Land - a scarce resource

Report on the interaction between food, animal feed and bioenergy

February 2008
Summary

Danish Ministry of Food, Agriculture and Fisheries
Summary of “Land – a scarce resource”
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The report published by the Danish Ministry of Food, Agriculture and Fisheries shows that Denmark can boost the production of bioenergy from biomass substantially without any reduction in animal feed and food production. There is huge untapped biomass potential in straw and especially in livestock manure. Today, less than five per cent of the manure is used for energy production.

At the same time, we can solve some of the pollution problems of the agricultural sector by means of bioenergy. This applies especially to nutrient leaching from farmland. For example, by biodigestion of slurry into biogas, we can reduce the agricultural impact on the environment and, in addition, we will get a valuable renewable energy source that contribute to reducing the CO₂ emissions.

However, the report on biomass also documents that the production and application of biomass is a complex area, which is very much affected by global conditions. The complexity of it is underlined by the many significant aspects within economy, trade, technology, the environment and ethics that impact on biomass. Therefore, political interest in and regulation of biomass is subject to many considerations, especially with regard to international regulation.

The following summary focuses on key subjects which the Danish Ministry of Food, Agriculture and Fisheries considers to be the most important ones when biomass is analysed on the basis of a holistic approach.

**Landuse**
In the forthcoming years, the demand for animal feed and foods is expected to increase at global level as a result of population growth and increased prosperity. The expected rise in prosperity will come in particular from a number of countries with high population rates in the third world, such as China, India and Brazil, where there is considerable economic growth. The increase in prosperity is expected primarily to raise the consumption of animal products, for example meat and milk. At the same time, it is expected that the use of biofuels produced from raw materials such as maize, sugar cane, wheat and vegetable oils will continue to increase. Today, crops grown for this type of bioenergy production account for approximately 1 per cent of global cultivated land.

With growing demand for biomass, the area of global agricultural land is expected to expand. The expansion will, however, to some degree depend on the extent to which production growth can be achieved through productivity development in the agricultural sector. In recent years, the annual productivity increase regarding vegetable raw materials has been relatively modest (1-1.5 per cent).
Expectations are, however, that in third-world countries, parts of Eastern Europe and in some of the new countries that emerged after the collapse of the Soviet Union, there may be a greater improvement in productivity as a result of better infrastructure (transport and storage facilities), better farm management, more intensive cultivation, and through the breeding of new varieties.

International political agreements may also become of some importance to the pressure on land. Even if biofuels are only of marginal significance to land use, demands for compulsory application of biofuels may impact on the use of land, as long as biofuels are produced on the basis of the land-requiring first generation technology. International trade conditions for bioethanol will be of importance to what areas will see the largest expansion of land. Liberalising trade in bioethanol will reduce the pressure on land in the EU and the USA, but will increase the pressure on land in South American and Asian countries that have a cost-effective production of bioethanol and vegetable oils.

In addition to international agreements, national subsidies will also play a part with regard to the increase in the production of raw materials from agriculture. Subsidies targeted at agricultural production as well as subsidies directed at bioethanol/biodiesel favour the production in specific areas. The main reasons for subsidising biofuels are consideration for greater national energy self-sufficiency and consideration for environmental advantages in the form of lower CO₂ emissions. The latter consideration is, however, more open to question as biofuels in most cases have only limited positive effects, if the entire production phase is taken into account.

It is difficult to predict how much land will be needed in the coming decades. At present, approximately 1.5 billion hectares of land are subject to crop rotation (crop area) at global level. Estimates indicate, however, that it is possible to cultivate another 0.4 billion hectares of land without reducing forest areas. At the same time, there will also be sufficient space for increasing grassland areas for the purpose of livestock production. There are relatively large uncultivated areas in countries such as Argentina, Brazil, Ukraine, South Africa, Nigeria and Kazakhstan.

Attention should be drawn to the fact that even if the EU agricultural area that is used for the production of bioethanol (maize and wheat) and biodiesel (rape, sunflower) were to increase from 3 million hectares in 2006 to 17.5 million hectares in 2020 according to an EU Commission scenario, it will only to a limited extent lead to an expansion of the EU agricultural area. By contrast, a more likely scenario is that the internal production of animal feed and foods in the EU will be reduced. Expectations are that the abolition of the compulsory set-aside scheme will provide a few million extra hectares, but that environmental restrictions will have a dampening effect on both land expansion and productivity increase in the EU agricultural sector as such. The consequence of increasing the use of land to produce biomass for energy in the EU may be that part of the production of animal feed and foods moves outside the EU.
International price trend of biomass

Prices of agricultural products rose substantially in 2006-2007 as a result of a number of coinciding factors, such as lower grain harvest, increasing food demand from among others China and India, and to a certain extent a rising application of crops for the production of biofuel. Grain stocks are the lowest in many years, which in itself has raised the risk of price increases.

Prices of most agricultural products are generally expected to remain at a higher level in the years ahead. There are, however, several factors that may lead to changes in either direction, and for example the production of biofuel may have a certain effect. Demand for especially animal foods, and thus for animal feed areas, may cause food prices to rise further. High oil prices will make biofuel production and other types of energy relatively more attractive and cause crop prices to rise. However, only to a certain extent as increasing prices of the crops that are used for bioethanol and biodiesel will also reduce the profitability of the production of these biofuels. Similarly, the maintenance of or further tightening of requirements for the admixture of biofuels to the transport sector’s fuels will keep prices at an “artificially” high level.

By contrast, trade liberalisation and reductions in national subsidies, particularly in the area of bioethanol, will result in more efficient production, leading to falling prices. Today’s tariff protection of bioethanol contributes to protecting the less efficient production of bioethanol in the USA and the EU.

Another factor that may contribute to dampening price increases is productivity developments in both primary agricultural production and in biomass energy conversion. A shift in technology regarding the production of bioethanol from first generation to second generation will, other things being equal, reduce the pressure on land and, consequently, also indirectly reduce the prices of crops.

From an economic point of view, biofuels in the EU and in the USA remain an expensive alternative to fossil fuels. Without state aid and tariff protection, the production of bioethanol and biodiesel would hardly be able to compete with the production from Brazil and other third-world countries. Nor does the biofuel production of the USA and the EU based on first-generation technology seem to have any major positive impact on the environment. If the wish was to reduce CO₂ emissions, it could be achieved far more inexpensively either by importing sugar cane - produced ethanol or by increasing the production of renewable energy through the use of residual products at CHP plants, which is traditional practice in Denmark. It means that it would be possible to reduce the role of, for example, coal in energy production.

Price trends of agricultural products are sensitive as a result of the above-mentioned conditions, and political regulation – especially regarding biofuel production – has a considerable impact on the future prices of animal feed, foods and biofuels.
Biomass in Denmark

International price conditions in the agricultural area impact on the Danish production of agricultural products. Rising prices of animal feed impact on the animal sector, which will have to manage by means of further improvement of efficiency and by consumers having to pay higher food prices.

Within the EU, where agricultural products move freely and where, furthermore, the Common Agricultural Policy applies with various types of subsidies and environmental restrictions, the Danish pig-meat production is expected to be relatively robust and Danish milk production is also expected to be maintained to the extent allowed for by the milk quota.

A Danish production of biofuels based on first-generation exploitation of starch and sugar products will hardly be competitive, not even if the EU maintains high tariff barriers against imports of bioethanol. Therefore, there are no expectations of a considerably changed crop composition in Danish agriculture as the bulk of the crops will continue to be used in the animal sector.

The Danish agricultural sector’s contribution to bioenergy production is already relatively high as 12 per cent of Danish energy consumption is covered by the use of residual products such as straw, wood chips and slurry. This is, in particular, a result of the application of these residual products in the CHP sector.

In Denmark, however, the potential for producing bioenergy from biomass is greater, and also without any particularly negative impact on the production of animal feed and foods. Estimates show that it is possible to raise Danish agricultural production of biomass for bioenergy 4-5 times through greater exploitation of straw at CHP plants, slurry for biogas, animal fat for biodiesel and by using perennial energy crops as well as grass from low-lying areas. It will, however, be necessary to include part of the former set-aside land in the production of perennial energy crops. It is a matter of a technical potential, which may not necessarily be realised with the economic framework that applies today. The previous Danish settlement price for electricity from biogas plants constitutes a barrier, but has now been improved. Nor is it certain that the farmers will consider the profit from utilising low-lying areas sufficiently large to harvest this biomass.

Environmental impacts

Biomass utilisation has a high impact on the condition of land, water and the atmosphere.

With regard to the traditional production of agricultural crops in, for example, the EU, environmental impacts are well known and generally well regulated.
The question of using biomass for bioenergy production is an issue that is complex and not so thoroughly examined. In order to calculate the best resource application, it is necessary to consider the entire production chain from raw materials to end products. Energy efficiency and total environmental impacts may differ considerably depending on how biomass is produced and used. Furthermore, energy balance and the individual environmental impacts do not necessarily go together but may run counter to each other.

With respect to greenhouse gas emissions, analyses show that the application of bioenergy has a positive effect compared with the use of fossil fuels. There are, however, crucial differences as the net effect from using first-generation technology based on maize, wheat and vegetable oils is modest compared with ethanol produced on the basis of sugar cane or ligno-cellulose (second-generation technology). On condition, however, that the use of sugar cane for ethanol production does not lead to rainforest deforestation.

The production of bioenergy on the basis of residual products such as straw, slurry, animal fat, grass and perennial crops provides a better energy balance and environmental effect when used in direct combustion, biogas or thermal gasification.

Increasing the production of biomass involves a risk of growing pressure on biodiversity and of increased leaching of nutrients unless there is sufficiently effective environmental regulation of this, for example in the form of demands for extensive land cultivation.

It is indicated in the report that it is possible to raise the Danish production of biomass and even achieve positive environmental effects from it. Better exploitation of straw, slurry, and animal fat as well as increased production of perennial crops and the utilisation of grass from low-lying areas will contribute to the Kyoto Agreement and the national Aquatic Environment Plan.

However, increased removal of straw from farm land and a halt to the spreading of slurry will have a negative impact on the carbon balance of the soil. This may be compensated for by demands for increased application of catch crops.

**North-South relations – and what steps to take regarding hunger and the rainforest?**

Increasing global demand for biomass provides the basis for growth and expansion in the agricultural sector. A number of third-world countries have a very strong position because of high competitiveness and access to new land. Some tropical countries have very good conditions for increasing their production, especially when it is a matter of producing raw materials for bioethanol and biodiesel. By contrast, expectations are that the USA and the EU have limited prospects of bringing new land under cultivation. They will therefore depend on the productivity increases that can be obtained within the existing environmental framework.
Consequently, there are indications that increasing production of biomass will make it possible for the South bloc\(^1\) to increase its share of global biomass production. It is also in the South bloc that the population growth and the prosperity increases will, at the same time, generate the largest increase in food demand.

A crucial factor in the balance between North and South in the agricultural area is the trade policy in the form of EU and USA import tariffs on bioethanol as well as the general subsidy policy regarding the national production of biomass, where the USA and the EU are among those providing the highest level of subsidy.

With rising prices of farm products and potentially increased trade liberalisation, producers in the third world have prospects of greater market access, both in terms of the national market and the international market. Improved profitability will imply increased supplies of agricultural products and, at the same time, better employment opportunities in both the primary sector and in the processing industry and service sector that will follow, for example in the form of trade, storage and transport. It is, however, a precondition that the necessary infrastructure is available, which is a challenge especially when it is a matter of new territories that are located far from ports of shipment.

Increased growth provides the basis for considerable development of third-world countries and especially rural districts. However, this does not automatically imply that the gains will benefit the entire population as the distribution of gains may be very much distorted. This depends to at large extent on ownership and structures in agriculture and the processing industry. In addition, it will depend on the prioritisation of the (re)distribution policy instruments adopted by the individual country, for example in relation to access to education, health, agricultural advisory services and credit. Also the balance of power in the labour market plays a role when pay and working conditions are to be fixed for wage earners in the agricultural sector and the associated processing industries.

Widespread hunger remains a global problem, especially as a result of extreme poverty among large population groups. To the extent that economic growth is utilised for broadly-based development, biomass may have a very positive effect on the eradication of poverty and, consequently, hunger.

Rising food prices may, however, constitute a risk to the most vulnerable population groups in the third world. Swift and drastic increases in the price of foods can be difficult for the poorest and most marginalised part of the population to catch up with, and will therefore lower their standards.

\(^{1}\) The South bloc is to be understood as primarily third-world countries, whereas the North bloc primarily refers to North America, the EU and Japan.
of living. There is a real risk of increased hunger and social unrest, especially in the countries that depend on imports of both more expensive foods and oil.

To the extent that the South bloc becomes able to produce a larger share of global biomass, the pressure on land will increase and consequently also on today’s nature areas, including the rainforests. Over the past 20-30 years, increased agricultural production has resulted in rainforest deforestation in, for example, Brazil, Indonesia and Malaysia. Even if there are substantial uncultivated areas available for expansion in these countries, constant growth in agricultural production will require considerable political regulation and protection, if the rainforests are to be protected against further reduction. With today’s impacts of climate change and especially the increased emissions of greenhouse gases, it is, merely from a climate point of view, very important to conserve the rainforest.

**Biomass policies**

The production and application of biomass is a particularly regulated area. This is the case both in terms of international political agreements, including trade conditions and in terms of direct and indirect subsidies.

Historically, the regulation has been most closely linked to the agricultural sector, among other things in the form of the EU Common Agricultural Policy. There has been a particularly strong link to the trade policy as a significant part of the agricultural policy of the EU and the USA has been targeted at protecting their agriculture against external competition. Subsequently, the environmental aspect has assumed a stronger position in the regulation of the agricultural sector, for example in the form of protection of the aquatic environment through limitations on agriculture’s discharge of nutrients and application of pesticides.

Over the last 5 years, another energy policy aspect has been added to the regulation of biomass, primarily as a result of political decisions on obligatory admixture of bioethanol and biodiesel to fossil transport fuels. Furthermore, the energy policy, especially with respect to the priority some countries give to national energy self-sufficiency, has also led to considerable subsidies in the USA and the EU, which impacts on agricultural markets.

The historical expansion of the political regulation of biomass reflects the dynamic development of the political objectives that have characterised the regulation. The instruments will continue to change and the need for coherent regulation will increase. The report mentions, among other things, the endeavours to achieve increased liberalisation of trade in bioethanol, at the same time as global sustainability is ensured through coordinated environmental policy efforts. It refers, furthermore, to the Commission proposal for a sustainability certification scheme regarding production and trade in biofuels.
**Blue biomass**
This report on biomass also reveals some areas suitable for further examining.

Blue biomass (biomass from the aquatic environment) is a very interesting area, in which there is a need for further analysis and research. Firstly, because the biomass potential may prove to be very large, for example in the form of algae. Secondly, because the use of blue biomass for foods, animal feed and perhaps bioenergy may take place to a greater extent without any mutual conflict in contrast to green biomass (land-based biomass) where the use of land is critical if it is to cover both the need for foods, animal feed and bioenergy.

Thirdly, there is the interesting perspective to ascertain whether agricultural waste in the form of leached nutrients may be put to advantage through a controlled production of blue biomass for the purpose of bioenergy use.

With regard to green biomass from the agricultural sector, the report points at the need for optimising plant breeding both in relation to contents of starch and cellulose and with a view to achieving less environmental impact.

With respect to conversion technologies, direct combustion, biogas and thermal gasification are interesting technology paths providing significant perspectives, among other things because they are based on raw materials that include agricultural residual products.