2.2 Rapeseed for biodiesel – strategic issues in sourcing

The OECD predicts increasing biodiesel projections basically due to changes in political regulation for the bio energy sector. The EU is the world's biggest biodiesel producer with a share of 30 % (Figure 2.2.1). Looking at the projections for 2019, the EU will even triple its biodiesel production. Main source for EU biodiesel production is rapeseed. The example of Germany shows, that in many countries – especially in EU member states – the political sustainability regulations are strictly linked to GHG saving potential. Since CO_2 is just one of several gases that have a negative impact on climate all relevant emissions are summarized under the headline of GHG emissions.

Just recently the German government changed the requirements for biofuel production. So far a mandatory blending (quotas) of biofuels was linked to the energy content of the respective fuel, which only needs to ensure 35 % GHG savings compared to fossil fuels. Therefore the overall emissions of the fuel did not matter as long as they fulfilled the 35 % GHG savings. From 2015 onwards a GHG saving quota will be introduced, which forces the petroleum industry to save 3-7 % GHG emissions, irrespective of the used fuel and raw materials.

The competitiveness of raw products for biofuel production to be sold in Germany will consequently not only depend on the production costs but primarily from their GHG emissions caused by the respective production system and the conversion process. Since raw material production is key for the entire GHG balance this article focuses on a comparison of typical farms producing rapeseed as one important source of biofuel production and compares 1) the cost of production and 2) the GHG balance of the production system. The results will lead to GHG mitigation cost, indicating which raw material (rapeseed) will be preferably used by the German petroleum industry to save GHG emissions at least possible cost.

Cost of production

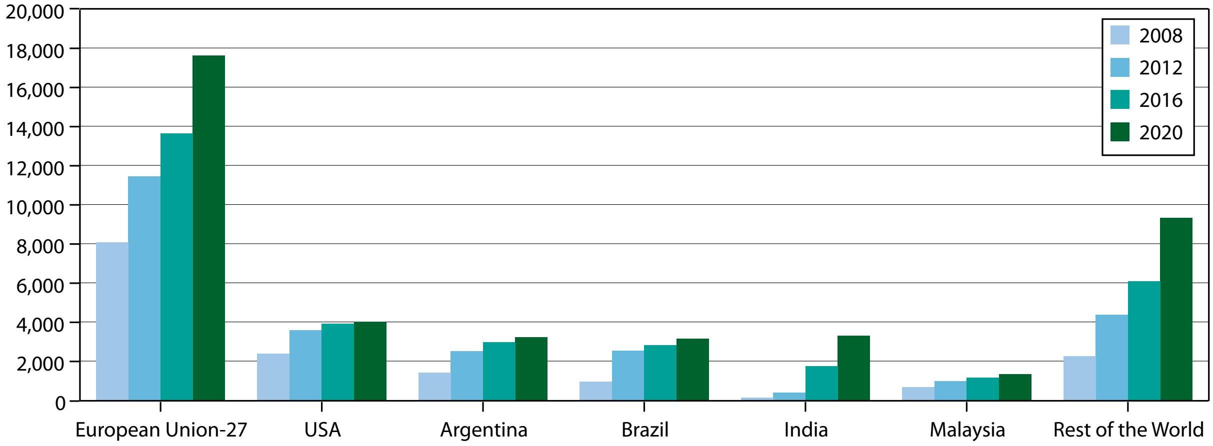
Figure 2.2.2 shows the 2010 cost composition and the total revenues in rapeseed of ***agri benchmark*** farms. To ensure better comparability, land costs have not been considered in this analysis. On a per tonne basis, lowest total costs with less than 300 USD/t were achieved in Canada (CA), the Ukraine (UA) and Romania (RO). Some farms in Kazakhstan (KZ), South Africa (ZA) and Poland (PL) were not able to cover their cash cost and depreciation in 2010. On larger farms in Europe (Germany, Czech Republic, Denmark, France, Hungary) the production costs per tonne have been roughly 100 USD higher compared to the previously mentioned low cost producers. The extremely high costs for the Australian Wheat Belt (AU_WB) farm per tonne are due to a complete crop failure in 2010 with rapeseed yields of 0.1 t/ha. This is less than 10 % of what farmers expect to achieve in this region. Same is true for the Swedish farm (SE) with yields of only 1.8 t/ha and for the Polish farm (PL_PO) with almost 40 % less yields than in 2008.

The average costs of production (2008–2010) can be seen in Figure 2.2.3. It shows that even in the three year average the high cost producer and the low cost producer are clearly differentiated. Farms in the Australian Wheat Belt, on the Danish island Funen and in the region Picardie (France) are producing with highest cost (per tonne). Cost leader are the farms from Canada and the Ukraine. The difference between these two groups can be assumed to be 200 USD/t.

Especially during the last three years (2008–2010) the variations in costs and yields have been tremendous. It can bee seen from Figure 2.2.4 that yield variation of more than 50 % like on the Australian farm can also be observed at Eastern farms in the Ukraine and Kazakhstan. Also farms from Canada (CA) and North-East Europe (PL, SE, RO) are facing high variations in yields. With only few exceptions, the yields from Middle and Eastern European farm vary between 5 and 15 %.

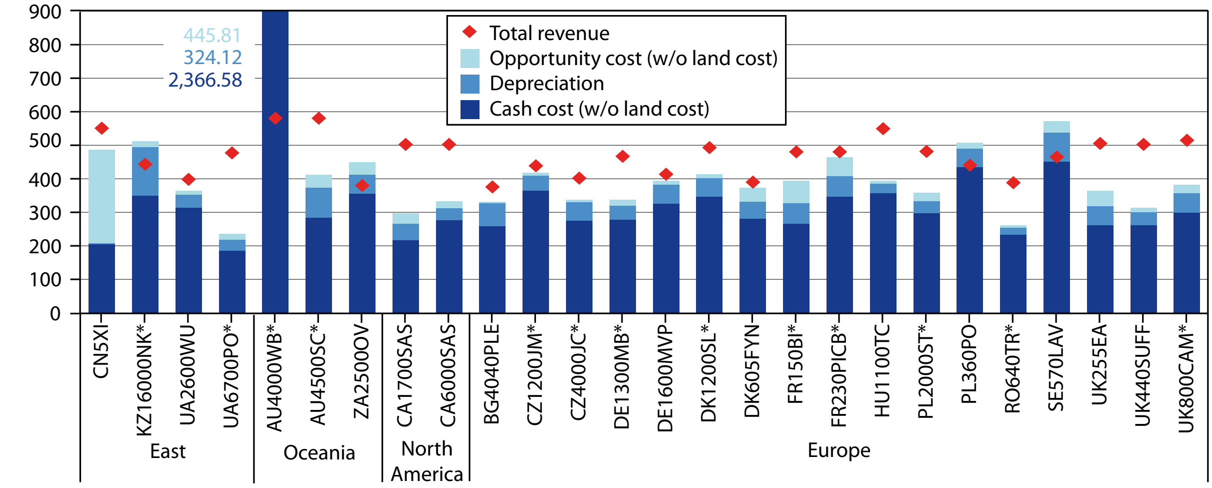
Looking at the variations in cost per hectare, one can see that on the Bulgarian (BG), the Czech (CZ), the Danish (DK) and the French (FR) farms the input costs have a larger effect than yields. Remarkably low are the cost variations on the Australian farms. Even though the relative variation of costs per hectare are the highest for KZ16000 and UA2600, the absolute variation on this farms is only little. On most farms the costs per tonne are mainly influenced by a variation of yields, especially in low input systems.

2.2.1 Biodiesel production projections ('000 t)

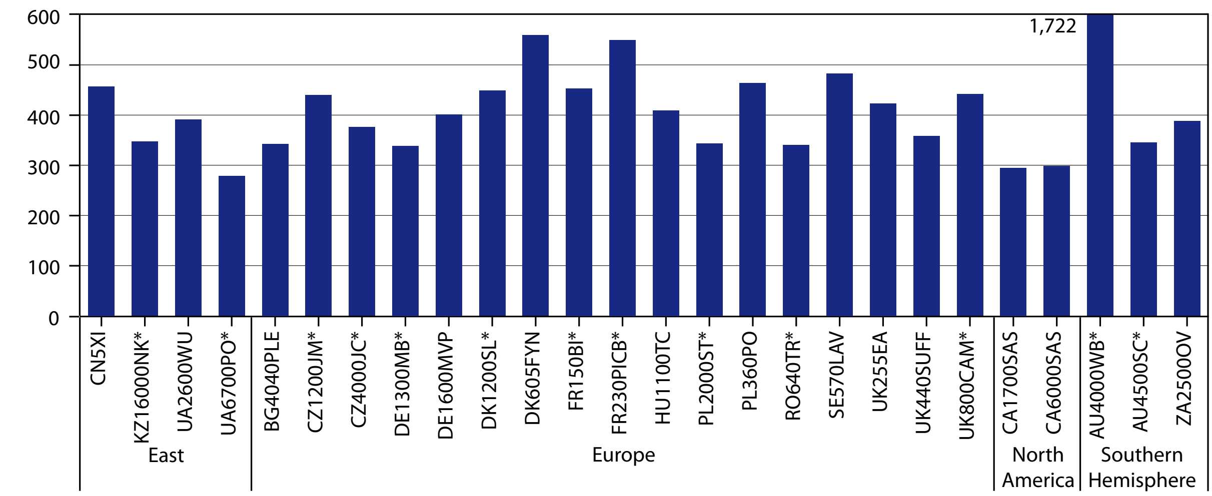


Source: OECD

2.2.2 Total cost rapeseed 2010 (USD/t; w/o land cost)



2.2.3 Average total cost rapeseed 2008-2010 (USD/t; w/o land cost)



GHG emissions from rapeseed production

The GHG emissions caused by rapeseed production depend on the production system applied on the specific typical farm. Main sources are: production and application of N-fertilizer, production and application of other fertilizers (phosphate, potash and lime), diesel consumption and the crop residue left on the field. The major cause for GHG emission in nitrogen production is energy use while the main factor driving GHG emissions of nitrogen application are N_2O emissions. With roughly 80 % N-fertilizer appears to be the main source of GHG emissions on all farms. Second important source with up to 10 % is the consumption of diesel, while the other sources play a minor role. Even though the absolute amount of kg CO_2 per hectare of rapeseed varies a lot between the different farms and production systems, N-fertilizer and thus the N-productivity is crucial for the competitiveness of rapeseed regarding GHG emissions.

Average N-input

The average N-input typical farms applied in rapeseed production varies from 25 kg/ha on the Kazakh farm to 230 kg/ha in Germany and Poland (Figure 2.2.5). With respect to the production system, three "intensification groups" can be defined: 1) low input systems with around 50 kgN/ha in the Southern Hemisphere and Canada, 2) mainly Eastern European farms with 150 kgN/ha and 3) high intensive systems with 200 kgN/ha and more in Western Europe. However, the question whether or not rapeseed can compete with other raw materials relates to the amount of kg CO_2 which is caused by producing one tonne of the respective material. Those systems using less N-fertilizer per tonne are therefore in favor.

N-efficiency

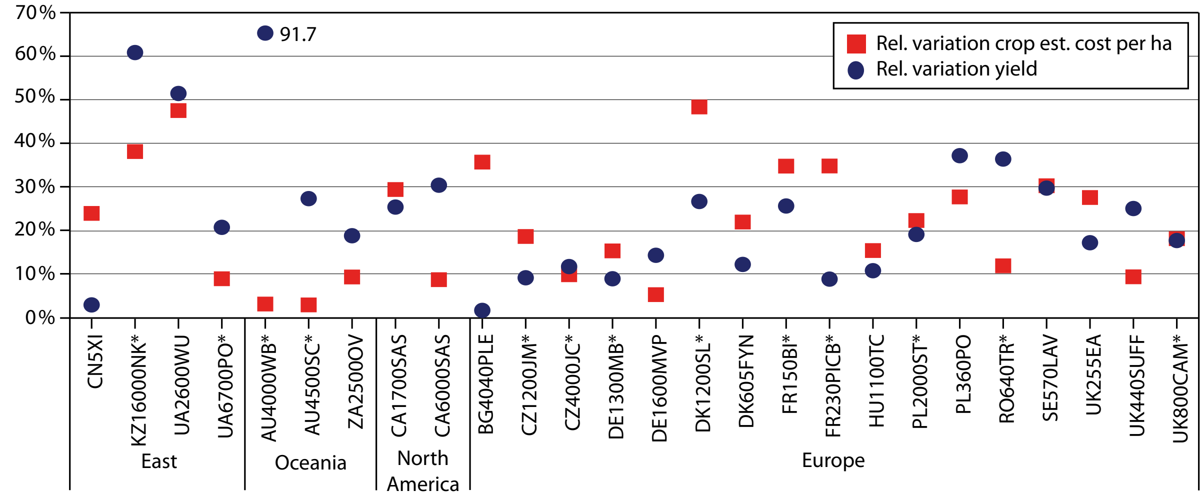
The advantage of low input systems with respect to N-efficiency can be seen in Figure 2.2.6. Even though the Canadian and the Kazakh farm are only yielding between one and two tonnes per hectare they are able to produce their rapeseed with relatively low N-input. Consequently, the N-productivity is with about 40 to 50 kg rapeseed per kg N highest in these countries. This is even more remarkable, when looking at the other farms in the ***agri benchmark*** network. Most farms are constantly producing about 20 kg rapeseed per kg of N-input. In particular on the EU farms are no major differences in N-productivity.

Concept of GHG mitigation cost

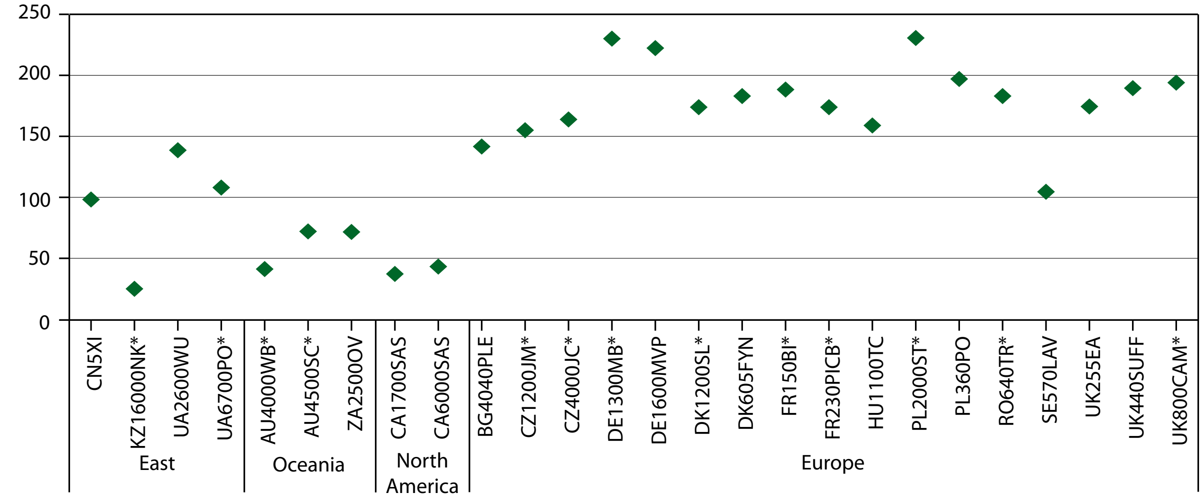
Decisive for the German petroleum industry in the future will be the GHG mitigation cost of optional biodiesel sources. They indicate the cost of avoiding 1 tonne of CO_2 compared to the use of fossil energy. One the one hand one has to consider the potential of the respective rapeseed to safe CO_2 emissions compared to fossil energy and on the other hand the cost disadvantages of rapeseed vs. fossil energy. The CO_2 emissions caused by the different rapeseed production systems vary as described depending basically on their N-efficiency. The results in the subsequent analysis base on standard values from the IPCC 2007 as well as from the EU's Renewable Energy Directive (RED).

In order to calculate the cost difference of fossil energy compared to biodiesel from rapeseed, an average diesel price of 0.62 USD/l has been assumed. The cost for biodiesel from rapeseed has been calculated in two different ways. For rapeseed producer a calculation related to their production cost and emissions would be of relevance, in order to better see how they can compete in the future. Therefore a first calculation on the basis of the different cost of production has been made. The calculation does not include the respective land cost, since the direct payments in the EU would lead to distortions of the results. Instead, the opportunity costs of wheat production were considered as land cost. A second calculation takes into account the relevance of market prices instead of production costs from the perspective of the petroleum industry. Instead of production costs a common market prices (cif Hamburg) of 450 USD/t was assumed. The processing costs of the biodiesel plant were considered in both calculations on standard values of a German biodiesel plant.

2.2.4 Relative variation rapeseed yields and crop establishment cost per hectare, 2008-2010 (% of max)



2.2.5 Average N-input 2008-2010 (kg N/ha)



Comparison of GHG mitigation cost

Looking at the results at market prices (see blue bars in Figure 2.2.7) rapeseed from the Canadian and from the Kazakh farms allows to save GHG emissions for about 100 USD/t compared to most other EU farms. Provided respective marketing channels are in place and ***agri benchmark*** figures proof to be representative for the bulk of produce from these countries, this will lead to a higher willingness to pay of fuel industries for Canadian and Kazakh rapeseed.

Amongst the European farms Danish rapeseed production causes the lowest GHG mitigation cost. Highest mitigation cost at market prices were calculated for the Australian Wheat Belt, the Polish and the Romanian farm and for the UK farm from the Cambridge region. Given the extremely low yields for the Australian farm included in this comparison this figure has to be treated with some greater caution. However, the variations in GHG mitigation cost at common market prices rank between 200 and 400 USD/t.

Calculating the mitigation cost on the basis of the production cost (see red diamonds in Figure 2.2.7), the differences between the farms increase. Some EU farms in Bulgaria (BG_PLE), Czech Republic (CZ_JC), Germany (DE_MVP) and Poland (PL_ST) are able to increase their competitiveness due to their relative low cost of production.

Conclusions

Since N-fertilizer is the main determinant of GHG emissions from arable production, the N-efficiency of production systems will become a crucial parameter for the competitiveness of rapeseed as a feedstock for biodiesel – at least as far it is to be sold in Germany. Even though transport and conversion cost and the respective emissions were not included in the calculation, it is not rather likely that they will have a major impact on the results.

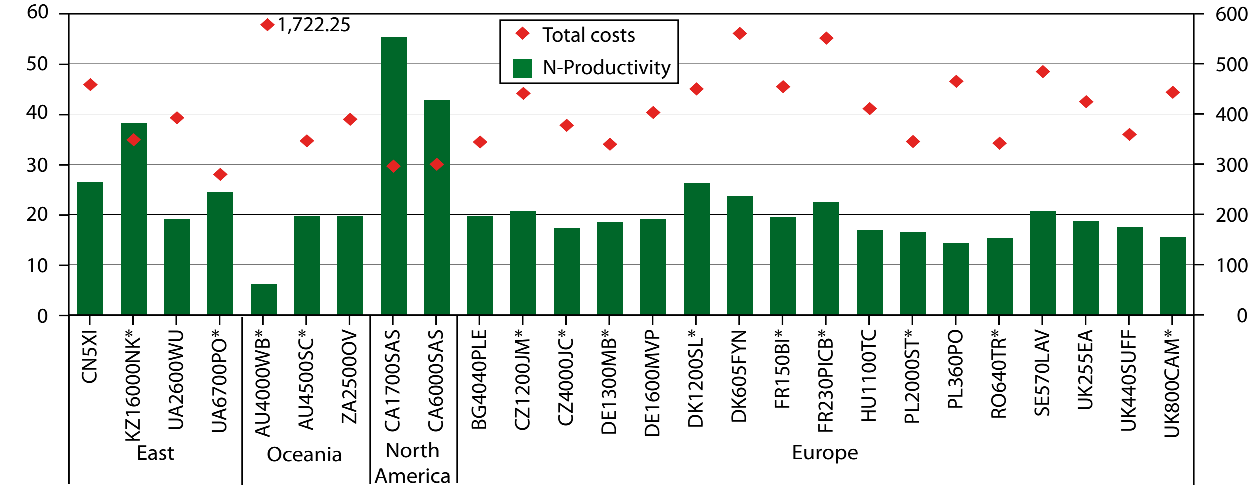
Provided more in depth future research will confirm preliminary findings from this analysis without adjustments in agricultural production RME (rapeseed oil methyl ester) based on EU rapeseed will become less attractive for the petroleum industry. Main reasons are the relative low N-efficiency in combination with relatively high cost of production. Rapeseed from Canada and Kazakhstan will increase its competitiveness as a feedstock for biodiesel. Further analysis of the third extensive producer in Australia is needed – given the distortion of current results due to extreme weather events in recent years. Whether this will lead to increasing rapeseed imports from countries such as Canada or Kazakhstan depends on the creation of dedicated marketing channels.

Ultimately, it has to be mentioned that rapeseed is only one possible raw material to produce biodiesel. Therefore the competition from soybeans and palm oil has to be kept in mind. Previous ***agri benchmark*** analysis (see ***agri benchmark*** Report 2009) indicates that these two products seem to be rather competitive at least as far as nitrogen efficiency is concerned.

The remaining challenge for European rapeseed producers will be the improvement of the GHG balance. Organizations such as the German UFOP are involved in related research.

2.2.6 Competitiveness in rapeseed regarding cost and N-efficiency, average 2008-2010

(left y-axis: kg yield/kg N; right y-axis: USD/t - w/o land)



2.2.7 GHG mitigation cost for different rapeseed origins