Bio-fuel Chains – An Overview on the Structure and the Value Chain Organization

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Structural change in the agricultural sector as well as in the whole agricultural value chain is an ongoing dynamic process and creates a number of diverse phenomena. The *EU Strategy for Biofuels* (2006) and the *Biomass action plan* (2005) set a clear signal that the EU wishes to establish and to support the bio energy-industry. The perceivable aim of the Common Agricultural Policy (CAP) consists in reducing food production and in enlarging the non-food production. Another driver for the attractiveness of bio-energy and bio-fuel production is the recent development of prices of crude oil and natural gas. Furthermore bio-energy is seen as one of the key options to reduce greenhouse gas emissions and substitute fossil fuels.

As a result the total production of biofuels in the EU is increasing rapidly. Drivers have been the adoption of Biofuels Directive (2003/30/EC) by the EU Commission. Additionally the pressure that in 2005 biofuels had to account for at least 2 % of the total used transportation fuels in the EU-member states catalysed the increase. On top, in 2010 a minimum stake of 5.75 % has to be met. Furthermore in Germany the Bundestag resolution of the 26th October 2006 on the introduction of a biofuel quota ensured that the mineral oil companies are obliged - starting at the 01 January 2007 - to secure that 4.4 % of the sales of diesel are made of biodiesel and 1.2 % (from 2008 2 %, from 2009 2.8 % and from 2010 3.6 %) of the sales at motor fuel are made of biofuel.

The EU`s production of liquid biofuels (bioethanol, biodiesel) amounted to a total of 3,2 million tonnes in 2005 (Fachagentur für Nachwachsende Rohstoffe); an increase of more than 30 % compared with the previous year. Bioethanol totalled 0,5 million tonnes and biodiesel 2,7 million tonnes. Probably this growth will continue. As an example, in 2007 German enterprises are planning to enlarge the production capacity for bioethanol production for 430,000 t/a as well as for biodiesel 1,9 million t/a. This development leads to structural changes in the agricultural sector as well as in the whole agricultural value chain. On one hand price increase of commodities and on the other hand in order to guarantee production efficiency (regional supply of raw material) as well as to safeguard the high investments the formation of vertically organized structures along the value chain can be observed.

A short overview on the biofuel production and potentials in the EU with special regard to Germany will be given. Based on this the aim of the paper is to clarify the structure of the biomass-based energy value chain exemplifying the production of bioethanol and biodiesel. Thereby the questions “who is the initiator of the biomass-based energy value chain?”, “who coordinates the process of bringing biomass into final energy products?” and “how to organize it?” will be answered. Furthermore the paper refers to the consequences of the rapid growth of the bio-energy sector and its diverse impacts on all stages along the whole chain. As Boehlje (1999) generally pointed out, the production is changing from an industry which is dominated by family-based,

small-scale, relatively independent firms to one of larger firms that are more tightly aligned across the production and distribution value chain. Hence an additional aim is to elaborate on the impact of verticalisation as a main consequence on the management of agricultural enterprises.

Overview of biofuel production and biofuel potentials in the EU and Germany

The biomass-based energy value chain consists of the planting and collection of primary biomass resources, followed by transport and storage of biomass at manufacturing plants, where the raw material is converted to fuels. In the next step the fuels have to be distributed to producers of electricity or directly to energy end-users. Thus, the involved actors in a biomass-based energy value chain are: (1) agricultural or forestry enterprises, (2) plant construction or technology firms, (3) producers of biofuels, (4) vehicle construction firms, (5) biofuellogistics, (6) transport companies and (7) consumers. In general, in Europe the feedstock for producing bioethanol is grain (wheat, rye and triticale) and sugar beets and for biodiesel rape seeds and sunflower seeds.

Biofuel production capacity and potentials in the EU and Germany

The EU`s production of biofuels amounted to 2,4 million tonnes in 2004 (EurObserver, 2005), approximately 0.8 % of EU petrol and diesel consumption. Whereas biodiesel accounted for 1,9 million tonnes Bioethanol totalled 0,5 million tonnes. This trend is amplified in 2005 with in increase of more than 30 % compared with 2004 (see figure 1).

		2002	2003	2004	2005
Biodiesel	EU 25	1,134,000	1,504,000	1,933,400	2,740,000
	Germany	450,000	715,000	1,035,000	n.s.
Bioethanol	EU 25	388,200	424,750	491,040	500,000
	Germany	n.s.	0	20,000	n.s.
Total	EU 25	1,522,200	1,928,750	2,424,440	3,240,000
	Germany	450,000	715,000	1,055,000	n.s.

Figure 1. Biofuel production in EU 25 and Germany in tonnes
Source: EurObserver 2005, European Biodiesel Board (EBB), Fachagentur für Nachwachsende Rohstoffe

On closer examination the German biofuel production shows a rapidly increase of production capacity since 2003 (see figure 1) especially for biodiesel. For 2007 the producers of biofuels are planning to enlarge the production capacity of biodiesel for additional 1.9 million tonnes and of bioethanol for 430,000 tonnes. Particularly in 2007 an expansion of existing as well as new entries into the bioethanol production is planned which is reflected in the initial public offering of Crop Energies in September 2006 and Verbio AG in October 2006. On account of this development we will focus on the bioethanol production in this paper rather. Nevertheless, a brief overview on the biodiesel production will be given alike.

To compare both, the production and the sales of biodiesel in Germany within the last few years shows a balanced relationship. Overall the biodiesel supply and the capacities of the plants are sufficient developed so that the biofuel quota for diesel is already fulfilled in Germany in 2007. In the future we expected that the potential for raw materials for the bioethanol production in Germany and in the EU 25 will increase. Reasons for this prognosis are stagnating food-prices and simultaneously increasing yields are. Additionally, the demand of land area for the increase

of raw material for biofuels can be made available without difficulties. For example, until 2010 more than 2.5 million ha agricultural crop land and until 2020 more than 5 million ha will be released from food production in Germany (Zeddies, 2006). Thus the demanded 5-6 million tonnes of grain could be produced on this disused land.
Moreover the production of bioethanol requires less land than of biodiesel, due to larger biofuel yield per hectare from the crops-potential feedstock for bioethanol (Kavalov, 2004). In respect to this aspect the potentials should be differentiate in biodiesel and bioethanol production.

Bioethanol production capacity and potentials in Germany

The production facility of bioethanol is different from biodiesel; instead of small units at the biodiesel production for bioethanol only large plant production is profitable due to the economies of size. Therefore investment activities in production facilities exclusively depend on investment incentives. Even there we can find some shortcomings. One factor, which could complicate the investments, is the tax break for bioethanol only until 2008. Beyond 2008 until 2012 the decision about a tax over compensation will be annually based on a new report. This aspect as well as the uncertainty about the development of the price of crude oil makes investments in large plants unsure. In addition the deferred WTO-Negotiations with MERCOSUR and the uncertainty about the import protection for bioethanol are problems for investors. The WTO suggestions provide a reduction of the import protection for ethanol by 40 %. In this case the production would be no longer competitive in the EU.

Operating Company	Location	Capacity in 2006 in t	planned in 2007	Capacity in 2007 in t
Crop-Energies (Südzucker Group)	Zeitz	260,000	100,000	360,000
Verbio Vereinigte Bioenergie AG (NBE)	Schwedt	230,000		230,000
Verbio Vereinigte Bioenergie AG (MBE)	Zörbig	100,000		100,000
fuel 21 (Nordzucker Group)	Klein Wanzleben		130,000	130,000
Bernhard Icking KG	Seyda	7,500		7,500
WABIO Bioenergie	Bad Köstritz	8,400		8,400
NAWARO Chemie GmbH	Rostock		100,000	100,000
PROKON Nord Energiesysteme GmbH	Stade		100,000	100,000
KWST	Hannover	30,000		30,000
Total		**635,900**	**430,000**	**1,065,900**

Figure 2. Bioethanol capacities in Germany in 2006 and 2007 in tonnes
Source: own source, Fachagentur für Nachwachsende Rohstoffe

Nevertheless as figure 2 shows, there is an obvious increase of production capacities for bioethanol in 2007 in Germany. For example, on top of the already planned capital expenditures of about € 500 million in bioethanol production the German “Südzucker Group” plans within the next years to triple the production capacity to over one million tonnes in Germany, Austria, Belgium, France and Hungary. Hence, the “Südzucker Group” will be the market leader in the EU with a market share of about 10 %. Taking a closer look on the example demonstrates the size of this plan. In Germany at the production location Zeitz 260,000 t bioethanol are produced from 700,000 t of wheat since 2005. In future on the basis of sugar beets additionally 100,000 t bioethanol will be produced. In Belgium “Südzucker AG” plans a bioethanol production based on wheat and sugar beets with an annual capacity of 300,000 tonnes. Its Austrian affiliate AGRANA started with building a bioethanol production plant in Pischelsdorf (Lower Austria) which shall produce an annual capacity up to 240,000 t bioethanol starting in autumn 2007.

Main raw material is wheat. Additional ones are thick juice from sugar beets and maize. In Hungary AGRANA already produces 50,000 t bioethanol annually. It is planned to increase the capacity to 160,000 t/a.

Organisation of the relations in the value chain

To answer the questions "who is the initiator of the biomass-based energy value chain?", "who coordinates the process of bringing biomass into final energy products?" and "how to organize it?" we will elaborate to a concrete example.
We pointed out that the initiation of the biomass-based energy value chain is a result of the EU Policy (EU Strategy for Biofuels (2006), Biomass action plan (2005)) and the concrete implementation in the resolution of 26 October 2006 in Germany). The key role for the embodiment and realisation of the process of bringing biomass into final energy products usually take the processor of biofuels.

For example the processor "Crop Energies" (Südzucker Group) located in Zeitz (bioethanol manufacturing plants for 260,000 t bioethanol) has long-term contracts with agricultural enterprises in Germany to cover the grain supply. The important reason for using vertical contracts is that processors want to safeguard their high investment costs by ensuring the necessary the feedstock supply.

Actually, "Crop Energies" offers via local co-operatives or wholesalers contracts to farmers in the Zeitz region. Such contacts contain a price premium for protein poor bioethanol-wheat a particular breed for energy production. Therewith, for the first time wheat with protein content less than 12 % receives a price premium (dlz 9/2006). The specific amount is not defined yet but it seems an interesting perspective for farmers. Backgrounds for this decision are different requirements for bioethanol and food production. Whereas for food production usually wheat with high protein content and low starch content is necessary wheat for bioethanol production needs high starch content combined with low protein content to ensure high crop of bioethanol.

In 2007 on the source of sugar beets "Crop Energies" will produce additionally 100,000 tonnes bioethanol in Zeitz. On account of this about 600,000 tonnes of sugar beets are required for the supply for the bioethanol plant every year. The decision about the investment in the new bioethanol production plant has been dependent on the fact, that at least 80 % of the required sugar beets are produced under binding contracts with a term of 5 years. To supply bioethanol beets farmers face the prerequisite that they have to subscribe the delivering right E. The delivering right E is a joint project of about 25,000 sugar beet farmers (SZVG, 2006). Having such a high number of farmers the total amount of the investment is divided upon them in order to share the risk. The amount of subscription of the delivering right E consists of fixed and variable components. The variable rate is coupled with the prices for bioethanol. On the one hand the farmers get additions capital in rising markets and on the other hand in falling markets they will discharged. The fixed rate constitutes the own capital contribution of the farmer. The delivering right is also delivery commitment up to 2011. Another important fact is the possibility of transfer the delivering rights for farmers until 2008. In the first year only 300,000 tonnes are required. In 2006 farmers all over south Germany signed up production contracts. According to the association "Süddeutscher Zuckerrübenanbauer e.V." and the regional associations the chances and risks were divided between farmers and "Südzucker" due to the fluctuating ethanol prices. Therefore the prices of bioethanol beets will vary according to the changing ethanol prices. The price trend for ethanol is increasing on all markets, the world market price is also increasing with 0.26 €/l in 2005. For Europe the actually import protection is € 0.192/l (Bayerische Landesan-

stalt für Landwirtschaft). Due to the great demand for bioethanol beets on the part of the farmers every farmer is allowed to signed up for a maximum of 14,4 % of unabridged contract amount of sugar beets.

Having analysed the processes in the biofuel chain and having taken a closer look on the relations between processors and farmers we identify firm boundaries overlapping interactions between independent firms. In this context the initial question on "how to organize the chain?" has to be enriched by managerial questions on cooperation. Again we will firstly argue in a more general way and afterwards return to the biofuel chain.

In the context of chain management on the one hand, the arising conflicts of the individual interests must be managed, but and on the other hand, the interdependent actions of the actors must be addressed (Gulati et al., 2005). Gulati (1998) emphasised that networks must be analysed not only from the perspective of the involved firms and the dyadic level of interaction but also out of the overall network perspective. Particularly in the context of chain management, Duysters et al. (2004) have shown that collaborations have to be analysed on three different levels, namely firm level, dyadic level, and network level. Supply chain networks are highly complex systems (Brito and Roseira, 2005; Goerzen and Beamish, 2005). Thus, reducing complexity is one of the most important tasks in chain management (Ulaga and Eggert, 2006). Furthermore the increased complexity bear potential for more mistakes and errors (Boehlje, 1999), more structured systems of control are essential to reduce these errors.

Although research on networks focuses on the interrelationships between firms, still single enterprises have to be regarded as the initial elements. Thus particular importance has to be paid on the firm level. Even though it may sound self-evident we consider the willingness of the firms and the involved people to cooperate as the necessary prerequisite. Because cooperation demands that enterprises adjust their own actions with the ones of their partners, on the firm level general cooperativeness means that the enterprises have to be willing to abstain from some of their managerial freedom. Thus firms have to recognise collaborations as a means to overcome limitations of their resources. If a firm is participating in a network, it will have additional tasks and added work. Thus collaboration consumes resources of the firms e.g. time restraints of the managers and employees have to be reallocated. Therefore managing collaboration on the firm level demands particular managerial skills as well as resources (Duysters and Heimeriks, 2002; Dyer and Singh, 1998; Kale et al., 2002; Zaheer and Bell, 2005).

Returning to biofuel collaborations the farmers, as well as the managers of farm enterprises and the producers of biofuel must be aware of the required resources and managerial skills. On one hand the determination of the production by long-term contracts can lead to a restriction of the liberties of the farmers. On the other hand the integration in supply chains is becoming increasingly important and it will be essential for farmers to identify strategies for becoming compatible with such systems.

The above mentioned example of Crop Energies exemplifies the opportunity for farm enterprises to specialize in new markets. Even though the income risk is shared on both partners - due to the rather short-term nature of the contracts - investments into technology and training on side of the farmers has to be regarded as risky. Because of this farmers might have only a limited cooperativeness. On the other hand the subscription of the delivering rights safeguards the access to new production potentials. In the case of bioethanol production the initiator is the processor, while only large plant production is profitable. Farmers have the opportunity to decide to invest in this new market with moderate risk. On the one hand production process knowledge

about e.g. new breeds and cultivation and on the other hand knowledge about cooperation problems and developments of new markets are essential requirements.

Conclusions and future outlook

The described changes in the biomass-based energy sector and the arising structures of vertical organized value chains raise a number of challenging issues for all stages of the whole chain. The main drivers for increasing future prospects for bio-energy in Europe are the Biofuels Directive (2003/30/EC) and the EU Strategy for Biofuels (2006). In total the EU`s production of liquid biofuels amounted to a total of 3,2 million tonnes in 2005 which is an increase of more than 30 % compared with the previous year. Because solely in 2007 German enterprises are planning to enlarge the production capacity for bioethanol production for 430,000 t/a as well as for biodiesel 1,9 million t/a we predict that the growth will continue.

Having shown the differences in the production chain of bioethanol and biodiesel we were able to focus on the bioethanol chain. Due to the chain's characteristics in particular large companies such as the German Südzucker AG can be regarded as the initiators of these chains. In order to safeguard their high initial investments and to secure efficient supply these companies are relaying rather on contract farming than on spot market interactions. Several well known articles (Duysters et al. 2004; Gulati et al., 2005; Gulati 1998) have emphasised that in the context of managing interfirm collaboration they have to be analysed not only from the perspective of the involved firms and the dyadic level of interaction but also out of the overall network perspective. However, in this article we want to emphasis the firm level because without the farmer's willingness to participate in contract farming the whole bioethanol chain would not exist. Fundamental issues like access to information, transaction transparency and equitable sharing of risk are necessary for effective cooperation in value chains. Therefore in this paper we focused on the challenges and risks for the managers of farm enterprises. For them it is sufficient to recognize the opportunities in the new market because of the forthcoming changes in the Common Agricultural Policy (CAP). To understand the mechanisms of value chain and to accept the prerequisite of the willingness to cooperate and to identify new strategies are basic requirements for successful strategic farm management and competitiveness.

In this article we focussed mainly on bioethanol production and the consequences for farmers as contractors. In future research we want to focus on biodiesel production how is organized in small units and often farmers by themselves are the initiators and processors. This constellation bears different risks and chances for farmers than bioethanol production. It seems be very interesting to compare both alternative value-added chains and the impacts and potential implications for farmers.

Keywords: *bio-energy, value chains, interfirm relationship*

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