Biomassa-upstream stuurgroep

Memo: **Report on BUS ticket D19**
By: M.J.G. Meeusen (Landbouw-Economisch Instituut)
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THE ECONOMICS OF BIOMASS FOR BIOFUEL

1. Introduction and objective

There is a worldwide orientation on the possibilities to produce fuels on the base of biomass. It helps to reduce the CO2-emission, as a renewable source it reduces the depletion of sources and the dependence of political instable systems is less. Many reasons to seriously consider the development of new production chains.

One of the issues to consider is the economics. “At what price is the biomass available?” is one of the key questions. And: “which factors determine the availability of the biomass?”. The last question can be translated into another question, namely: “What affects the use of biomass for bio-energy applications?” This paper aims to give a handle to assess cost prices of biomass. Furthermore it gives a quick scan overview of calculated cost prices of the bio fuel, which results in some conclusions. Conclusions about the costs of bio fuels and biomass and conclusions about underlying factors, determining the cost price. These factors affect the use of biomass for bio-energy applications.

The paper distinguish two types of biomass. First the agricultural crops will be discussed. These crops are used primary for bio fuels: wheat, sugar beets, rape seed, other vegetable oil crops; the biomass used for the first generation technology. Secondly by products will be considered. This group is more interesting, in terms of economics and sustainability: the costs of by products differ from those of crops. Secondly , the factors which affect the use of crops differ. Those differences form the reason to distinguish the two feed stocks from each other in this paper.

2.Crop as a feed stock for bio fuels

2.1. Approach

First of all the economics of biomass will be explained. The paper pays attention to the diversity of methods to calculate costs of biomass. It will emphasize the necessity to choose the most suitable method to calculate production costs of biomass – which is highly depending on the circumstances, involved market actors and term.

Then some studies will be discussed. First studies on the (economics of) agricultural new crops will be considered. The OECD-report “Agricultural market impacts of future growth in the production of biofuels” (2006) aimed to look at the economics of biofuel production; this study is relevant for the questions to be answered. The study is based on available data on production technologies and costs; many assumptions has been made due to a lack of data. In the report the production costs of agricultural based fuels have been calculated for several countries. Those production costs have been compared (a) across countries and (b) to the oil-based fuel prices. The OECD mentions a “rough” estimation of the functional relationship between fuel prices, production costs and biofuel production. Besides the OECD-report which considers the OECD-countries, the research with the help of the

Policy Analysis System (POLYSYS) will be discusses. This research is focused on the United States, but results of the studies can be used for other countries also.

During the writing of the paper it became clear the impacts of the expected growth in the biofuel-related demand for agricultural products on commodity markets can not be ignored. The biofuel production has several links with other commodity markets, which effects the farmers income and the viability of the system. Also the US Policy Analysis System (POLYSYS) takes the impact on other market into account. The model estimates the potential impact of bioenergy crops production on traditional crop prices and quantities and the – resulting – (potential) impact on net farm incomes. Therefore this paper considers also the effects of the expected growth in the biofuel market on commodity markets which have a relation to the biofuel-commodities.

2.2 Relevant factors

The cost price of agricultural raw materials can be calculated in various ways, but not all of these automatically qualify as a basis for feasibility studies. The circumstances under which the production takes place, the length of time to which the decision refers and the consequences of further production for the rest of the cropping plan determine to a large extent which method is suitable. Several factors can be distinguished which determine which method for calculation costs price is best suitable.

Table 1: Breakdown of factors that determine methodology selection

Producer	Term	Position in relation to one crop	Consequences for cropping plan and/or farming system	Method for calculating costs price
Processor	Long	Not applicable	Not applicable	Full cost price
Farmer	Long	Yes	Yes	Partical cost price
Farmer	Long	Yes	No/few	Partical cost price
Farmer	Long	No	Yes	Full cost price
Farmer	Long	No	No/few	Full cost price
Farmer	Short	Yes	Yes	Partial cost price
Farmer	Short	Yes	No/few	

Source: Meeusen-van Onna, M.J.G, 1998

Table 1 shows that four groups of factors determine the most suitable method for calculating costs prices. First of all, there is the question of whether the agricultural production is to be undertaken place for profit or not, i.e. that the produce is seen as an internal supply by the processor of the raw materials or by the farmer who generates income through producing biomass. A second factor is the period of time the decision refers to. In het context of long term decisions, the changes in the fixed costs should also be taken into consideration, while for the short-term decisions, this element does not have to be taken into account. A third factor is whether the crop is to be positioned in relation to one single crop or not and a fourth factor is whether the growing of new crops is linked to changes in the farming system.

Horring (1948) gives the following definition of cost price: “On the one hand, the cost price is the relationship between the standardized quantities of the means of production multiplied by their monetary value in the next-best application available locally which no longer qualifies and in the period to which the cost price refers, and on the other hand, the non-monetary yield standardized according to quantify and quality corresponding to these quantities of the means of production, these yields being in a certain stage of production."

This definition refers to "standardized" quantities of means of production and products. "Standardization" of this data means that the quantities are averaged out over a number of years. The second element which Horring touches upon in his definition is the valuation of means of production in the next-best applications that no longer qualify. These alternative applications and the corresponding valuations are an important point of interest in particular in relation to labour and land.

Figure 1 gives the components of a full cost price:

- Direct costs
  - Costs of sowing seed/planting materials
  - Costs of fertilizers;
  - Costs of crop protection agents;
  - Other directly attributable costs
  - Interest on circulating assets;
  - Costs of labour carried out by third parties
- Labour costs
- Costs of implements
- Costs of building
- Costs of land use
- General expenses

Figure 1: composition of the full cost price

In some cases it may be reasoned that the crop should be compared with a single other crop that is to be replaced in order to gain insight into the (micro-economic) advantages and disadvantages of that crop. In that case, the partial cost price is the most obvious approach. Then one has to take into account the direct costs and the profit of the crop to be replaced. When the new crop yield more than the direct costs and the profit of the crop to be replaced then one can assume that the new crop will be produced. Sometimes one has to correct for a difference in demand on labour, buildings and implements.

The valuation of labour and capital is a particular point for discussion if the growing is carried out by famers. If the growing is in the hands of the industrial processor, valuation of the resources employed should be made on the basis of the collective labour agreement wage and the market interest rate. If the production is in hands of farmers this is not necessarily the case. Then the value that farmer himself attaches to his labour and capital is relevant. Often, this value is below the level of the going market prices. The following question is raised: "How much lower can the reward for the farmer be?". Of course, in the (extreme) case the farmer does not get anything for his labour and capital, one can assume that there is no long term guarantee of supply. The higher the value for the labour and capital input, the more assurance the farmer has and higher the guarantee of supply.

2.3 Production costs of bio-ethanol

Cost prices differ from region to region and from feed stock to feed stock
Table 2 gives the production costs of bio-ethanol based on agricultural feedstocks.

Table 2: Production costs of bio-ethanol based on wheat, maize, sugar cane and sugar beet, in USD per litre fuel

	Wheat	Maize	Sugar cane	Sugar beet
USA	0.545	0.289		
Canada	0.563	0.335		
EU-15	0.573	0.448		0.560
Poland	0.530	0.337		0.546
Brazil			0.219	

Source, OECD, 2006

The following conclusions can be drawn:

- Production costs of bio-ethanol vary widely:
    - They vary across regions. One can conclude that mainly for bio-ethanol based on maize the production costs vary between 0.289 USD per litre fuel in the USA up till nearly 155 % more in the EU-15.
    - They vary according to the feedstock that has been used. Using sugarcane in Brazil leads to production costs of 0.219 USD per litre fuel, while the used of wheat in the EU-15 leads to production costs of 260% more: 0.573 USD per litre fuel.
- The production costs in the EU are the highest. In the USA bio-ethanol can be produced at a lower price. Also Brazil is able to produce bio-ethanol at relative low costs.
- The differences in production costs are not related to different cost prices of technology; they are based on the differences in costs of
    - feedstock,
    - energy used and
    - prices that are received for the co products from the production process.
- The production costs of ethanol from maize can be produced at lower costs in USA, Canada and Poland.

High impact of costs of feed stock

Another study underlies some of these conclusions. His (2004) has compared some cost prices of bio-ethanol in the same regions as the OECD did.

Table 3: Cost price of bio-ethanol from several regions around the world compared to the price of petroleum motor fuel, in euro per litre and euro per GJ

	Bio-ethanol Europe	Bio-ethanol Brazil	Bio-ethanol USA	Petroleum motor fuel (25 USD/bbl)	Petroleum motor fuel (50USD/bbl)
Price per litre	0.4-0.6	0.23	0.3	0.2	0.4
Price per GJ	19-29	11	14	6	12

Source: His, 2004

Table 3 gives also the costs of production of bio-ethanol in several countries. Again the difference between countries and between feed stock is clear. However, the final cost prices differ from table 1. For bio-ethanol based on USA-corn the cost price is lower, while for bio-ethanol based on EU-feed stocks (wheat as well as sugar beets) the cost price is higher. As the calculated method is not quite clear, it is difficult to explain the causes of the differences. However, both studies give a clear insight that in the USA-case and the case of the EU the feed stock cost are responsible for more than 50 percent of the total costs. In Brazil this share is less: only one-third.

Table 4: Production cost of bio-ethanol based on several feed stocks from several regions in the world, in euro per litre

	Bio-ethanol based on US corn	Bio-ethanol based on EU sugar beet	Bio-ethanol based on EU wheat	Bio-ethanol based on Brazil sugar cane
Feedstock cost	0.20	0.23	0.25	0.06
Operating cost	0.11	0.23	0.20	0.08
Co-product credit	-0.10	0.00	-0.11	0.00
Capital repayment	0.04	0.00	0.09	0.04
Factory gate cost	0.26	0.45	0.42	0.18
Cost per gas-oline-eq.litre*	0.38	0.68	0.64	0.27

*adjusted for the lower energy content of bio-ethanol
Source: International Energy Agency (2004)

Table 5 shows again the differences in cost price caused by the feed stock. It shows – like the other studies – the impact of the feed stock and the costs of the biomass.

Table 5: Costs of feed stock for bio-ethanol, in euro per litre

	USD per bushel	Yield (litres/bushel)	Feedstock (USD per litre)	Feedstock (euro per litre)
Bio-ethanol based on US corn (2003)	2.11	10.60	0.20	0.16
Bio-ethanol based on US corn (2002)	2.40	10.60	0.23	0.18
Bio-ethanol based on US sugar cane (2002)	28.77	76.84	0.37	0.30
Bio-ethanol based on India sugar cane (2002)	19.08	74.91	0.25	0.20
Bio-ethanol based on Brazil sugar cane (2002)	6.00	76.84	0.08	0.06

Source: Shapouri, 2003

2.4 Production costs of bio diesel

Cost prices differ from region to region
Table 6 gives the production costs of bio-diesel based on vegetable oils. One can compared those costs with the market prices of the petrol-based bio fuels in order tot assess the viability of bio fuels.

Table 6: Production costs of bio-diesel based on vegetable oil, in USD per litre fuel

USA	0.549
Canada	0.455
EU-15	0.607
Poland	0.725
Brazil	0.568

Source: OECD, 2006

The following conclusions can be drawn:
- The production costs for bio-diesel are the lowest in Canada.
- The production costs for bio-diesel are within or close to the range of production costs for ethanol from wheat and sugarbeets. They are higher than the production costs for ethanol from maize and sugarcane.

His (2004) comes to a lower cost price of bio-diesel: 0.35 to 0.65 euro per litre (10.5 to 20 euro per GJ).

The quick scan literature search learned that only in the Agricultural Simulation Model of the US Agricultural Sector (POLYSYS) the issue of the competing crops is taken into account. This model seeks to estimate the farmgate price needed to make bio-energy crops economically competitive with alternative agriculturual uses for cropland. The model has been used to estimate the economic impacts of increasing the demand for biodiesel fuel and the resulting impacts on the agriculture sector. The model has estimated the potential supply of two new crops that can be used as feedstock for biodiesel: sunflower and canola. The study was focused on the Southeastern states of the US.

Table 7: Impacts on area, crop prices and crop net returns in 2007 in the scenario "USD 2,90 per MBTU"

Crop	Area (baseline) (mill. Acres)	Area (scenario) (mill. acres)	Change in area (%)	Change in crop prices (%)
Corn	84.50	83. 20	-1.5	2.3
Sorghum	11.20	11.20	0.0	2.1
Oats	4.70	4.70	0.0	1.1
Barley	7.10	7.10	0.0	1.4
Wheat	76.00	76.10	0.1	0.4
Soybeans	69.50	70.70	1.7	1.0
Cotton	14.00	13.90	-0.7	0.0
Rice	3.20	3.20	0.0	0.0
Sunflower	0.00	0.00		11.9

Canola	0.00	0.10		8.2

Source: De La Torre Ugarte, 2000

Table 7 shows the crop area and price impacts for the "most aggressive" demand scenario in which 1% of the diesel have to be replaced by biodiesel. It's clear that the additional demand requires oilcrops: the area of soybeans is increasing and the area of corn decreases. The demand results in higher prices of vegetable oils. Higher prices for oil and soybeans can be expected. However, due to the fact that the feed market is not increasing which the supply of soy bean meals is growing, the price of soy bean meals declines. This results in only a small increase of the price of soybeans.

2.5 Competitiveness of bio fuel

Competitiveness at 60 USD per barrel

Enclosure 1 gives the marketprices of oil in 2004; when corrected for the differences in energy content one can compare the competitiveness of the biofuels in 2004. However, more interesting is the threshold oilprice at which the biofuels are competitive. Table 3 and table 4 give the threshold oil prices for the bio-ethanol and biodiesel at which they are competitive to the petroleum based fuels.

The following conclusions can be drawn:

- Brazil is the only producer able to produce at lower costs than the marketprice of petrol-based gasoline in 2004 (USD 39 per barrel).
- However – when expressed in USD per litre of gasoline equivalent (taken into account the differences in the energy content) – the production costs of bio-ethanol based on maize is higher than the price of gasoline (without taxes) in 2004 (USD 39 per barrel). It would be competitive at a price of USD 44 per barrel.
- For bio-ethanol based on wheat or sugar beets from EU, Canada and USA the threshold price is higher: up to 60 USD per litre of gasoline equivalent. For the Canadian bio-ethanol from wheat the threshold price is even 140 USD per litre.
- Bio diesel production costs are almost 1,5 to 2 times the oil-based diesel price net of tax in 2004 (USD 39 per barrel). Bio diesel is competitive at a higher threshold price than bio ethanol. The Canadian bio diesel is competitive at a oil price of 60 USD per litre, but the other bio diesels from EU, USA and Brazil are less competitive. The oil price has to rise to the level of 80-90 USD per litre to be competitive.

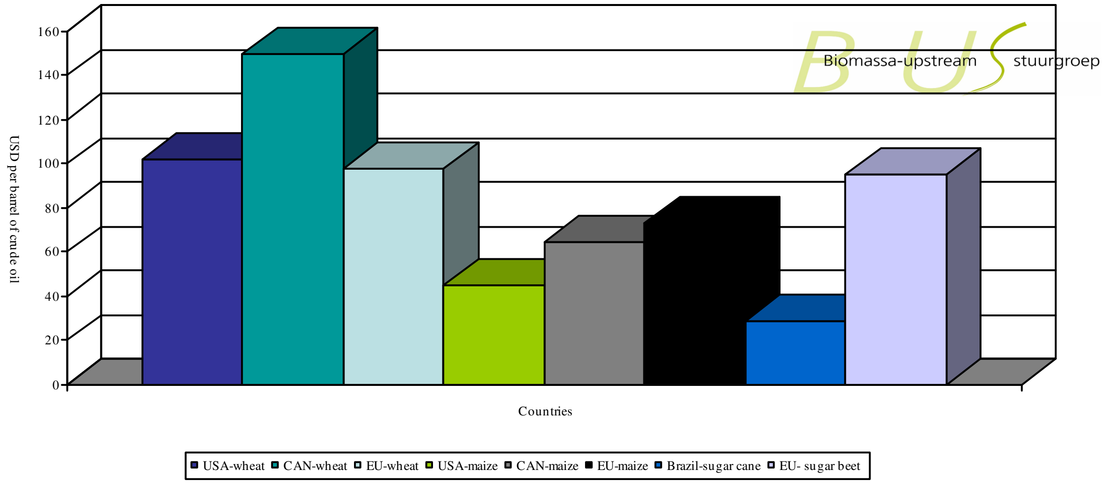

Figure 3: Threshold oil price at which bio-ethanol is competitive, in USD per barrel
Source: OECD, 2006

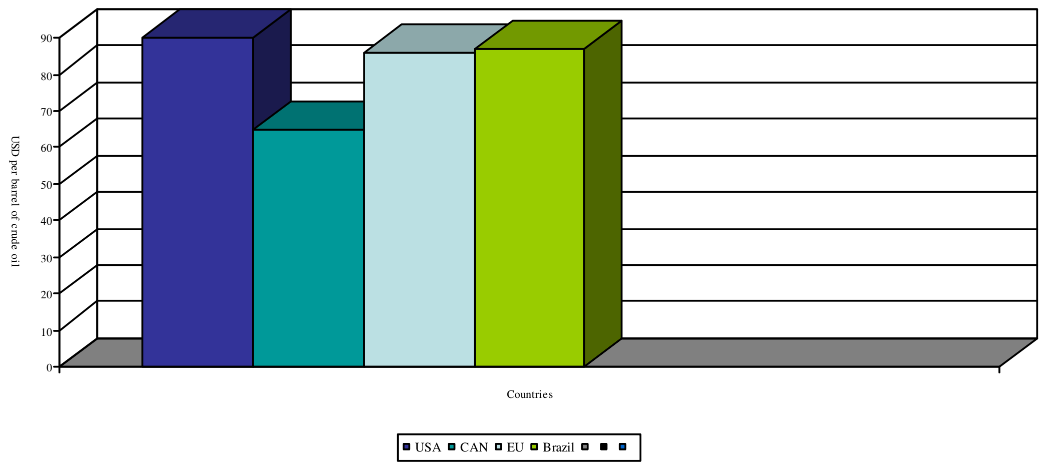

Figure 4: Threshold oilprice at which bio-diesel is competitive, in USD per barrel
Source: OECD, 2006

2.6 Impacts of an expected growth in the biofuel-related demand for agricultural products on commodity markets, which has an effect on the farmers income.

In the OECD-report attention has been paid to the impacts of an expected growth in the biofuel-related demand for agricultural products on commodity markets, which has an effect on the farmers income. Also the POLYSYS – with the focus on the United States pays attention to this issue.

The OECD-study has assessed the impacts on commodity markets by using the OECD partial equilibrium model for temperate zone agricultural commodities. It assumes that prices are developing to a (new) point at which supply and demand are at a (new) equilibrium.

First of all the needed area in the different countries has been assessed. "What area is needed in order to produce 10% biofuels of the total transport fuel consumption?" has been the question. Figure 5 gives an idea of the needed area.

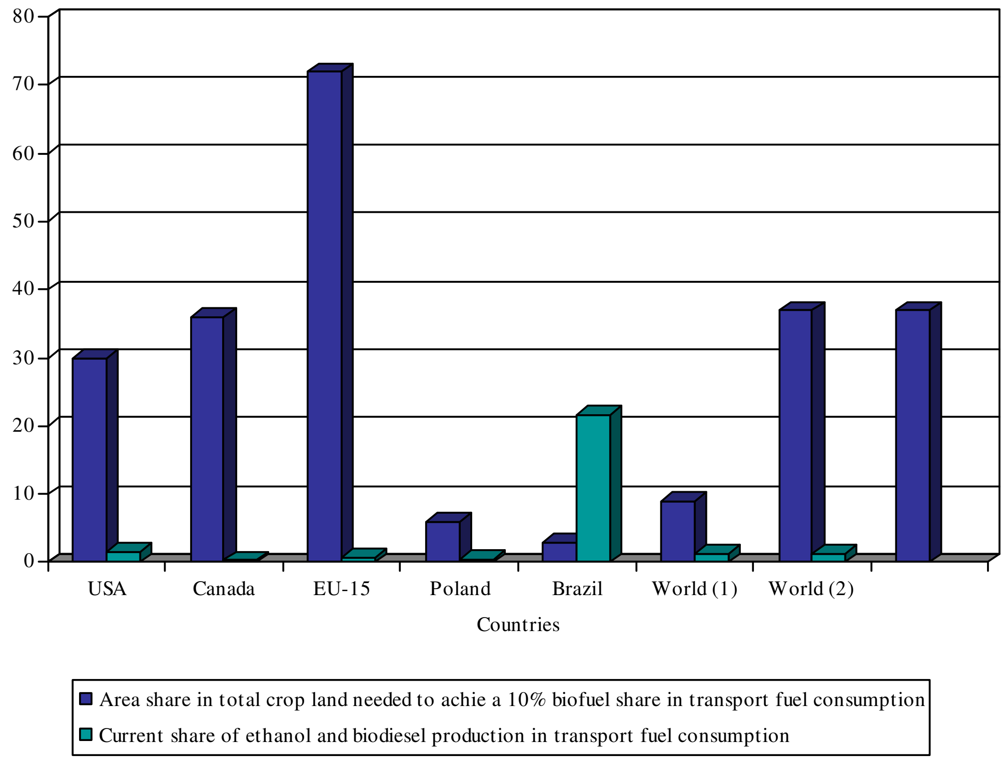

Figure 5: Biofuel shares in transport fuel consumption and land requirements for 10% biofuel shares in major biofuel producing regions
Source: OECD, 2006

One can see that the area requirement is substantial with the current technologies. In the USA and Canada about one third of all land currently harvested for cereals, oilseeds and sugar crops would be needed to produce biofuels equivalent to 10% of their transport fuel consumption. The EU-15 needs more, namely more two-third of the area (72%) currently used for these crops. It's clear that such a development does affect the markets of

- commodities and therefore
- the farmers income and
- the world supply of agricultural products

One has to take into account that these calculations are based on current crop yields and bio fuel production technologies. The necessity to develop technologies which are able to use less prices feedstocks of feedstock mixes is clear, the second generation technologies.
The impacts of the expected growth in the biofuel-related demand for agricultural products on commodity markets have been calculated in the OECD-report. The OECD has formulated three scenario's[1].

[1] Namely (1) Constant biofuels scenario, (2) Policy target scenario and (3) High oil prices scenario

the use of wheat and coarse grains and sugarbeets for ethanol production increases,
the use of vegetable oils for biodiesel production increases
↓
increasing imports and decreasing exports
↓
world prices of oilseedmeals, sugarbeets and vegetable oils will rapidly increase
world prices of grain will increase less
↓
moderate impacts on meat and dairy markets (except butter due to the rise of vegetable oil prices)
↓
lower growth in ethanol and biodiesel production

Figure 6: Relations between (prices on) the agricultural markets

The *high oil price scenario* assumes higher oil prices, namely USD 60 per barrel. This affects world markets for agricultural products in two ways:

- Higher energy prices will result in higher production costs of agricultural products;
- Higher energy prices will result in more production of biofuels.

The share of energy costs in total production costs is 25 to 43%. When energy prices rise the world prices of agricultural products will be higher. The OECD assumes a rise of world prices from 10% (wheat) to 17% (oilseeds). Furthermore, the world prices of agricultural products will rise due to the fact that the production of biofuels will be more attractive. Mainly for sugar, vegetable oils and oilseed meals this will result in substantial higher world prices. For the other agricultural markets the effects are less, they are relatively small.

The same conclusions have been drawn by Walsh et al. (…) by using the POLYSYS-model, in which the potential impacts of bioenergy production on agricultural markets are being assessed. This has been done mainly for crops which can be used for electricity: switchgrass, willow and poplar. Walsh et al. (??) conclude that a shift of cropland from traditional crops to bioenergy crops results in higher prices for traditional crops. The impact on prices depends on (a) the area shifted to the new bioenergy crops and (b) the elasticitiy of supply and demand for each crop. Walsh et al. calculated fairly large effects: up to 10% in certain scenario's.

The Policy Analysis System (POLYSYS) is able to estimate supply of biomass at different price levels. The model is designed to estimate the area of new crops that will be produced. The land allocation among competing crops in several regions (305 in the US) is based on the maximization of the expected returns. POLYSYS is able to take into account new established prices – due to the new equilibrium in supply and demand. POLYSYS has been used to calculate the area of three new bioenergy crops: switchgrass, poplar and willow.

Table 8: Impacts on area, crop prices and crop net returns in 2007 in the scenario "USD 2,90 per MBTU"

Crop	Area (baseline) (mill. Acres)	Area (scenario) (mill. acres)	Change in area (%)	Change in crop prices (%)	Change in crop net returns (%)
Corn	84.50	83.80	-0.9	1.9	2.4
Sorghum	11.20	10.80	-3.8	7.9	15.2
Oats	4.70	3.85	-18.1	20.5	372.2
Barley	7.10	6.66	-6.2	8.6	10.8

Wheat	76.00	72.10	-5.2	8.5	12.5
Soybeans	69.50	68.20	-1.9	3.6	3.5
Cotton	14.00	13.60	-3.0	1.5	0.0
Rice	3.20	3.15	-1.6	2.4	2.0
Alfalfa	26.60	25.90	-2.7	0.0	
Other hay	32.60	26.70	-17.9	0.0	
Switchgrass	0	14.50			
Poplars	0	0.07			
Willows	0	0.18			

Source: De La Torre Ugarte, 2000

Table 8 shows the effect on crop prices – nearly up to 10%. In response to the large relative acreage loss, the price of products increase

Summarized, the additional demand for agricultural commodities is likely to substantially affect the outlook for their markets. The major producers of biofuels will reduce their exports and increase their imports, resulting in higher world prices.

3. By products as a feed stock for bio fuels

3.1 Approach

A quick scan literature search forms the base for this section. The literature search results in some graphs and tables which show cost prices. Furthermore an analyses of the Dutch situation on by products forms the base for answering the question "which factors affects the use of by products for bio energy applications?". The relevant factors, which affect the use of by products for bio energy will be illustrated by the Dutch case.

3.2 Relevant factors

Why available?

Table 9 gives an overview of the by products in the Netherlands.

*Table 9: By products in the Netherlands, in tonnes per year**

Industry	By product (the typical Dutch word)	Quantity	Comments
Products from the potato-industry	"afgekeurde aardappelen" "aardappelstoomschillen" "snijverlies" "vlokken/snippers"	957.000	Totally
Fats and oils	"oliezadenschroot" "diermeel" "dierlijke vetten" "gebruikte oliën, vetten"	3.725.000 210.000 30.000	Totally schroot, schilfers industrieel huishoudelijk

Zetmeel en meel	"aardappelpersvezel" "aardappeldiksap" "snippers" "sorteerafval" "aardappeleiwit" "tarweconcentraat" "maïsgluten" "tarwegries"	1.760.000	Totaal
Sugar	"bietenstaartjes" "natte bietenperspulp" "gedroogde bietenpulp" "bietmelasse"	1.089.000	Totaal
Liquid	"graanspoeling" "bierbostel"	5.000 500.000	

* on wet base

Sources: Vis, 2002; Gave, 2003a; Elbersen et al., 2004).

Table 9 gives the an overview of the raw materials which are available in the Netherlands. The first impression is: "a high amount of biomass!". However, when one looks a little bit closer at the source of the co product the picture is less optimistic for the bio fuel market. One can see that a large amount of the by products is used in the Dutch feed industry. More than 13,5 million tonnes is used as feed. From this amount 8 million tonnes is imported from abroad – as a raw material which can be used in the Dutch feed industry. Only 5 million tonnes is available at the Dutch processing sites. One can ask himself whether the amount of 8 million tonnes will be imported for the bio fuel market. Only when the bio fuel market can offer competitive prices the import will be attractive; otherwise this amount will not be available. This is less the case for the 5 million tonnes, which become available at the Dutch processing sites. When the competitiveness of this industry is – on long term – high this amount will be much more "sure".

Table 10: The raw materials used in the Dutch feed industry, in 1.000 tonnes

Source of the biomass	Processing	Example	2003	2004
The Netherlands	The Netherlands	Potatos, sugarbeets	1.422	1.520
Import to the Netherlands	The Netherlands	Soybeans, corn, mais	4.078	3.894
Import	Import	Pulp, sojaschroot….	7.884	8.128
Total			13.502	13.668

Source: Productschap Diervoeder

The main driving force for the existence of the by products in the Dutch economy is the demand of (cheap) feed in the pig- and chickensector. The Netherlands are famous because of the ability to use all kinds of by products from all over the world for their feed industry. This ability has formed the base of a high competitive pig and chicken sector. However, one can see a declining demand in this industry. Bolhuis (mondelinge mededeling) expects that the demand will decrease with 1 million ton per year. The large amount of by products is often mentioned as a change for the bio fuel market. However, one can see that a large amount is imported from abroad for the feed industry and the question to be answered is: "will the import take place for a less valuable product as bio energy?". To summarize: one has to be aware of the driving factors behind the existence of the by product in order to form a realistic picture about the availability of biomass.

Demand of main products, position of the farmers and processing industry
The key driving force of the availability co products is the market of the main product which has to compensate (for a high share) the production costs. The supply of co products is a direct result of the market of the products which form the core business of producing and processing. Therefore: What happens when the market of the main product will decline? What happens when the industry is not competitive any more and the production will move to more competitive countries or regions in the World? Such developments – which have no direct relation to the (bio)energy market – have severe impacts on the availability of the co products. Less demand on processed sugar means: less melasse. The movement of agricultural processing to a low cost country means: less agricultural co products. Therefore: one has to take into account that there is much more dependency on other markets – which have less relation with energy.

Competing uses
The competing markets for the co products have to be considered. In some cases the co products have high value components which can be used in high value outlets (food, farma, feed); fuel is an outlet which can be characterized as "low value". The owner of the co product will consider the pro's and contra's of several outlets and will choose the one which fits the best with his strategy. When the processor wants to focus on products which give the highest yield and he wants to take the risks, the biofuel market is less attractive. However, in the case the processor wants to focus on his core business – production and product development of his main product – the market of biofuel might become more interesting.

In the Netherlands, a high share of the co products (80-85 %) is used as feed component. This market is highly competitive and more attractive than the energy market.

Costs of transport and logistics
Co products can be available at low prices at the site of production. However, they have to be transported to the place of processing to bio-energy. This requires often high costs.

Importregime
The question where to process the co products to biofuel is also affected by the importregime. The EU required a higher percentage of tax on product which are processed than on the raw materials. For example: cacaobeans can be imported for 0% and for choclat the EU asks 8-18,7%; the same accounts for soybeans, which can be imported for 4,75% and the import of soybean-oil is taxed by 11,5-12,8%.

3.3 Costs of by products

First figure 7 shows the relation between prices of biomass and sources of biomass. The figures tries to emphasize that by products from mills, forestry and agriculture are relative cheap compared to the energy crops. It's clear that with a more spread …. Of the biomass the prices are higher. By products from mills are concentrated: they are … at the mill site;

however by products from farms …. At several places: in (relative) small quantities at (relative) many places. This results in high costs of transport and logistics.

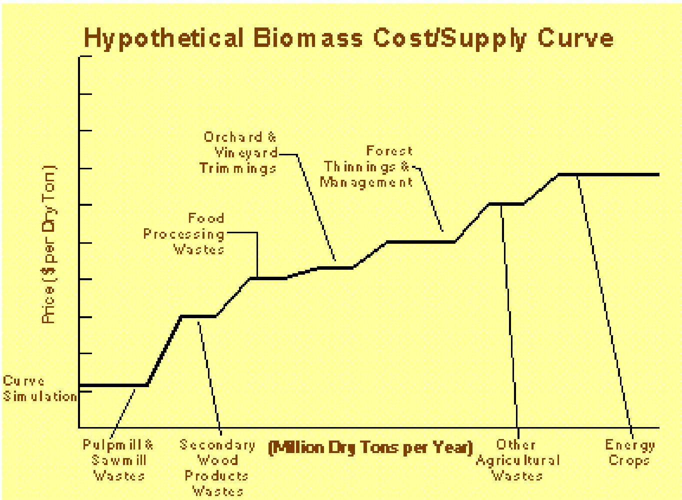

Figure 7: the relative price for by products and energy crops (http://www.woodycrops.org/mechconf/turnbull.html).

Figure 2 also shows that by products are available at relative lower prices.

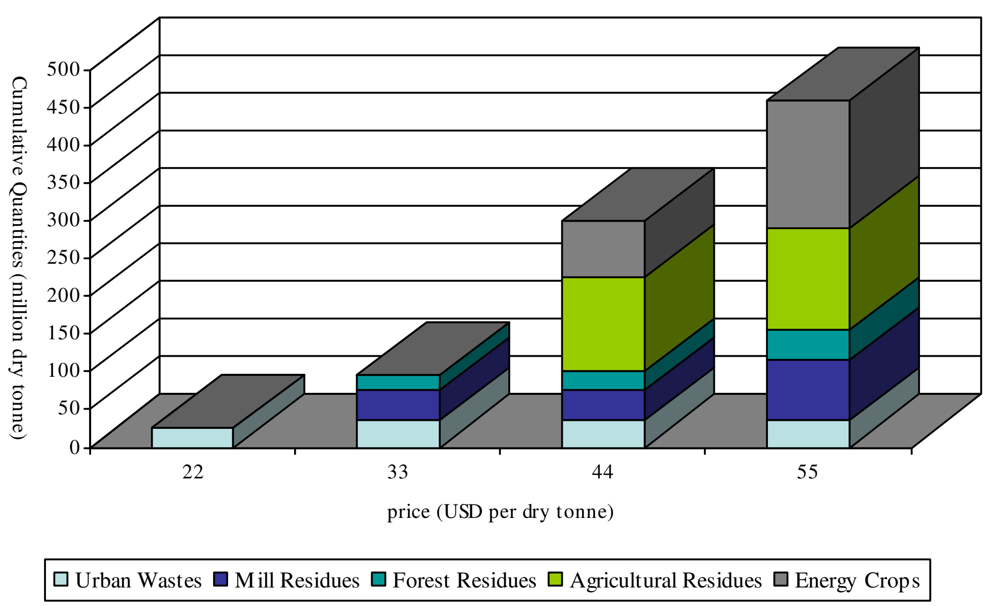

Figure 8: Cumulative quantities of biomass at different prices.
Source: Wright et al., 2000

Table 11 gives the predicted cost price of bio fuels based on second generation processes with the use of "cheap" biomass as a source. One can learn from the previous sections that the costs of feed stock take a high share of the total costs. The challenge – therefore – is: how to reduce those costs? One of the "solutions" is to use less costly feed stock. Therefore it is important to develop the second generation processes, which are able to use all kinds of feed stock. Table 11shows the effect of implementation of the second generation processes with less costly feed stock: the cost price will be nearly 50 percent lower.

Table 11: Predicted cost price of bio fuels based on second generation processes, in euro per litre

	US Cellulosic case 2000	US Cellulosic case 2010
Feedstock cost	0.12-0.13	0.08
Operating cost	0.03	0.01
Co-product credit	-0.02	0.00
Capital repayment	0.11-0.14	0.06
Factory gate cost	0.23-0.29	0.15
Cost per gasoline-equivalent litre*	0.34-0.42	0.22

- adjusted for the lower energy content of bio ethanol

4. Conclusions

Cost prices differ from region to region and from feed stock to feed stock

- Brazil is by far the most cost-effective producer of fuel ethanol – with production costs of about USD 0.22 per litre of ethanol or USD 0.33 litre of gasoline equivalent. USA is following Brazil: USA is able to produce bio-ethanol based on maize for USD 0.289 per litre of ethanol.
- The Canadian biodiesel is (far) the most attractive in terms of cost price.

Production costs of bio diesel are almost 1,5 to 2 times the oil-based diesel price

- Bio diesel production costs are almost 1,5 to 2 times the oil-based diesel price net of tax in 2004 (USD 39 per barrel). Bio diesel is competitive at a higher threshold price than bio ethanol. The Canadian bio diesel is competitive at a oil price of 60 USD per litre, but the other bio diesels from EU, USA and Brazil are less competitive. The oil price has to rise to the level of 80-90 USD per litre to be competitive.

Costs of feedstock have a substantial influence on the cost price

A high percentage of the production costs of biofuels is caused by the costs of the feedstock. More than half of total costst of ethanol production is represented by the value of the feedstock. The same goes up for biodiesel, where three quarters of total production costs is represented by the costs of vegetable oils.

Therefore: bio fuels based on by products have a lower cost price, but …

In general by products are more attractive in terms of economics (cheaper) and in terms of sustainability. However, using by products requires more awareness on risk management. One has to consider the driving forces behind the availability of by products; market developments of the main products have to be considered, the competitiveness of the processing industry have to be taken into account. One has to think about the competitive outlets for the by products and the development in outlets, technology etc. Using by products means: being more influenced by developments outside the bio fuel markets.

Therefore: the development of the second generation technology is important
New technologies – in the longer run – have to be developed in order to use less priced biomass feedstocks.

Influencing factors
Factors that affect the use of biomass for bio-energy applications can be distinguished in three groups: people, planet and profit. The paper has focused on profit, but one can summarized the aspects concerning people and planet.

- Profit:
  - Competing outlets and uses for land and labor
  - Competing outlets for products (by products)
  - Driving forces behind the availability of by products (why are they available?)
  - Technology (second generation is able to use less prices biomass)
  - Logistics and transport (by products!)
- People
  - Income – calculated in a “good” cost price
  - Effects on other agricultural markets and their effects on food security and income
  - Transparency in the agricultural chain
- Planet
  - Use of water, minerals, pesticides, energy
  - Effect on biodiversity, climate, resources

Effect on other markets
The additional demand for agricultural commodities is likely to substantially affect the outlook for other agricultural commodity markets. The major producers of biofuels will reduce their exports and increase their imports, resulting in higher world prices. Also: the production of bio fuels results in more feed. However, is the feed industry demanding this product? And: what does that mean for the cost price of the bio fuels? One has to be aware of the fact that development in market A has influence on the prices of product B, which results in movements on market C and prices of product D. Especially in the case of bio fuels, which requires large amounts of area.

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Annex 1: Market prices of petrol-based gasoline

Table 1.1: Marketprice of petrol-based gasoline, in 2004, in USD per litre fuel

Gasoline	With tax	Without tax	RSC
USA	0,540	0,.384	0.311
Canada	0,680	0.401	0.311
EU-15	1.316	0.406	0.311
Poland	1.200	0.392	0.311
Brazil	0.840	0.394	0.311
Diesel			
USA	0.570	0.373	0.301
Canada	0.680	0.391	0.301
EU-15	1.286	0.396	0.301
Poland	1.090	0.382	0.301
Brazil	0.490	0.384	0.301

Source: OECD, 2006

Conclusion
Cost prices differ from region to region and from feed stock to feed stock

Markets depend on each other - influences
Table 1.1 shows the crop area and price impacts for the "most aggressive" demand scenario in which 1% of the diesel have to be replaced by biodiesel. It's clear that the additional demand requires oilcrops: the area of soybeans is increasing and the area of corn decreases. The demand results in higher prices of vegetable oils. Higher prices for oil and soybeans can be expected. However, due to the fact that the feed market is not increasing which the supply of soy bean meals is growing, the price of soy bean meals declines. This results in only a small increase of the price of soybeans.

The following conclusions can be drawn:

- Brazil is the only producer able to produce at lower costs than the marketprice of petrol-based gasoline in 2004 (USD 39 per barrel).
- However – when expressed in USD per litre of gasoline equivalent (taken into account the differences in the energy content) – the production costs of bio-ethanol based on maize is higher than the price of gasoline (without taxes) in 2004 (USD 39 per barrel). It would be competitive at a price of USD 44 per barrel.
- For bio-ethanol based on wheat or sugar beets from EU, Canada and USA the threshold price is higher: up to 60 USD per litre of gasoline equivalent. For the Canadian bio-ethanol from wheat the threshold price is even 140 USD per litre.