-BP Fuel Crops guarantees that it will purchase the seeds, whereas the farmers commit themselves to selling to D1-BP Fuel Crops (Altenburg et al. 2009).
12. Another example from India is provided by Alterburg et al. (2009) in the State of Tamil Nadu. D1 Mohan Bio Oils Ltd. is a biodiesel-processing actor operating in 12 districts. D1 Mohan Bio Oils Ltd. offers

> a buy-back contract to the farmers for jatropha cultivation. It provides assistance in training and linking up the farmers to credit facilities and crop insurance providers. The company signs a contract with each individual farmer. So far, it has contracted mostly medium farmers who have started cultivating Jatropha as a block plantation on part of their agricultural land. Around 5000 such contracts are already in place. As not enough medium farmers are willing to engage in major block plantations, the company has recently shifted its focus to small and marginal farmers.

Critical points

Within the bioenergy energy chain, the agro-industry usually retains a lead role, reflected in the distribution of value added across the principle economic sectors (Dufey, Vermeulen, and Vorley 2007). Private investors could favour large-scale production because they entail lower production costs. There is a risk that smallholders are excluded from the supply chain or not given a fair share of value creation because they typically cannot provide processing facilities with large quantities and/or are unable to invest in productivity growth.

In addition, as we pointed out in 4.3.2, bioenergy crops are often high volume, low value crops and therefore more suitable for large-scale commercial production than for smallholder farming. Some crops that are high volume per hectare perennial crops, (sugarcane or oil palm) may be suitable for smallholders under certain conditions (company provides inputs and secures a market).

The model of independent smallholders can only succeed when supply chains are in place. Many activities that focussed on small-scale community based jatropha production for local or national energy provision have been less successful than expected (see for instance Bonnet and Gheewala 2012; German, Schoneveld, and Gumbo 2011; Saikia et al. 2012). Often, such activities failed because no supply chains and/or processing facilities were in place and farmers lacked organised input supply (seeds, fertiliser, and pesticides) or outputs markets. The lack of farmers' organisation brought about high transaction costs for companies buying from individual farmers. These may be reduced by working with farmers organisation, see 6.3. Smallholders need to be supported to make it work. The case of Mali Biocarburant (see box 1 in this report) shows that it is possible.

When a new bioenergy crop is introduced, it should be accompanied by market development, as the experience in some countries show (e. g. in Mozambique, India). In these countries, the governments promoted jatropha production without domestic markets in place (NL Agency 2010). The prices of seed to establish new plantings were attractive but did not generate sufficient revenue when used for oil production. As soon as local seed markets became saturated, the lack of seed demand for oil production became apparent and seed prices dropped. Farmers who engaged in jatropha production and who suffered from low yields and low prices have not been able to recuperate the costs of allocated land and labour. These resources could have been used for food production instead.

Recommendations

There is no single option which will lead to stabilising incomes of small-scale farmers: they may be included into bioenergy value chains in various ways. However, certain conditions need to be in place to protect the stability of incomes.

Project level

In a setting in which agribusiness firms control land, production process or both, they should offer small-scale farmers contracts that provide a secure marketing outlet. This could involve:

1. Offering a stable price. This may be achieved by sharing price risk, in which the risk of price fluctuations are shared between farmers and contracting firms
2. Offer long term perspective for supply. Contracts may be short-term (e.g. annual), which may benefit both farmers and firms because it introduces flexibility. Firms may signal a longer term perspective by investing in the relationship with farmers, which may benefit the firm also, by securing a stable supply. The investment may consist of training, supplying inputs etc.

Policy level

In a more market setting, where smallholders control the production process and the land, supply chains or well-functioning markets should be in place. To achieve these, governments at national and local level, together with the private sector, should invest in processing facilities, transport and infrastructure.

5.2 Creating additional employment and income by increasing opportunities for small to medium enterprises (SMEs) in biomass value chains

Many of the bioenergy production firms are small to medium scale enterprises, and as such, provide additional employment and income. In addition, bioenergy production may lead to additional demand for services or production that may be provided by other SMEs. This spin-off effect of generating wider employment and income opportunities is the focus on this section. Especially in developing countries, SMEs have a pivotal role in development and therefore many governments and developing agencies have set out SME support programmes of considerable size and scope (UNIDO 2009).

Ways to combine bioenergy production and food security

Increasing opportunities for SMEs is important to ensure a more equal distribution of the benefits from the emerging biomass market. SMEs may provide additional employment to the rural non-farm sector, which is known to enhance and supplement the stability of incomes of rural households (Barrett, Reardon, and Webb 2001; Reardon, Berdegué, and Escobar 2001).

Examples

We could find little information on the role of SMEs in biomass value chains. The main reason for this is probably that the value chain is usually short. Typically, farmers sell directly to bioenergy companies (see 5.1), which leaves little room for other actors in the chain, such as service providers.

Critical points

Lamers et al. (2008), in a study on liquid biofuel, in Argentina find that the biodiesel market in Argentina is dominated by large-scale enterprises. The roles of SMEs remain uncertain and depend on a number of factors, such as the new law on liquid biofuels and its incentive mechanisms. They find that the mechanisms in place are too weak to strengthen the role of SMEs. The law lacks transparency and does not clearly outline the ranking criteria for tax exemptions, while high investment costs and perceived risk still prevail in Argentina.

Recommendations

Project level

Although we could not find any clear examples of how bioenergy production has led to additional SME activities, firms involved in bioenergy production may actively involve local small to medium scale service providers, by for instance locally outsourcing certain production components.

5.3 Local, small-scale value adding by local processing

In this section we do not focus on spill-over effects of investments in bioenergy production which we discuss in section 6.1. The effects of large-scale bioenergy production on employment is discussed in 4.2.1. Instead, we focus on to what extent small-scale, local processing can contribute to value added of agricultural production in a region, or has created additional jobs.

Ways to combine bioenergy production and food security

Local, small-scale value adding may increase food security, by creating employment in the processing industry, as well as providing income to skilled people in countries where skilled jobs are scarce. Like SMEs, local, small-scale value adding may provide additional the rural non-farm employment sector, which is known to enhance and supplement the stability of incomes of rural households.

Examples

1. In Brazil, a farmers' cooperative in Chapada Gaucia acquired a crushing and biodiesel processing unit and added value to their own produce (field visit Dal Belo Leite and Slingerland, 2012). In another part of Minas Gerais state Brazil, a smaller cooperative acquired a crusher to crush oil seeds from a local palm (Macauba) which also allowed to add benefit potentially serving a biodiesel processing plant (field visit Dal Belo Leite and Slingerland, 2011).
13. In Mali, biomass is processed locally into biodiesel in two factories by Mali Biocarburant (see Box 1). The biodiesel is sold in the domestic markets.
14. Also the example of FACT foundation in Cabo Delgado, Mozambique (Nielsen and de Jongh, 2009) shows that there is some potential for local added value especially for pure plant oil or biodiesel as the technology is less expensive and complicated than for bioethanol.
15. Local processing of biomass into bioenergy allows co-products to be used locally (see 3.4 for explanation of co-products of bioenergy production). An example is cassava processing in Mozambique where by-products are used as fertiliser (Zvinavashe et al, 2011).
16. In the Philippines, several agribusiness investors have established food-processing ventures, for which they directly lease adjacent land to supply a desired proportion of their raw material requisites. They then enter into contract-growing agreements with nearby farm owners to provide the balance of their requirements (Montemayor 2009).

Critical points

In Sub-Saharan Africa, local value adding is not just a concern for biomass production, it is a concern that applies to primary crop production in general. Especially least developed countries are exporters of raw, unprocessed materials and importers of processed materials.

To ensure local, small-scale value-adding, investment in biomass production requires a link to local processing opportunities and assured domestic markets, for instance through obligatory blending targets. However, first the sustainable potential should be carefully assessed. If this is not done properly, a country may end up like Jamaica, which has to import ethanol to fulfil its E10 blending mandate.

Local value adding might become more attractive when a domestic market is created due to obligatory blending regulations, although there may be macro level (price) risks to food security of such policies. Countries such as South Africa and Malawi in Africa, Brazil and Canada in America, China and India in Asia to name a few examples, have introduced mandatory blending regulations. In other countries, such mandates are still planned. For instance, in Mozambique, laws are in preparation for blending targets, obliging companies to produce a certain amount of feedstock (or bioenergy) for the domestic market. This will be reinforced by a tax on export of raw materials, such as jatropha seeds (Schut et al. 2013). Due to absence of binding blending targets in several African countries, there is not yet a domestic market for bioenergy making it unattractive or even impossible for investors to produce for the domestic market despite the economic benefits (price differentiation between imported and locally produced biodiesel) and environmental benefits (lower transportation costs and hence lower GHG emissions related to transport) attached to that option.

This may explain why there are surprisingly few examples of local value adding through bioenergy production. The process of converting biomass to fuels requires relatively advanced techniques (see also Figure 6), that are not suited to local circumstances, especially in poor countries. Thus, the first criteria is often not met: processing plants or factories should not be very capital intensive.

Recommendations

Project level

There are several successful examples of how bioenergy production firms have invested in local processing to generate local value adding. These examples show that local value adding is often accompanied with an orientation on local or domestic markets.

Policy level

Governments, especially in Sub-Saharan Africa, in collaboration with the private sector, should create an enabling environment that will stimulate investments in local, small-scale value adding, such as local processing plants. Harnessing foreign investment may be an effective strategy, as the Mali Biocarburant example shows, which was facilitated by Dutch investors. Dutch policy from their side, can also stimulate local small-scale value adding by providing start-up capital for Dutch investors.

6 Policy objective no. 4: Improved investment climate - Creating an enabling environment for producers

Stability of food availability, access and utilization

Bioenergy developments may contribute to an overall improved macroeconomic performance and living standards. Bioenergy production may generate growth linkages (i.e., multiplier or spill-over effects) to the rest of the economy through investment in processing capacity, infrastructure (such as roads) and employment. In this way, they contribute also to the stability dimension of food security.

However, achieving these growth linkages requires strict control and governance of the proposed biomass investment. It is important to ensure that the investment strengthens the rural economy and that local population benefits from additional economic activity and employment. We identify three issues that can facilitate this. First, enabling government policies need to be in place to ensure biomass production for bioenergy benefit rural communities. Second, investments in biomass production for bioenergy may have spill-over effects that benefit food production. Finally, farmers' organisations may play an important role in this.

6.1 Enabling government policies

National governments and international institutions have an important role to play in shaping the environment for investments in land and bioenergy processing. In general, developing countries rank poorly in the Ernst & Young country attractiveness indices for investments in biomass production, with notable exceptions being India and China. The indices provide scores in 40 countries for national energy markets, energy infrastructures and their suitability for individual technologies (Ernst & Young 2012).

Ways to combine bioenergy production and food security

National governments and international institutions should not only aim to improve their bioenergy markets, energy infrastructure and stimulate bioenergy technologies, but also ensure that bioenergy investments contribute to local livelihoods and food security. National and international regulations determine how foreign and domestic investments in land, water and other natural resources are made.

Examples

1. In Brazil, the biofuel social seal policy allows farmers to produce biodiesel crops and sell these to the market (Dal Belo Leite et al. 2013; Watanabe, Bijman, and Slingerland 2012; German, Schoneveld, and Pacheio 2011). This policy supports farmers in supply of seeds, fertiliser, transport, credit and guaranteed market. The biofuel social seal policy provides factories with a tax reduction and access to markets when they engage smallholders.
17. Arndt et al. (2011) observed that many bioenergy investors negotiate fiscal advantages and government investments in desirable infrastructure such as roads and harbours. Combined with the recommendation of FAO (2012) to governments to provide incentives to companies (bioenergy producers) who incorporate smallholders into their value chain, this could be an example to follow.

18. Foreign assistance may help to improve national investment climate. For instance, the NL Agency recently supported the national government of Mozambique with a sustainability framework to provide governmental departments clear criteria to assess investors plans and indicators to control their execution. These criteria and indicators are communicated to potential investors making the assessment process much more transparent (NL Agency 2012b; Schut et al. 2013). These criteria also used for land acquisition, and may therefore be important to section 4.1 on Land rights. This will contribute to making Mozambique’s investment climate more transparent, cutting waiting times for proposal approval and increasing certainty regarding the outcome of the assessment process.

Critical points

The case of castor oil in Montes Claros in Minas Gerais state shows that an enabling institutional environment is not always sufficient. In this case, the crop does not fit in most of the present farming systems, preventing farmers to enter the supply chain (Dal Belo Leite et al. 2013).

Investors in Mozambique and Tanzania have requested lower taxes on bioenergy vis-a-vis imported fossil fuels in order to encourage domestic sales and offset the cost of initial capital outlays. Petroleum taxes accounted for 10.7 and 15.8 % of government tax revenues in Mozambique and Tanzania in 2004. Blending with 10% tax-free ethanol would mean a reduction in revenues by 1.1 and 1.6% respectively. This would require 5 to 6% increase in direct taxes or 13-19% reduction in investments in agriculture to make up for this measure. These costs are substantial.

Recommendations

Policy level

Specific policies should be formulated to optimise the positive effects of bioenergy production on local livelihoods and food security, such as providing tax reductions or other incentives to biofuel producers when smallholders are engaged. A good example is the social seal policy in Brazil (see above).

Foreign assistance may also provide support to improve enabling government policies, such as capacity development of agencies involved in bioenergy investments, or helping to devise procedures and criteria that will improve transparency of decision-making and will assist in better assessing which investments should be approved. Criteria such as involvement of smallholders are important to optimise the positive effects of bioenergy production on local livelihoods and food security.

6.2 Spill-over effects of biomass investments

With the rise of bioenergy production, significant investments in infrastructure for transportation, intermediate storage, blending, and distribution have been made in many countries. Most of these investments have been made in the developed world, Latin America, and Asia (Malaysia, India and China) (Ernst & Young 2012; Sridhar et al. 2010). Currently, however, in both the US and the EU, the bioenergy policies have become less pronounced, with the EU relaxing its targets, while the Brazilian ethanol markets have suffered almost two years of shrinking demand and low margins. This has led to a sharp slowing of first-generation bioenergy investment, while investment in the next-generation biofuel and biochemical arena has been low (Ernst & Young 2012).

Very little information is available on actual investments made in for instance infrastructure by bioenergy companies, and therefore we could not find sufficient information about the spill-over effects of these investments. This does not mean that these investments have not been made. We know that in Latin America and many Asian countries for instance, large-scale investments in processing facilities, infrastructure etc have been made.

There is much more information on large-scale land investments which may provide a proxy for the scale of investments over the world, especially because many of these have been in Sub-Saharan Africa. In recent years, there has been an increase in such large-scale investments. The LAND Matrix, an online public database of large-scale land deals by the International Land Coalition, is the most recent and detailed inventory of large-scale land acquisitions (Anseeuw et al. 2012). The Land Matrix data finds that jatropha production has been an important driver for large-scale land acquisitions in the world. However, we could not find any studies on the macro-economic spill-over effects of land investments.

Ways to combine bioenergy production and food security

Large-scale biomass investments have the potential to generate economic spill-over effects or "multiplier effects", stimulating employment, tax revenues, technology transfer, and infrastructure and communication services, and, in doing so, also improve the access of local farmers to markets and input supplies. These spill-over effects may also include health or education facilities, and project infrastructure that can be used by the local population. This is why the World Bank stated that "done right, large-scale farming can provide opportunities to poor countries with large agricultural sectors and ample endowments of land" (World Bank 2010). All of these have direct and indirect effects on food security, but all will contribute to enhancing the stability dimension of food security.

Examples

We were not able to find good examples of bioenergy investments such as infrastructure improvements. This does not mean to say these do not exist, only that they are not well-recorded.

1. The LAND Matrix that was mentioned above (Anseeuw et al. 2012) finds evidence that large-scale land investments indeed lead to infrastructure improvements.
2. The several decades of experience with the production and use of biofuels in Brazil, show that the establishment of a strong biofuel sector provide opportunities for economic development (Janssen and Rutz 2011).

Critical points

The debate over the impact of bioenergy in the food price hikes of 2008-9 has been accompanied by a discussion over the importance of bioenergy in the surge of global land investments, also termed land grabbing. Land and water are perceived to be globally scarce resources, reflected in the increasing prices of agricultural commodities, but also in land prices (von Braun and Meinzen-Dick 2009). This has made land an attractive investment, which explains the surge of large land deals of the past decade. Large-scale land investments have also accompanied the global restructuring of value chains as in the case of forestry, paper and pulp (Wilkinson et al. 2013).

The benefits of large-scale land investments to income of local populations, and therefore food security are rather mixed. Creation of additional employment has been touted as one of the more important potential benefits for the local community. At the same time, the *type* of jobs created is often criticised because of low wages and poor working conditions: too often the jobs are temporary, low-paid, and insecure (Kugelman and Levenstein 2009; see also section 4.2.1).

Although there are various promising opportunities and "win-win" situations, these often do not materialise. Da Vià (2011) for instance describes a case in Sierra Leone where Addax Bioenergy, a division of the Swiss-based energy corporation Addax & Oryx Group, won a 50-years lease for around 40,000 hectares to produce ethanol for export to the EU market. The promised benefits of employment, good wages, sustainable use of land have not or only partly been fulfilled.

One of the main obstacles in achieving a win-win situation, whereby the local population benefits from large-scale investments, are the local and national governments that do not enforce rules on land rights, minimum wages or working conditions (Borras, McMichael, and Scoones 2010; Hallam 2009) see also 6.2.

Besides positive spin-offs of investments in bioenergy production, there may also be negative spin-offs in the social and environmental sphere (Janssen and Rutz 2011)

Recommendations

Policy level

There is little that governments can do to actively promote positive spill-over or multiplier effects of investments in biofuel production, because most of these effects are indirect and are achieved through a well-functioning economy.

Of course, governments can try to limit the negative spill-over effects of biofuel investments, such as limiting environmental damage that results from large infrastructural investments. This links up with the following sections.

More research needs to be directed in exploring what the macro-economic spill-over effects of bioenergy investments and production are; as well as quantify the size of these spill-over effects.

6.3 Role of farmers' organisations

In general, the role of farmers' organisations is increasingly recognised as being pivotal as part of civil society. More specifically for bioenergy production, farmers' organisations are able to perform various useful functions.

For bioenergy companies, collaborating with farmers' organisations may be useful because they can help to organise farmers, thus lowering transaction costs to companies. To safeguard farmers' interests, farmers' organisations also have an important role to play. Dubois (2008) uses the framework of Mayers et al. (2005) to list the different issues that should be taken into account when protecting the farmers' interests:

- information (access, coverage, quality, transparency);
- participatory mechanisms (representation, equal opportunity, access);
- finances (internalising externalities, cost efficiency);
- skills (equity and efficiency in building social and human capital);
- planning and process management (priority-setting, decision-making, coordination and accountability).

Ways to combine bioenergy production and food security

By protecting the interests of the farmers, and negotiating on their behalf with bioenergy companies, farmers' organisations may contribute to protecting the livelihoods and therefore food security of farmers.

Examples

1. An important bottleneck to bioenergy companies is the lack of farmers' organisation which makes them unattractive for potential buyers, prohibits them to organising input supply against competitive prices and negotiating good selling prices. From examples in Peru, Mali and Thailand, FAO (2012a) identified farmer organisation as a key determinant for successful participation of smallholders in bioenergy supply chains.
19. An example of effective organisation concerns soybean production by family farmers for biodiesel in Chapada Gaucia, Minas Gerais state, Brazil. The family farms form a cooperative which can more easily buy inputs collectively, transfer new technologies to its members and negotiate prices on behalf of them. The family farms can also decide to store the crops until a better price is offered (Watanabe et al., 2012). Such a cooperative may prove to be useful for a starting bioenergy company, allowing it purchase timely large amounts of feedstock of required quality for an agreed price.

Critical points

A strong farmers' organisation may not always be present to take on the different roles outlined above. In the absence of a strong farmers' organisation, a model of vertical integration may be more fitting. In Mozambique for instance, farmer-led cooperatives hardly exist. Cotton and tobacco outgrower schemes are based on vertical integration (Bijman, Slingerland, and van Baren 2010); this could also be a model for bioenergy production. NGOs may also substitute for farmers' organisations. A recent experience with sugarcane outgrower schemes in Mozambique shows that a true grassroots organisation may mediate negotiations between the company and local communities but also assists in strengthening the smallholder association (Jelsma, Bolding, and Slingerland 2010). Successful cases largely depend on coordination between NGOs and on availability of attractive markets (see for instance Nadeau and Novoa 2004). For bioenergy investors this would mean that they need to invest collaboration with NGOs and associated farmers.

Recommendations

Project level

Explore the possibilities to collaborate with farmers' organisations. The farmers' organisation may help in contacting and contracting large numbers of farmers, and ensure that the terms in the contract are fair.

If a well-functioning farmers' organisation is missing, an NGO may assume a role in initiating and training farmer organisations while temporarily acting on their behalf by contacting and contracting farmers.

At policy level, farmers' organisations should be recognised and supported, especially when they implement activities that protect the farmers' interests (see above).

7 Certification of sustainable production and trade of bioenergy

7.1 Certification schemes

Certification schemes help to ensure that bioenergy production does not harm the different dimensions of food security. In addition, certification schemes may outline best practices in management. Such Best Management Practices (BMP) can help farmers achieve higher yields as well as higher incomes, both which contribute to an improved food security status.

There are numerous certification schemes for biomass,[14] and some have been examined in earlier reports by (2011; 2012c; 2013). In this section, we will not provide an extensive discussion of all schemes, but provide some guidance on how certification may be used to produce bioenergy while contributing to the different dimensions of food security.

Best practice

The Roundtable on Sustainable Biofuels incorporates food security in the most comprehensive manner, with clear criteria. Therefore, projects wishing have their produce certified, and audited explicitly on food security, the use of RSB guidelines may be most useful.

The RSB has developed international sustainability standards for biofuels. In 2008, the Roundtable for Sustainable Biofuels released its standards for sustainable biofuels, which includes 12 principles[15]. The sixth principle explicitly mentions food security by stating that "Biofuel production shall not impair food security". The concern over ILUC effects of bioenergy production (see chapter 4), led the RSB to publish a report (with Ecofys and WWF International) that outlines a methodology for companies, policy makers and certification schemes on how to achieve bioenergy production while lowering the risk of unwanted indirect impacts. The report presents detailed ILUC mitigation approaches that are field-tested and audited in international pilot projects (RSB 2012).

The RSB Food Security Assessment Guidelines are quite comprehensive, encompassing the four dimensions of food security (availability, access, utilisation, stability). It provides recommended indicators that could be used by biofuel operators to best measure food security under the headings:

- Measuring household food and nutrient intake
- Measuring the 4 dimensions of food security
- Other measures of food security (anthropometric measures)

The indicators are all at community level. The RSB Services website[16] provides information on several certified biofuel production projects, of which three are in developing countries (Sierra Leone-sugarcane, Peru-sugarcane and Mexico-jatropha).

Other certification schemes, that incorporate food security less comprehensively, may also be useful tools to ensure bioenergy production does not harm the different dimensions of food security. Even when food security impacts are not mentioned explicitly in guidelines, food security issues may arise through for instance mandated local consultation as well as impact

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[14] See for a list of voluntary schemes that are recognised by the EU since 19 July 2011 the European Commission webpage: http://bit.ly/pm3Osr

[15] See www.rsb.org or http://rsbservices.org/principles-criteria/principles-criteria-2/

[16] http://rsbservices.org/certificates/ Accessed 14 April 2013

assessment and mitigation processes. Certification schemes may also outline Best Management Practices (BMP). For instance, the Roundtables include requirements for BMP, which may be used for food security purposes.

Policy-makers may support and stimulate the use of the different available certification schemes. They may also help by providing information and increasing transparency of how food security is incorporated in the different certification schemes.

7.2 Other tools

Certification schemes are not the only way to ensure bioenergy is produced with a focus on food security. There are also other tools available to assess and monitor the links with food security. These may be simpler to apply, less costly but yet robust.

For instance, the FAO Support to Decision-Making for Sustainable Bioenergy: Bioenergy and Food Security (BEFS) is a comprehensive toolkit, which aims to support policy makers, investors and producers in making bioenergy development sustainable. Its various components contribute the following:

- Definition of the scope for opportunities and risks in bioenergy production;
- Contours of an enabling policy and institutional environment;
- Good practices for investors and producers and appropriate policy instruments to promote these good practices;
- Impact monitoring and evaluation and policy response mechanisms.

BEFS includes support tools for decision-making at the national level as well as project level (FAO 2012b) [17] with the former being more comprehensive.

At a policy level, the Global Bioenergy Partnership (GBEP) is a useful tool because it focuses on bioenergy policy development. The Global Bioenergy Partnership (GBEP)[18] aims to promote the wider production and use of modern bioenergy, particularly in the developing world where traditional use of biomass is prevalent. Its report on Sustainability Indicators for Bioenergy presents 24 voluntary sustainability indicators for bioenergy (Global Bioenergy Partnership 2011). The emphasis is on providing information for the development of national bioenergy policies and programmes. Its indicators represent a level of consensus among a range of national governments and international institutions on the sustainability of bioenergy. When measured over time, the indicators should show progress towards or away from sustainable development.

The GPEB indicators cover the environmental, social and economic dimensions of sustainability. While there is no single food security indicator, of the 24 indicators, at least eight variables connect to the concept of food security as discussed in the present report[19]. Food security is predominantly positioned in the social domain, and also features in the environmental and economic domain.

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[17] See for more information: http://www.fao.org/energy/82318/en/
[18] See for more information http://www.globalbioenergy.org/
[19] These are:

- Social: Allocation and tenure of land for new bioenergy production ; Price and supply of a national food basket ; Change in income ; Jobs in the bioenergy sector
- Environmental: Soil quality; Land use and land-use change related to bioenergy feedstock production
- Economic: Productivity; Gross value added

8 Conclusions

This paper examines the connections between bioenergy production and food security on the well-established dimensions of food security, i.e. food availability, food access, food utilisation and stability. The analysis spans the spectrum from the micro level (farms, households) to the macro level (the prices and market developments for energy, food, land and labour, and the composition of economic growth).

We argue, in chapter 2, that the impact of changes in bioenergy production on the different dimensions of food security is determined through a number of intermediary variables:

- agricultural producer (output) as well as input prices;
- consumer food prices;
- yields of food production;
- food trade;
- access to land and other farm household resources;
- household income, through crop production or employment;
- macro-economic variables.

and that these effects operate on different scales and time dimensions. The impact of bioenergy production on food security through these variables is sometimes positive (e.g. on food access through producer prices and household income), sometimes negative (on food availability through food production, food trade or food access through consumer prices) and sometimes can go either way (on utilisation and stability dimensions through macro-economic variables). As a result, generic claims stating that bioenergy production entails a risk for food security or a benefit to food security should be treated with caution. Such claims often reflect a partial view on the issues at hand.

In order to shed light on the debate, we bring together a body of scientific literature to examine whether and how biomass production for bioenergy can be combined with the four policy objectives of development cooperation policy for food security in the Netherlands. In particular, we synthesise empirical evidence on the relations of bioenergy crop production, agriculture and food security (chapter 3-6).

Based on the analysis, we draw the following conclusions:

1. A necessary condition to safeguard food security concerns in bioenergy production is that is leads to little or no displacement of agricultural land for food production, and that it is ensured that land titles are properly addressed. There are several examples of ways to bring bioenergy and food production into integrated farming systems that maximise farm output per hectare. These may include livestock or co-products to close nutrient cycles and support business cases. Appropriate guidance and means for verification on good management practices will be necessary to deliver sustainable bioenergy production. Bioenergy investments, particularly when they involve new land claims, should propel productivity growth for *food* production. Clear but rather different benefits for food production have been documented in the literature in relation to bioenergy production. The benefits include rising yields of food crops and cash crops, and expanded livestock production through stable and cheap feed supply. Further analysis will help to clarify the effects on food availability at micro and macro level.

2. Macro level food price effects and changes to growth patterns are important, and potentially overriding, factors contributing to the food security outcome

of bioenergy production. We argue that many of the macro level effects will depend on how energy markets and policies will drive bioenergy use and the volume of bioenergy production at global, national and local levels. A national biofuel subsidy or mandate policy is better replaced with a market-led strategy for the development of the sector, because subsidies or mandates provide the wrong signal, distorting markets.

3. A necessary condition for a positive impact of bioenergy production on food security is that it contributes to stable income opportunities for households, from expanded crop revenues, off-farm employment or both. Any additional income that is generated by bioenergy production raises the purchasing power of the household, and also results in a lower share of food in household expenditures. Both channels lead to improvements in food security, in particular to better food access, including more stable access in times of crisis. Whether food insecure households will benefit is determined by the specific setup of the energy and food supply chains involved. Bioenergy production is able to provide opportunities for inclusive growth, but does require a number of targeted interventions.

4. We conclude that the four policy objectives on food security of Dutch development cooperation, as formulated in 2011 and 2012, are a useful framework to guide the efforts to combine sustainable bioenergy production and food security. The policy framework addresses the multiple dimensions of food security, which are all potentially affected by bioenergy production. In addition, it emphasises the importance of connecting sustainable farming with the organisation of inclusive supply chains and well-functioning markets, to promote food security, from the individual to the national level. This, effectively, is the cornerstone of the challenge for bioenergy production: to strike a balance between opportunities and risks, at field and household level as well as at the macro level.

The analysis in the study results in a number of recommendations for addressing food security issues in bioenergy crops. The recommendations (listed in Annex A) are specified as the conditions that need to be realised in the areas of food production, food access, functioning markets, and investment climate. In addition, the contributions of decision makers at the project level and the policy level in realising the conditions are specified. It should be noted that certification schemes and other guidelines may provide useful instruments to bring some of the recommendations into practice. Certification schemes may be helpful in specifying how bioenergy production does no harm to the different dimensions of food security. In addition, certification schemes may outline best practices, for instance in plantation establishment (with respect of land use rights) and plantation management (aimed at improving crop yields, enhancing local economic benefits). Such best practices can help farmers achieve higher yields as well as higher incomes, and thereby contribute to improve their food security.

There are several examples of certification schemes that specifically include food security as principles or criteria. However, the indicators and the way to assess them are often rather weak in many certification schemes. The analysis in this report provides several leads for developing more concrete indicators and verifiers. Similarly, at the policy level, it will be useful to further develop best practices for a bioenergy and food security framework.

Annex A. Recommendations to address food security issues in bioenergy crops

Increased sustainable food production		
Key conditions	**Recommendations**	**Recommendations**
	Project level	**Policy level**
Increased efficiency in land use	If an expansion of bioenergy production makes new claims on agricultural land, there is a need to increase the efficiency of agricultural land outside bioenergy systems. Targeted activities to raise the yields of food crops need to be developed alongside bioenergy production, such as training of farmers in crop production or improving farmers' access to inputs.	Land titles and food markets need to facilitate a distribution of benefits of land deals for bioenergy and local food availability (see under food access)
Crop production on abandoned or degraded lands	Before deciding to use degraded lands two steps must be made: An assessment needs to be done what the degraded areas are and how they are used, to avoid competition with other uses of degraded land. The Low Indirect Impact Biofuel (LIIB) methodology Responsible Cultivation of Areas (RCA) may be useful tools to identify plots of land. When using degraded lands, a prognosis should be made of the expected yields that can be used in a cost-benefit analysis to assess whether using degraded lands will be profitable.	
Producing bioenergy from wastes or residues	more needs to be invested in developing technologies that can process waste and residues in a cost-efficient manner, specifically targeted at low-income countries where technologies should be easy to maintain and cheap to use using residues and waste should not conflict with fertilising soils, feeding animals and other uses. A careful assessment should be made of the existing uses of residues and waste.	The investment needs for technologies that can process waste and residues may require support at a policy level, particularly in in developing countries (Sub-Saharan Africa). This support may be in the form of subsidies, tax reductions or soft loans for investing in such technologies, but may also be directed at research and development into cost-efficient technologies that are affordable for low-income countries.
Production of co-products	Investments should be made in the production or process facilities for co-production. However, investments in co-products should be weighed against the profitability of selling co-products. Several questions should be asked before investing to assess profitability: 1. What is the demand for that particular co-product? 2. What price will it fetch? 3. What are the alternatives and their prices? 4. Will a large supply of co-products influence prices and therefore profitability?	

Improved access to food of sufficient quality		
Key conditions	**Recommendations**	**Recommendations**
	Project level	**Policy level**
Land rights	When land is acquired, there should be fair and equal representation of the communities affected in the terms of compensation. Tools that can be used to ensure land rights are dealt with correctly are the FAO's Voluntary Guidelines or the Responsible Agricultural Investment (RAI) guidelines.	National and local governments should clarify legal land acquisition procedures (through sale or lease), increase transparency of such deals and enforce the laws. This may be achieved by encouraging the use of the FAO's Voluntary Guidelines or the RAI.
Consumer prices		There are two ways to counter the concern over the influence of bioenergy production on consumer prices: Reducing the effect of bioenergy on food prices by dismantling subsidised or targeted shares of bioenergy in energy consumption. Partial measures in this direction include making mandatory targets for bioenergy more flexible and reducing trade restrictions on bioenergy in the global market. Reducing the effect of high food prices on vulnerable groups, e.g. through social safety-nets or an emergency food reserve to shield food insecure population from the effects of food price spikes.
Household income: *A. Employment*	To ensure that higher employment leads to food security the following could be pursued: • Hire local workers to ensure local food security effects. Invest in training if necessary • Ensure the workers receive at least the minimum wage and provide for good working conditions, especially for women.	Low-skilled workers who run the risk of losing their job because of mechanisation, may be retrained and offered support in finding different work by governments, in combination with the private sector and NGOS.
B. Cash crop income	In order to provide farmers with sufficient income, the bioenergy crop should be economically attractive, which usually means the creation of stable and secure market outlets for farmers and mechanisms to ensure input and output at competitive prices.	At a local policy level, multiple marketing outlets should be promoted, to make it more attractive for smallholders to invest in food crops that can also be used for biofuels (e.g. soy) rather than investing in specific biofuel crops that have only a biofuel outlet (e.g. jatropha). In most parts of the world, local food markets function properly. However, in those, usually remote parts of the world where they do not, investments should be made to lift the most important constraints, such as investing in roads.

Improved functioning of markets		
Key conditions	**Recommendations**	**Recommendations**
	Project level	**Policy level**
Inclusion of small-scale producers and low-skilled labourers in modern biomass value chains	In a setting in which agribusiness firms control land, production process or both, they should offer small-scale farmers contracts that provide a secure marketing outlet. This could involve: Offer a stable price through sharing price risk, in which the risk of price fluctuations are shared between farmers and contracting firms Offer long term perspective for supply. Contracts may be short-term (e.g. annual), which may benefit both farmers and firms because it introduces flexibility. Firms may signal a longer term perspective by investing in the relationship with farmers, which may benefit the firm also, by securing a stable supply. The investment may consist of training, supplying inputs etc.	If there is no agri-business firm that is providing access for small-scale farmers to well-functioning supply chains or markets, governments at national and local level, together with the private sector, should invest in processing facilities, transport and infrastructure.
Creating additional employment and income by increasing opportunities for small to medium enterprises (SMEs) in biomass value chains	Firms involved in bioenergy production may actively involve local small to medium scale service providers, by for instance locally outsourcing certain production components.	
Local, small-scale value adding by local processing	Local value adding should be accompanied with an orientation on local or domestic bioenergy markets.	Rather than creating domestic bioenergy markets through subsidies or mandates, governments should create an enabling environment that will stimulate investments in local, small-scale value adding, such as local processing plants, especially in Sub-Saharan Africa. Harnessing foreign investment may be an effective strategy.

Improved investment climate		
Key conditions	**Recommendations**	**Recommendations**
	Project level	**Policy level**
Enabling government policies need to be in place to ensure biomass production for bioenergy benefit rural communities.		Specific policies should be formulated to optimise the positive effects of bioenergy production on local livelihoods and food security, such as providing tax reductions or other incentives to biofuel producers when smallholders are engaged. Foreign assistance may also provide support to improve enabling government policies, such as capacity development of agencies involved in bioenergy investments, or helping to devise procedures and criteria that will improve transparency of decision-making and will assist in better assessing which investments should be approved. Criteria such as involvement of smallholders are important to optimise the positive effects of bioenergy production on local livelihoods and food security.
Investments in biomass production for bioenergy may have spin-off effects that benefit food production		There is little that governments can do to actively promote positive spin-off effects of investments in biofuel production, because most of these effects are indirect and are achieved through a well-functioning economy.
Farmers' organisations may play an important role in this.	Explore the possibilities to collaborate with farmers' organisations. A farmers' organisation may help in contacting and contracting large numbers of farmers, and ensure that the terms in the contract are fair. If a well-functioning farmers' organisation is missing, an NGO may assume a role in initiating and training farmer organisations while temporarily acting on their behalf by contacting and contracting farmers.	At policy level, farmers' organisations should be recognised and supported, especially when they implement activities that protect the farmers' interests

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