IMPACTS OF EUROPEAN BIOFUEL POLICIES ON AGRICULTURAL MARKETS AND ENVIRONMENT UNDER CONSIDERATION OF 2ND GENERATION TECHNOLOGIES AND INTERNATIONAL TRADE

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ABSTRACT

Even though recent discussions on food prices and indirect land use change point at potential conflicts associated with the production of biofuels the appraisal of biofuels as an effective instrument to slow down climate change and reduce energy dependency still prevails. The EU Renewable Energy Directive (EUROPEAN COMMISSION, 2009) underlines this trend by setting a target of 10% share of energy from renewable sources in the transport sector by 2020. As economic competitiveness of biofuel production is still not given in most European countries, support policies are essential to achieve this target. Second generation technologies have still not attained marketability, wherefore biofuel consumption will continue to significantly affect agricultural markets. Furthermore, biofuel trade receives more attention. Apart from Brazil the USA has evolved to one of the key biofuel producer in recent years replacing the EU as the dominant biodiesel exporter. Those developments in regions outside the EU have to be considered within the evolution of biofuel markets. The primary objective of this paper is to analyse in detail impacts of future biofuel developments on agricultural markets under several assumptions regarding the availability of 2nd generation technologies, the EU support policy framework and the EU trade policy regime. Therefore, we developed an extended version of the comparative static agricultural sector model CAPRI which covers global biofuel markets with a detailed focus on Europe. The results supplement already existing model-based impact assessments while focussing on EU Member State level and introducing global bilateral trade of biofuels based on the Armington approach. The results of our scenario analysis presented in this paper indicate that the European 2020 biofuel target will significantly affect global and European biofuel- as well as agricultural markets. Thereby, global biofuel trade will notably increase, especially flows of biodiesel from the USA and Argentina and of ethanol from Brazil into the EU will increase accentuating the net-importing position of the EU by 2020. On the agricultural markets, we can observe that additional demand caused by European biofuel production will be, on the one hand, partially compensated by substitution effects on the feed market and, on the other hand, mainly filled by increasing imports. Thus, effects on agricultural product prices will also be significant, while effects on EU agricultural production will only be marginal. This leads consequently to only marginal environmental impacts within Europe and confirm the assumption that notable environmental effects caused by EU biofuel production and consumption will mainly take place outside Europe, especially in those countries which are important producers of biofuel feedstock.

1. INTRODUCTION

With an increasing production driven both by market forces and public support, biofuels play an increasingly significant role in agricultural and energy markets. The US and Brazil are the main ethanol producers while the EU is the largest biodiesel producer. High production cost limit the economic viability of biofuels (with maybe the exception of ethanol production in Brazil), thus rendering the biofuel industry very dependant on public support.

The European Union (EU), as well as many other countries, has introduced several policies to promote the production and use of biofuels. The new Renewable Energy Directive (EUROPEAN COMMISSION 2009), establishes a common framework for the promotion of energy from renewable sources. The RED sets a mandatory target of 20% for the overall share of energy from renewable sources in gross final consumption of energy by 2020. As regards the transport sector, each Member State (MS) has to achieve a 10% share of energy from renewable sources (including biofuels) in total fuel consumption in transport in 2020.

Previous EU policies have tried to foster the use of renewable energy. The Directive 2003/30/EC (EUROPEAN COMMISSION 2003b) focused on the promotion of the use of biofuels or other renewable fuels for transport, establishing the goal of reaching a 5.75% share of renewable energy in the transport sector by 2010. Under this Directive, Member states are invited to implement individual support policies like consumer tax exceptions or blending obligations on the demand side and e.g. investment incentives or production subsidies on the supply side of biofuels. Annually, Member states shall report about the market status of biofuels and the policy instruments they have implemented to support them. By comparing the 2006 and 2009 reports (EUROPEAN COMMISSION 2006 and 2009b), a tendency of changing from predominately consumer tax reductions in the initial phase (2004-2006) to predominately blending obligations in recent years can be observed. The 2009 report points out that the efforts undertaken in some Member states are still not sufficient to reach the 2010 target of 5.75%.

That is one of the reasons why the new EU Renewable Energy Directive sets a binding target for biofuels in 2020, subject to compliance with sustainability criteria for biofuels and the promotion of 2nd generation biofuels. Because of the complex interrelations between biofuels production, food markets and GHG emissions, the development of the biofuel sector might have strong implications for both agriculture and the environment. Better understanding these implications becomes then crucial.

From an agricultural market perspective, in particular the technology of biofuel processing is of high interest. Until today, the bulk of biofuels is produced by 1st generation processing technologies relying on traditional agricultural commodities like cereals, vegetable oils, or sugar crops. Thus, the production of biofuels is still significantly connected to agricultural product markets. An increasing share of 2nd generation biofuels might reduce this linkage as feedstock other than agricultural commodities, such as agricultural residues or new energy crops, could be used. Important is the fact that at present only pilot or at most small scale facilities for 2nd generation production exist, which only have a marginal market share. However, the future prospects of these technologies are immense. EUROPEAN COMMISSION (2009b) gives an overview on planned and existing 2nd generation facilities in Europe which indicates that from 2010 on an increase in production might occur. To which amount this increase will be take place is very uncertain.

Therefore, the following paper will address three central questions:
(1) What are the impacts of the EU 2020 biofuel target on agricultural markets?
(2) How strong do these impacts change if 2nd generation biofuels become more available?
(3) How strong do these impacts change if the EU allows free biofuel market access?

To answer these questions, we extended the comparative static agricultural sector model CAPRI to cover global biofuel markets with a detailed focus on Europe (CAPRI biofuel module). The most relevant extensions will be described in the following section. Based on this model we analysed three scenarios, each defined to address one of the above mentioned questions. The scenario results presented in this paper supplement already existing model based impact assessments (e.g. LAMPE, M. VON, 2007; BANSE, M. ET AL., 2008; BANSE, M., GRETHE, H., 2008; SCHNEIDER, U. ET AL., 2008; MANTZOS, L., CAPROS, P., 2006) by focusing on the European agricultural sector under consideration of 2nd generation biofuels and global bilateral trade.

2. THE CAPRI BIOFUEL MODULE

2.1. General methodology and database

CAPRI is a comparative-static, spatial, partial equilibrium model specifically designed to analyse CAP measures and trade policies for agricultural products (Britz and Witzke, 2008). CAPRI models agricultural commodity markets worldwide, whilst also providing a detailed representation of the diversity of EU agricultural and trade policy instruments. It consists of two interlinked modules, the supply module and the market module, such that production, demand, trade and prices can be simulated simultaneously and interactively.

The development of the CAPRI biofuel module[1] covered 5 steps.

(1) Implementation of new variables into the model required for the biofuel market representation.
(2) Building an ex-post database which includes all market balance positions for biofuels and biofuel feedstock in each EU MS and non-European region, covered by the model.
(3) Construction of a reference scenario (baseline) by trend estimates based on the database and external expert knowledge.
(4) Specification and calibration of behavioural functions for biofuel supply and feedstock demand as well as fuel and biofuel demand and global biofuel trade.
(5) Definition and evaluation of counterfactual biofuel scenarios.

Whereas the first two steps will be shortly described in this section the latter three steps will be addressed in more detail in the following sections. The core advantage of the CAPRI biofuel module is that biofuel supply and feedstock demand react flexibly to the price ratio of biofuel and feedstock prices as well as biofuel demand and bilateral trade flows react flexibly to biofuel prices and further relevant drivers.

Basically two biofuel product markets are covered: Ethanol (BIOE) and Biodiesel (BIOD). For total domestic ethanol production, five technology pathways are covered distinguished by usable feedstock groups: Cereals - differentiated in wheat (WHEA), barley (BARL), rye (RYEM), oats (OATS), maize (MAIZ), and other cereals(OCER) - , sugar (SUGA), table wine (TWIN), 2nd generation ethanol (SECG), and non-agricultural ethanol (NAGR). For biodiesel, three technology pathways are covered distinguished by usable feedstock groups: vegetable oils - differentiated in rape oil (RAPO), sunflower oil (SUNO), soya oil (SOYO), and palm oil (PLMO) - , 2nd generation biodiesel, and non-agricultural biodiesel. Thereby, the position SECG includes biofuel quantities which are produced from agricultural residues (ARES), like cereals straw or sugar beet leaves, or new energy crops (NECR), like fast growing wood species or miscanthus grass.

[1] The CAPRI biofuel module has been developed within the IPTS project "Integrated Impact Assessment of an Increase in Biofuel Demand in Europe: The Economic and Technological Dimension" (more information available at <http://www.ilr1.uni-bonn.de/agpo/rsrch/projects/ipts_biofuel_e.htm>)

The availability of biofuel market data is still very limited due to the fact that this market has mainly developed within the last years. Thus, different data sources had to be consulted to build a sufficient database. Thereby, homogeneity in variable notation as well as consistency was not fully given which necessitates adjustments to ensure completeness and consistency and to derive closed market balances. The main data sources used for the development of the biofuel database were F.O.Licht, AgLink 2009 baseline, PRIMES 2009 baseline, EBIO, EBB and EUROSTAT. Apart from data for market balance positions, conversion coefficients for 1st and 2nd generation biofuel processing were collected. Technology parameters for 2nd generation feedstock production include usability rates for agricultural residues and average yields for new energy crops, which were also collected. This ex-post database is used to estimate trends for the projection year (2020). However, given the very short ex-post horizon (2002 - 2005) of biofuel data, the baseline projections are mainly fed by expert knowledge. Main sources in this case were the AgLink 2009 and PRIMES 2009[2] baselines which provide projections of domestic use and supply of biofuels for the single EU27 countries (PRIMES) and non-European countries (AgLink). This kind of expert knowledge was also fed into the trend estimation system of CAPRI.

2.2. Behavioural model

2.2.1. Biofuel supply and feedstock demand

Total domestic ethanol production ($MAPR_{BIOE}$) is defined via a profit maximization approach as a function depending on processing margins, except for 2nd generation and non-agricultural ethanol, where, production quantities are exogenously given and thus depend on scenario assumptions.

While the margin of sugar and table wine in the supply function depends on ethanol-, feedstock-, and by-product prices and related conversion coefficients (α, β), cereals margins are covered in this top level by using an aggregated average margin (mar_{CERE}) depending on weighted individual margins for all usable cereals. The decision of the distribution among the different cereals is done on a lower level. Here, demand quantities for individual cereals ($BIOF_{ilow}$), which can be assumed to use the same capacities, are then solved by using a cost minimization approach. It depends on single cereal prices and the overall demand quantity for cereals used for ethanol ($BIOF_{CERE}$). On the top level feedstock demand for aggregated cereals, table wine and sugar is derived from the above mentioned profit

[2] Baseline results from AGLINK and PRIMES models were made available in the course of the IPTS project "Integrated Impact Assessment of an Increase in Biofuel Demand in Europe: The Economic and Technological Dimension" (more information available at <http://www.ilr1.uni-bonn.de/agpo/rsrch/projects/ipts_biofuel_e.htm>)

maximisation assumption. Using a normalized quadratic functional form the profit function can be formulated as displayed by Equation 1.

Equation 1:

$$\frac{\pi}{p_{index}} = \lambda + \sum_{itop} \tau_{itop} \frac{mar_{itop}}{p_{index}} + \frac{1}{2} \sum_{itop} \sum_{ktop} \tau_{itop,ktop} \frac{mar_{itop}}{p_{index}} \cdot \frac{mar_{ktop}}{p_{index}}$$

where:

$\lambda, \tau,$ = calibration parameters

p_{index} = price index

itop = set of CERE, SUGA, TWIN

ktop = alias for itop

mar = margin

The equation for estimating profit maximal input demand ($BIOF_{CERE}$*, $BIOF_{TWIN}$*, $BIOF_{SUGA}$*) is derived from this function via Hotellings Lemma. The resulting derivative gives the input demand function as shown in Equation 2.

Equation 2:

$$BIOF_{itop}{}^{*} = \tau_{itop} + \sum_{ktop} \tau_{itop,ktop} \cdot \frac{mar_{ktop}}{p_{index}}$$

For biodiesel the specification is similar. Total production ($MAPR_{BIOD}$) is a function of the average margin of vegetable oils and the exogenous parts. The margins for individual vegetable oils are covered in the top level by using an average margin (mar_{OILP}) depending on weighted individual margins for all usable vegetable as displayed in Equation 3.

Equation 3:

$$mar_{OILP} = \frac{\sum_{ilow} \left(mar_{ilow} \cdot BIOF_{ilow} \right)}{\sum_{ilow} BIOF_{ilow}}$$

where:

$$mar_{ilow} = \frac{p_{BIOD} + \frac{p_{GLY} \cdot \beta_{ilow}}{\alpha_{ilow}}}{\frac{p_{ilow}}{\alpha_{ilow}}}$$

where:

ilow = set of different vegetable oils usable for biodiesel production

p_{GLY} = price of the by-product glycerine

α, β = conversion coefficients

The distribution among the different vegetable oils is then driven by a cost minimisation approach. The equation for estimating profit maximal feedstock demand ($BIOF_{OILP}$*) can be derived from the profit function, the resulting derivative displays the input demand function as given by Equation 4.

Equation 4:

$$BIOF_{OILP}^{*} = \tau + \mu \cdot \frac{mar_{OILP}}{p_{index}}$$

where:

τ, μ = calibration parameters

2.2.2. Biofuel demand and global biofuel trade

In contrast to the supply side, behavioural functions for fuel- and biofuel demand are estimated based on existing specifications in other models and their simulations respectively. Based on the available information, a two level demand system was implemented. The top level defines total fuel demand, differentiated in overall gasoline and diesel demand as a function of fuel prices and economic growth (represented by the GDP indicator) based on PRIMES simulation results. The lower level defines biofuel demand as a share of overall fuel demand depending on fuel- and biofuel prices and further explanatory variables, derived from the AgLink model.

For **total fuel demand** a response surface was estimated based on available PRIMES scenarios of 2008. These scenarios allowed for estimating the relation between total fuel demand, GDP and fossil fuel prices, using an ordinary least square estimator. A double log demand function was chosen because the estimation coefficients can directly be interpreted as elasticities. The regression function and thereby the total fuel demand function is defined by Equation 5.

Equation 5:

$$\log\left(y_{i,j,s,t}\right) = \delta_{i,j} + \alpha_{i,j} \cdot \log\left(p_{i,j,s,t}\right) + \beta_{i,j} \cdot \log\left(gdp_{j,s,t}\right) + \gamma_{i,j} \cdot \log\left(trend_{t}\right) + \varepsilon_{i,j,s,t}$$

where:

i	= Fuel Type	trend	= Trend variable
j	= Region	ε	= Error term of the regression
s	= Scenario	δ	= Intercept
t	= Year	α	= Price elasticity of demand
y	= Fuel demand	β	= GDP elasticity of demand
p	= Fuel price including tax rates	γ	= Trend elasticity of demand
gdp	= Gross Domestic Product		

The results of the regression analysis (differentiated into biodiesel and ethanol for every EU MS) cover estimates for α, β, γ and the intercept (δ). The significant estimates are used directly in the respective fuel demand function. If no significance was observed for a coefficient in a respective country, the estimated value was replaced by an average value which was derived from the weighted average of significant coefficients over all EU MS. As the PRIMES data only covers values for EU MS but also estimates for non-European regions are required, it was assumed that the coefficient estimates for the aggregated EU27 are also applicable for those regions[3].

Biofuel demand, defined as share of biofuels on total fuel demand (HCOS), is specified according to the existing specification in AgLink (OECD, 2008). Following this approach the resulting overall ethanol demand function depends not only on to the price relation between ethanol and gasoline, but also on some technological parameters, some country specific coefficients and on the total consumption of gasoline. The functions selected for approximating the AgLink ethanol demand functions are s-shaped between a price ratio where a maximum level for the share of ethanol is realised and a price ratio where it would be completely kicked out of the market. However, the demand system implemented in AgLink could not be taken over directly, since endogenous if/else conditions are used which are not allowed in the CAPRI model code. Therefore sigmoid functions were chosen in order to fin a smooth approximation of the existing AgLink specifications.

The final fuel ethanol demand function ($HCOM_{BIOE}$) resulting from the estimated single demand functions ($HCOS^{ADD}$+ $HCOS^{LBLE}$ + $HCOS^{HBLD}$), the overall gasoline consumption quantity ($HCOM_{GASL}$) and the energy content of ethanol is given by Equation 6. Thereby it was assumed that the additive part ($HCOS^{ADD}$) is part of quota obligations if existent. Thus, it only comes in place, if the quota is below the maximal additive share.

Equation 6:

$$HCOM_{BIOE} = \frac{\left(MAX\left(HCOS^{ADD}_{BIOE}, QOBL_{BIOE}\right) + HCOS^{LBLE}_{BIOE} + HCOS^{HBLE}_{BIOE}\right) \cdot HCOM_{GASL}}{ERAT_{BIOE,GASL}}$$

where:

$QOBL_{BIOE}$ = Ethanol Quota obligation

$HOCM_{BIOE}$ = Total domestic ethanol demand for fuel use

$HCOM_{GASL}$ = Total domestic gasoline demand (exougenously given)

$ERAT_{BIOE,GASL}$ = Energy content of ethanol in relation to gasoline (0.67)

[3] This assumption might be too strong, as fuel demand reactions in developing countries will definitively differ from those in developed ones.

The single demand functions for ethanol as an additive, ethanol as a low-level blend and ethanol as a high-level blend are displayed in Equation 7, Equation 8, and Equation 9.

Equation 7:

Demand for ethanol as an additive

$$HCOS_{BIOE}^{ADD} = \left(1 - \frac{1}{1 + e^{-\left(\frac{p_{BIOF}}{p_{GASL}} \cdot \alpha - \beta\right)}} \right) \cdot BLD_{ET,GAS}^{ADD,GE},$$

where:

$HCOS_{BIOE}^{ADD}$ = share of ethanol as an additive in total gasoline consumption

$BLD_{ET,GAS}^{ADD,GE}$ = max. share of ethanol as additive in gasoline

α, β = calibration parameter

Equation 8:

Demand for ethanol as a low-level blend

$$HCOS_{BIOE}^{LBLE} = \left(1 - \frac{1}{1 + e^{-\left(\frac{p_{BIOF}}{p_{GASL}} \cdot \alpha - \beta\right)}} \right) \cdot \left(QCS_{ET}^{Limit} - HCOS_{BIOE}^{ADD} \right),$$

where:

$HCOS_{BIOE}^{LBLD}$ = share of ethanol as low-level-blend in total gasoline consumption

QCS_{ET}^{Limit} = max. share of ethanol in low-level gasoline blends

α, β = calibration parameter

Equation 9:

Demand for ethanol as a high-level blend (neat fuel)

$$HCOS_{BIOE}^{HBLE} = \left(1 - \frac{1}{1 + e^{-\left(\frac{\alpha - ((PREM-0.1)\cdot 20)}{MP_{FFV}^{spr} \cdot 10}\right)\left(\frac{\beta + ((PREM-0.1)\cdot 20)}{MP_{FFV}^{spr} \cdot 10}\right)}} \right) \cdot FFV \cdot QCS_{ET}^{HBLD} \cdot \left(1 - HCOS_{BIOE}^{ADD} - HCOS_{BIOE}^{LBLD} \right)$$

where:

$HCOS_{BIOE}^{HBLD}$ = share of ethanol as a high-level blend in total gasoline consumption

FFV = share of FFVs in total vehicle fleet

QCS_{ET}^{HBLD} = max. share of ethanol in high-level gasoline blends

MP_{FFV}^{spr} = price spread in which substitution for FFVs occurs

PREM = country specific parameter given by the AgLink model

α, β = calibration parameter

Demand for biodiesel is modelled in a simpler way as no comparable differentiation exists. The main driver is the price ratio between biodiesel and fossil diesel and the potential existence of a quota obligation. For biodiesel the dynamic model AgLink uses a sort of a logarithmic function where the consumer demand decision in a respective year (t) depends also on variable values in the foregoing years (t-n). As CAPRI is a static modelling system this functional construction could not be transferred without modifications. Therefore, it was assumed that for the projection year (2020) the demand function derived from the original AgLink function has the form as given by Equation 10.

$$\ln\left(\mathrm{HCOS}_{\mathrm{BIOD}}\right)=\mathrm{constant}_{\mathrm{new}}+\alpha\cdot\ln\left(\mathrm{PR}_{\mathrm{BIOD,DISL}}\right)$$

Equation 10:

where:

$\mathrm{constant}_{\mathrm{new}} = \mathrm{constant}_{\mathrm{AgLink}} +$ dynamic effects covered by $\beta\left(t-n\right)$ and $\alpha\left(t-n\right)$

$\mathrm{PR}_{\mathrm{BIOD,DISL}}$ = Price ratio biodiesel / diesel in projection year 2020

α = Calibration parameter

As the AgLink model results provide values for the price ratio ($\mathrm{PR}_{\mathrm{BIOD,DISL}}$) and the related consumer demand $\mathrm{HCOS}_{\mathrm{BIOD}}$ for the year 2020 in each covered region, it is possible to take both values and calculate a new constant ($\mathrm{constant}_{\mathrm{new}}$) so that Equation 10 fits the respective value for $\mathrm{HCOS}_{\mathrm{BIOD}}$ under the given price ratio. Having this new constant the price ratio can be varied and the consumer demand behaviour subject to different price ratios can be calculated. However, the resulting logarithmic functions for different regions show significant demand increases resulting from price ratios that are smaller than 0.7. To overcome this problem we assume that the calculated LOG-function gives a realistic picture for biofuel demand in a defined range of price ratios which are for example in the case of the EU greater than 0.7. Taking into account the considerations for a sufficient functional form in the case of ethanol we take again a sigmoid function and calibrate the functional parameters in a way that they fit the LOG-function in the defined range of price ratios. Thereby, the sigmoid function depends exclusively on the price ratio of biodiesel and diesel and the country specific function parameters as displayed in Equation 11.

$$\mathrm{HCOS}_{\mathrm{BIOD}}=\left(1-\frac{1}{1+e^{-\left(\frac{p_{\mathrm{BIOF}}}{p_{\mathrm{DISL}}}\cdot\alpha-\beta\right)}}\right)+\mathrm{QOBL}_{\mathrm{BIOD}}$$

Equation 11:

where:

$\mathrm{HCOS}_{\mathrm{BIOD}}$ = share of biodiesel in total diesel consumption

$\mathrm{QOBL}_{\mathrm{BIOD}}$ = biodiesel quota obligation

α, β = calibration parameter

$\frac{p_{\mathrm{BIOD}}}{p_{\mathrm{DISL}}}$ = price ratio biodiesel / diesel

The final biodiesel demand function ($HCOM_{BIOD}$) then depends on the estimated function $HCOS_{BIOD}$, the overall diesel consumption quantity ($HCOM_{DISL}$) and the energy content of biodiesel as it was displayed for ethanol by Equation 6.

Behavioural functions for global bilateral trade of biodiesel and ethanol are intrinsically tied to the final biofuel demand functions. The general methodology is that of a two stage demand system relying on the Armington assumption as already applied for other agricultural commodities in the standard CAPRI version and described in (BRITZ, W., WITZKE, P., 2009).

3. BASELINE AND SCENARIO DEFINITION

3.1. Baseline assumptions

The baseline scenario, which is in line with the latest AgLink baseline, includes the current policy setting and the most plausible developments of exogenous variables until 2020.

3.1.1. CAP policy assumptions

A continuation of the CAP until 2020 (including the Health Check, sugar market reform, and reform of the EU milk quota regime) has been considered. The CAP policy specifications are shortly described in Table 1.

Table 1 : Core assumptions regarding direct payments in the Baseline

Instrument	Baseline
Direct payments EU15	2003 reform fully implemented
Direct payments EU10	2003 reform fully implemented, special accession conditions recognised.
Direct payments BUR	SAPS
Set aside EU15	Abolished
Set-aside EU10 and BUR	Abolished
Article 69 payments	Implemented
Modulation	EU25 5% minus franchise, BUR none. Voluntary modulation for UK and PT

3.1.2. Specific Biofuel assumptions

In line with the recent AgLink baseline we assume fossil fuel demand for EU27 in 2020 as displayed in Table 2. To derive estimations for fossil fuel demand in the single EU MS we take the respective demand shares by EU MS resulting from the recent PRIMES baseline and apply them to the EU27 fuel demand assumption of AgLink.

Table 2: Fossil fuel demand by EU Member state in 2020 (relative and absolute values)

	Fuel demand 2020			
	Gasoline		Diesel	
	%	kton	%	kton
EU27	100.00%	106,256	100.00%	248,558
Austria	1.86%	1,972	2.40%	5,972
Belgium / Luxemb.	1.94%	2,064	4.03%	10,025
Netherlands	3.18%	3,380	3.24%	8,042
Germany	18.24%	19,376	14.99%	37,259
France	9.02%	9,587	14.52%	36,091
Spain	6.72%	7,144	15.71%	39,044
Portugal	1.60%	1,700	2.23%	5,551
United Kingdom	16.28%	17,295	10.41%	25,884
Ireland	1.84%	1,952	1.26%	3,131
Italy	13.74%	14,600	11.04%	27,446
Denmark	1.54%	1,642	1.11%	2,750
Finland	1.62%	1,725	1.03%	2,567
Sweden	3.53%	3,748	1.80%	4,473
Greece	3.86%	4,101	1.29%	3,216
Poland	5.22%	5,551	5.27%	13,090
Hungary	1.83%	1,941	1.61%	4,008
Czech Republic	2.27%	2,417	2.20%	5,458
Slovakia	0.81%	856	0.81%	2,016
Slovenia	0.73%	775	0.86%	2,143
Lithuania	0.39%	410	0.55%	1,365
Latvia	0.41%	437	0.44%	1,090
Estonia	0.27%	291	0.24%	598
Romania	2.17%	2,308	1.88%	4,681
Bulgaria	0.53%	568	0.80%	1,991
Cyprus	0.35%	372	0.19%	472
Malta	0.05%	48	0.08%	195

Source: CAPRI model, calculated based on AgLink and PRIMES 2009

Equal to the AgLink assumption, we fixed an energy share of 8.5% biofuels in total transport fuel consumption for the EU27 average in 2020, of which we assume approx. 7% consisting of 1st generation and approx. 1.5% of 2nd generation biofuels. In accordance with article 21 of Directive 2009/28/EC, the energy provided by 2nd generation biofuels is considered twice. Thus, the 2020 target of 10% biofuels in the EU27 is fully reached by this assumption.

Table 3: Share of biofuels in EU Member states (2020): Baseline assumption

	2020		
	Energy share of ethanol in gasoline consumption	Energy share of biodiesel in diesel consumption	Energy share of biofuels in total fuel consumption
EU27	8.5%	8.5%	8.5%
Austria	9.4%	8.5%	8.8%
Belgium / Luxemb.	9.3%	7.9%	8.2%
Netherlands	5.9%	7.7%	7.2%
Germany	11.7%	11.1%	11.3%
France	8.2%	9.1%	8.9%
Spain	10.5%	8.6%	8.9%
Portugal	5.6%	6.5%	6.3%
United Kingdom	9.4%	7.4%	8.2%
Ireland	5.9%	7.0%	6.6%
Italy	7.1%	9.2%	8.4%
Denmark	9.2%	10.3%	9.9%
Finland	7.5%	6.9%	7.1%
Sweden	9.4%	8.1%	8.7%
Greece	6.5%	6.2%	6.3%
Poland	6.4%	7.1%	6.9%
Hungary	4.9%	8.1%	7.0%
Czech Republic	7.1%	8.4%	8.0%
Slovakia	6.0%	6.9%	6.6%
Slovenia	5.2%	9.0%	7.9%
Lithuania	7.2%	6.1%	6.4%
Latvia	4.0%	6.7%	5.9%
Estonia	5.6%	5.1%	5.3%
Romania	3.2%	3.3%	3.3%
Bulgaria	3.4%	3.4%	3.4%
Cyprus	1.5%	3.9%	2.8%
Malta	1.3%	2.1%	1.9%

Source: CAPRI model, calculated based on AgLink and PRIMES 2009

The distribution of the 8.5% EU27 average across the single EU MS, displayed in Table 3, is thereby also derived from the biofuel demand shares of the recent PRIMES baseline. The same procedure is applied to distribute the 1.5% 2nd generation share across the single MS.

It is also assumed that the predominately share of this biofuel demand in 2020 results from the implementation of quota obligations. Therefore we take the information on implemented quotas until 2009 covered in EUROPEAN COMMISSION (2009b) as the base information. We assumed that all existing quota obligations which are defined for a year before 2015 will be increased in the respective EU MS in 2020 by 1.5%. All existing quotas which are already defined for a year beyond 2015 will only exceed the existing level by 1.1%. For all EU MS where no quota exists it is assumed that a minimum quota of 6% will be introduced in 2020. The resulting calculated quota obligations which are assumed to be implemented in 2020 for every EU MS are displayed in Table 4.

Table 4: Assumed quota obligations in 2020 (Baseline)

	Quota obligations by EU MS (%)																									
	BL	DK	DE	AT	NL	FR	PT	ES	EL	IT	IR	FI	SE	UK	CZ	EE	HU	LT	LV	PL	SI	SK	CY	MT	BG	RO
BIOD	6.0	6.0	9.0	7.5	6.7	8.0	5.5	7.6	5.2	8.2	6.0	5.9	6.0	6.4	6.0	4.1	6.0	5.1	5.7	6.0	8.0	5.9	2.9	1.1	2.4	2.3
BIOE	6.0	6.0	8.7	6.4	2.9	5.2	2.8	7.5	3.5	4.1	2.9	4.5	6.0	6.4	4.1	2.8	2.4	4.2	2.0	3.4	2.6	3.0	0.8	0.6	1.7	1.6

Source: CAPRI model, calculated based on AgLink 2009 and EUROPEAN COMMISSION (2009b).

Conversion coefficients for 1st generation biofuel processing are assumed to be in line with the AgLink assumptions. Furthermore, conversion coefficients are assumed to increase gradually due to technological progress. Conversion factors for 2nd generation biofuels are derived from the PRIMES baseline (see Table 5).

Table 5: Conversion coefficients for 2nd generation biofuel production

Conversion coefficients (t/t)	**Fischer Tropsch (FT) Diesel**	**FT By-product (tailgas)**	**Prolysis Diesel**	**Hydro Thermal Upgrading (HTU) Diesel**	**Lingo-cellulosic (LC) Ethanol**	**LC By-product (lignin)**
Agricultural Residues (ARES)* and New Energy Crops (NECR)**	0.700	0.250	0.236	0.278	0.147	0.120

* Grain and oil seed straw, sugar beet leaves ***Poplar, Willow, Miscanthus

Source: PRIMES baseline 2009

The share of Flexible Fuel Vehicles (FFV) in total vehicle fleet by country is also derived from the AgLink 2009 baseline. For the EU27 2.5% FFV are assumed in 2020. As the AgLink model gives only values for the EU aggregate it is assumed that this share is equal over all EU MS. For non-EU countries the FFV shares are assumed in line with the AgLink specification (taking the US share when no information is available). Table 6 displays the assumed biofuel tariffs, differentiated in ad valorem and specific tariffs. In the case of ethanol the applied tariffs for undenatured ethanol which is used for fuel purpose is assumed.

Table 6: Assumed import tariffs: Baseline

	Fuel ethanol		Biodiesel	
	Tariff specific	Tariff ad valorem	Tariff specific	Tariff ad valorem
Norway	300.00	0.00%	0.00	6.50%
Turkey	0.00	3.00%	0.00	16.29%
EU15	300.00	0.00%	0.00	6.50%
EU10	300.00	0.00%	0.00	6.50%
Bulgaria and Romania	300.00	0.00%	0.00	6.50%
Rest of Europe	300.00	0.00%	0.00	6.50%
Russia, Belarus, Ukraine	0.00	15.23%	0.00	13.69%
USA	151.94	2.50%	0.00	4.60%
Canada	47.21	0.00%	0.00	0.00%
Brazil	47.63	20.00%	0.00	4.60%
India	0.00	34.24%	0.00	99.84%
Japan	0.00	15.23%	0.00	13.69%
LDC countries	0.00	23.75%	0.00	16.25%
ACP countries	0.00	0.00%	0.00	10.00%
Rest of World	0.00	15.23%	0.00	13.69%

Source: CAPRI model, based on AgLink 2009 (specific tariffs in Euro/toe)

3.2. *Counterfactual scenario*

Compared to the baseline the simulation scenarios will mainly focus on an increasing production and use of 2nd generation biofuels, the abolishment of the EU biofuel import tariffs, and a situation assuming no policy support for biofuels in the EU. Therefore three scenarios are defined.

Scenario 1 builds on the baseline with the only exception that the availability of 2nd generation biofuels is assumed to increase rapidly. To introduce a higher share of 2nd generation biofuels in overall fuel consumption, it is assumed that all EU MS are able to produce at least 50% of their total biofuel production by 2nd generation technologies. **Scenario 2** is also based on baseline assumptions with the only exemption that all applied EU import tariffs for biofuels are abolished by 2020. **Scenario 3** represents a situation where there is no internal EU biofuel policy. Therefore, there is no blending obligation for biofuels and the existing consumer taxes for fossil fuels are also applied for biofuels. However, EU import tariffs for biofuels remain unchanged.

4. *QUANTITATIVE ANALYSIS*

4.1. *Baseline results*

The general effects of the baseline are summarized shortly in the following:

Production and consumption of biofuels increase strongly in 2020. As quota obligations are the main support instrument in most EU MS, biofuel demand is directly linked to the absolute demand quantities for fossil fuels. Due to the higher consumption of diesel in Europe, fuel consumption of biodiesel is still higher than fuel consumption of ethanol. Most EU15 MS will be net-importers of ethanol and biodiesel. Within the EU15 only two notable exceptions exist which are in the cases of biodiesel in Germany and ethanol in France. In 2020, Germany is still the most important producer of biodiesel in the EU, approx. 45% of the EU27 production in 2020 coming from Germany. As these quantities exceed the domestic demand significantly, Germany gets in a strong net-export situation. The same is true for ethanol production and trade in France, which is traditionally the most important ethanol producer in the EU27.

In the case of biodiesel, imports into the EU in 2020 increase significantly (by app. 4.8 mil tons) whereas European exports only change marginally. Main biodiesel exporters become Argentina, the USA, India, Indonesia and Malaysia. In the case of the USA, the strong increase in biodiesel exports can be explained by the strong support of production which is given by the US government.

As for ethanol, the main exporters in 2020 are Brazil, the EU10, USA and the other South American countries. With over 2.5 mil tons, Brazil is still the dominant ethanol exporter. Exports of the EU10 go nearly completely into the EU15 which is also true for Brazilian exports. Main ethanol importers are the EU27 and the USA.

Due to the significant increase in 1st generation production in 2020, feedstock demand also increases. The shifts in feedstock demand cause changes in the individual market balances for agricultural products. These changes are of high importance and interest from an agricultural sector perspective as they provide indications for changes in domestic production and trade of directly affected agricultural commodities. However, the resulting shifts are not exclusively caused by the biofuel sector as the baseline also includes CAPRI standard assumptions for different CAP policies and trade regimes as already described within the baseline assumptions.

Feedstock demand for biofuel production mainly causes the increase of total demand which significantly increase for all commodities. By looking at the single crops the following different effects can be observed.

(1) The increase of biofuel feedstock demand leads to a proportional increase of total demand or even to an over-proportional increase if simultaneously feed demand increases, too. This is true for wheat and maize where the increase in total demand even exceeds biofuel feedstock demand. In both cases the additional demand is mainly filled by a strong increase in EU27 domestic production.

(2) The increase of biofuel feedstock demand leads to an under-proportional increase of total demand which is mainly caused by a decrease of feed demand. This effect can be explained by a substitution effect on the feed market as the by-product of cereals processing to biofuels (DDGS) can be used as substitute for traditional feed crops. In general this is true for rye and meslin, barley, oats, and other cereals. Depending on the level of this substitution effect still an increase of total demand or even a decrease of total demand can be observed. Under consideration of trade shifts this leads to shifts in domestic production where we can observe an increase for barley and oats and a decrease in the case of rye and meslin and other cereals.

(3) In the case of rape oil the additional demand quantities are filled by significant increasing imports and decreasing exports, whereas domestic production shows only slight changes. For sunflower and soya oil the picture is different. Here, the demand increase (which is on a significant lower level as in the case of rape oil) is predominately compensated by increasing domestic production. In the case of palm oil, which is only produced in the EU on a marginal level, the demand increase is completely compensated by increasing imports.

(4) A special case is sugar (SUGA). Here, we cannot observe a substitution effect on the feed market as sugar is only used on a marginal level by the livestock sector. Thus, the strong increase in biofuel feedstock demand leads to a proportional increase in total demand. However, the absolute production quantities in Europe decrease by a significant amount. This shift can be explained by the CAP policy assumptions of the baseline, as the sugar market reform, which includes a significant reduction of sugar quotas, is already included in the baseline. The increase in total demand caused by biofuel processing only lowers the general effect of decreasing production quantities of sugar in Europe.

4.2. Scenario results

Changes in the EU27 biofuel market balance caused by the different scenarios are displayed in Table 7.[4] In Tables 8 to 10 global bilateral trade flows of biodiesel and ethanol are covered.

Table 7: Biofuel market balance for EU27 (Scenarios)

EU 27		Baselline		SC1 (high SECG)		SC2 (no EU tariffs)		SC3 (no EU support)	
	Unit	BIOD	BIOE	BIOD	BIOE	BIOD	BIOE	BIOD	BIOE
Total Production (MAPR)	*kton*	20865	13070	24785	14392	20734	10413	3256	4333
	% Diff.			*18.79%*	*10.12%*	*-0.63%*	*-20.32%*	*-84.40%*	*-66.85%*
1st gen. Production (FIRG)	*kton*	9638	9883	7419	7366	9507	7226	3244	3839
	% Diff.			*-23.02%*	*-25.47%*	*-1.35%*	*-26.88%*	*-66.34%*	*-61.16%*
2nd gen. Production (SECG)	*kton*	4294	2696	10433	6535	4294	2696	4	3
	% Diff.			*142.96%*	*142.43%*	*0.00%*	*0.00%*	*-99.90%*	*-99.90%*
Non-agri. Production (NAGR)	*kton*	6933	491	6933	491	6933	491	7	491
	% Diff.			*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-99.90%*	*0.00%*
Fuel Demand (HCOM)	*kton*	24862	14794	27828	15845	25116	17935	3201	3174
	% Diff.			*11.93%*	*7.11%*	*1.02%*	*21.23%*	*-87.12%*	*-78.55%*
Industrial Demand (INDM)	*kton*	0	1956	0	1967	0	1976	0	1974
	% Diff.				*0.55%*		*0.98%*		*0.91%*
Biofuel share in total fuel consumption (HCOS)	*%*	8.49	8.43	9.46	8.98	8.58	10.13	1.07	1.78
	% Diff.			*11.43%*	*6.52%*	*1.06%*	*20.17%*	*-87.40%*	*-78.88%*
Quota obligations (QUTS)	*%*	7.19	5.49	7.19	5.49	7.19	5.49	0.00	0.00
	% Diff.			*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-100.00%*	*-100.00%*
IMPORTS	*kton*	4825	6189	4201	6232	5210	11303	456	1747
	% Diff.			*-12.93%*	*0.70%*	*7.97%*	*82.64%*	*-90.55%*	*-71.78%*
EXPORTS	*kton*	827	2508	1159	2811	828	1806	510	931
	% Diff.			*40.05%*	*12.10%*	*0.07%*	*-28.01%*	*-38.31%*	*-62.87%*
Consumer Price (CPRI)	*€/toe*	1283	1486	1119	1444	1264	1326	1328	2253
	% Diff.			*-12.81%*	*-2.84%*	*-1.48%*	*-10.81%*	*3.46%*	*51.58%*
Consumer Tax (CTAX)	*€/toe*	33	404	33	396	33	389	497	1245
	% Diff.			*-1.33%*	*-2.00%*	*-0.03%*	*-3.81%*	*1405.76%*	*207.93%*

Source: CAPRI model (Biofuel branch), 07.06.2010

Due to the scenario assumptions of **Scenario 1**, biofuel production based on 2nd generation technologies increases significantly over 140% for both biofuels. This supply shock leads to a decrease of the consumer price by 12% in the case of biodiesel and 3% in the case of ethanol. Thereby, fuel consumption of biodiesel increases by 12% and of ethanol by 7%. This higher demand consequently leads to a higher share of biofuels in total fuel consumption, app. 9.5% for biodiesel and app. 9% for ethanol. On the supply side, total biofuel production increases above 10% in both cases as a result of the higher 2nd generation quantities. These higher 2nd generation quantities in total domestic production lead then consequently to a decrease of 1st generation production (more than 20% in both cases). Imports of biodiesel decrease by 13% whereas EU biodiesel exports increase by 40%. As one can observe in the bilateral trade balance, most of the mentioned biodiesel exports are intra EU exports between the EU15 and the EU10 countries. The decrease in EU biodiesel imports results mainly from a decline in US and Argentinean exports into the EU. Imports of

[4] It has to be mentioned that total imports (IMPORTS) and total exports (EXPORTS) of the EU27 in Table 7 cover in addition to the EU - nonEU trade flows also intra EU trade between the EU10 and the EU15 aggregate. Within Table 8, Table 9, and Table 10, which display global bilateral trade, this overlap can be differentiated.

ethanol from non-EU regions decrease slightly between 5 - 6%. Contrary to this, intra EU imports from the E10 into the EU15 increase by more than 10% which consequently leads also to the increase in total exports, while flows from or in non-EU regions only change marginally. This observation approves the assumption that this scenario mainly affects intra European biofuel markets and thereby first and foremost leads to a partial substitution of 1st generation by 2nd generation biofuel production within the EU.

The abolishment of the EU import tariffs for biofuels in **Scenario 2** leads to a reduction of the consumer price by 1.5% in the case of biodiesel and 11% in the case of ethanol. The stronger impact on the ethanol price results from the higher specific tariff applied for fuel ethanol (300 €/toe) compared to the ad valorem tariff of 6.5% in the case of biodiesel. Consequently, this scenario has a higher impact on the ethanol market as on the biodiesel market. Due to the price changes, fuel consumption of ethanol increases by 21% and for biodiesel by 1%. Whereas domestic production decreases by 0.6% for biodiesel and 20% for ethanol, biofuel imports increase significantly by 8% for biodiesel and over 80% for ethanol. In line with the reduced domestic production, European exports decrease also more significantly in the case of ethanol (-28%). The price decrease in this scenario and the resulting demand increase leads consequently to a higher share of biofuels in total fuel consumption. In the case of ethanol an increase of 20% to an ethanol share in gasoline of 10% can be observed. The bilateral trade balance for biodiesel confirms the observation that the biodiesel market is not affected significantly by this scenario. Whereas biodiesel exports only shift marginally (and this mainly between the EU10 and EU15) the increase in imports results mainly from an increase in US and Argentinean exports into the EU. In contrast to this ethanol trade is more affected. Whereas exports from the EU10 into the EU15 decrease by 30%, exports from US (+140%), Brazil (+200%) or further South American countries (+68%) increase significantly. Thereby, Brazil is still the most important ethanol exporter into the EU with more than 6.7 mil ton.

Table 8: Global bilateral trade of biodiesel in kton (Scenarios)

BD	SC1 (high SECG)								SC2 (no EU tariffs)								SC3 (no EU support)							
IM/EX	EU15	EU10	BUR	USA	ARG	IND	LDC	ROW	EU15	EU10	BUR	USA	ARG	IND	LDC	ROW	EU15	EU10	BUR	USA	ARG	IND	LDC	ROW
EU15	~	87	32	1206	1132	132	45	149	~	76	27	1641	1429	240	51	288	~	4	1	76	100	5	3	4
%Diff.	~	*11%*	*8%*	*-20%*	*-15%*	*-35%*	*-20%*	*-37%*	~	*-3%*	*-9%*	*9%*	*7%*	*19%*	*-9%*	*23%*	~	*-94%*	*-98%*	*-95%*	*-92%*	*-98%*	*-95%*	*-98%*
EU10	477	~	18	303	488	43	10	55	325	~	13	367	549	69	10	95	113	~	1	36	82	3	1	3
%Diff.	*41%*	~	*21%*	*-11%*	*-6%*	*-27%*	*-11%*	*-30%*	*-4%*	~	*-10%*	*8%*	*6%*	*18%*	*-10%*	*21%*	*-67%*	~	*-96%*	*-89%*	*-84%*	*-95%*	*-89%*	*-96%*
BUR	0	0	~	0	22	1	1	2	0	0	~	0	23	2	1	3	0	0	~	0	23	1	0	1
%Diff.	*0%*	*0%*	~	*0%*	*3%*	*-20%*	*-2%*	*-23%*	*0%*	*0%*	~	*0%*	*12%*	*25%*	*31%*	*28%*	*0%*	*0%*	~	*0%*	*12%*	*-67%*	*-25%*	*-72%*
ARG	0	0	135	0	~	0	0	17	0	0	104	0	~	0	0	23	0	1	53	0	~	0	0	13
%Diff.	*0%*	*40%*	*35%*	*0%*	~	*0%*	*0%*	*-21%*	*0%*	*11%*	*5%*	*0%*	~	*0%*	*0%*	*3%*	*0%*	*77%*	*-47%*	*0%*	~	*0%*	*0%*	*-42%*
USA	17	3	0	~	121	246	87	311	11	3	0	~	94	275	83	369	49	4	0	~	256	201	132	224
%Diff.	*79%*	*56%*	*0%*	~	*20%*	*-8%*	*13%*	*-11%*	*15%*	*14%*	*0%*	~	*-8%*	*3%*	*8%*	*6%*	*432%*	*89%*	*0%*	~	*152%*	*-25%*	*71%*	*-36%*
ROW	0	133	255	11	434	29	0	~	0	95	173	8	325	32	0	~	0	178	107	17	1010	27	0	~
%Diff.	*0%*	*55%*	*52%*	*12%*	*19%*	*-8%*	*0%*	~	*0%*	*10%*	*3%*	*-10%*	*-11%*	*-1%*	*0%*	~	*0%*	*107%*	*-37%*	*85%*	*176%*	*-17%*	*0%*	~

Source: CAPRI model (Biofuel branch), 07.06.2010 / (BUR=Bulgaria and Romania, ARG=Argentina, ROW=Rest of World)

The abolishment of all EU biofuel support policies in **Scenario 3** leads to a strong decrease in biofuels demand in Europe (-87% for biodiesel and -78% for ethanol), caused, on the one hand, by the removal of the quota obligations and, on the other hand, by a significant increase of the biodiesel (+3.5%) and ethanol (+52%) consumer prices for which the fossil fuel taxes are also applied. Therefore, the share of biofuels in total fuel consumption decreases to a level of 1.07% in the case of biodiesel and 1.78% in the case of ethanol. Within the specification of this scenario, it is also assumed that 2nd generation production, which depends also on a strong financial support, is reduced to a marginal level. At the same time, biodiesel produced from non-agricultural sources, e.g. waste oil from the food industry and black liquor, is also assumed to vanish. Caused by the significant decrease in demand in Europe, imports also decrease significantly by app. 90% in the case of biodiesel and 71% in the case of ethanol. The production of biofuels in Europe is consequently also strongly affected. 1st generation production of ethanol and biodiesel decreases by more than 60%. Total domestic production of biodiesel decreases by app. 85% and that of ethanol by 67%. The bilateral trade balance shows that this scenario has the highest impact on global biofuel trade. In the case of biodiesel, the strong import decrease of 90% results from a equivalent reduction of exports from all notable biodiesel export countries, first and foremost that of the US and Argentina which export into the EU decline by more than 2.8 mil tons. The same is true for ethanol where the main export regions reduce their export flows by more than 70%.

Table 9: Global bilateral trade of ethanol in kton (Scenarios 1, 2)

BIOE	SC1 (high SECG)														
IM/EX	EU15	EU10	BUR	RBU	USA	CAN	MEX	BRA	BOL	ARG	RSA	IND	CHN	ANZ	ROW
EU15	~	2593	9	92	143	38	11	1683	135	52	189	31	37	19	319
%Diff.	~	12%	12%	-8%	-8%	-8%	-8%	-8%	-5%	-7%	-7%	-8%	-8%	-8%	-7%
EU10	32	~	3	87	29	4	2	372	56	14	71	7	6	4	79
%Diff.	19%	~	20%	-1%	-2%	-1%	-1%	-1%	2%	0%	0%	-1%	-1%	-1%	-1%
BUR	0	16	~	2	0	1	0	53	4	1	4	3	1	0	0
%Diff.	0%	16%	~	-4%	0%	-4%	0%	-4%	-1%	-3%	-3%	-4%	-5%	0%	0%
BRA	0	0	0	0	496	0	0	~	0	0	0	0	21	0	2
%Diff.	0%	0%	0%	0%	0%	0%	0%	~	0%	0%	0%	0%	0%	0%	1%
CHL	1	1	0	0	0	0	0	8	4	22	0	0	0	0	0
%Diff.	20%	21%	0%	0%	0%	0%	0%	-1%	3%	0%	0%	0%	0%	0%	0%
USA	14	1	81	0	~	42	4	5	0	78	391	0	0	13	323
%Diff.	17%	18%	18%	0%	~	0%	1%	0%	0%	1%	1%	0%	0%	0%	1%
CAN	0	0	0	0	28	~	15	0	0	0	0	0	0	0	2
%Diff.	0%	0%	0%	0%	0%	~	1%	0%	0%	0%	0%	0%	0%	0%	1%
MEX	0	1	0	0	15	0	~	0	0	10	1	0	1	0	2
%Diff.	30%	20%	0%	0%	0%	0%	~	0%	0%	1%	1%	0%	0%	0%	1%
RSA	0	0	0	0	0	1	1	0	42	7	~	0	4	0	0
%Diff.	0%	0%	0%	0%	0%	-1%	0%	0%	3%	0%	~	0%	-2%	0%	0%
IND	0	0	0	0	17	1	0	1	0	0	0	~	7	0	3
%Diff.	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	~	0%	0%	1%
CHN	0	0	0	0	0	0	0	0	0	0	0	0	~	81	7
%Diff.	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	~	0%	1%
JAP	0	0	0	0	3	1	0	265	0	0	9	8	60	0	15
%Diff.	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	2%	0%	0%	0%	1%
ACP	0	58	0	0	0	0	0	4	0	0	0	66	0	0	0
%Diff.	0%	19%	0%	0%	0%	0%	0%	-2%	0%	0%	0%	-2%	0%	0%	0%
ROW	0	0	0	5	19	15	0	0	7	100	0	62	0	272	~
%Diff.	0%	0%	0%	0%	-1%	0%	0%	0%	4%	1%	0%	0%	0%	0%	~

BIOE	SC2 (no EU tariffs)														
IM/EX	EU15	EU10	BUR	RBU	USA	CAN	MEX	BRA	BOL	ARG	RSA	IND	CHN	ANZ	ROW
EU15	~	1617	5	190	380	101	24	5817	187	103	342	48	91	48	663
%Diff.	~	-30%	-40%	92%	143%	149%	96%	219%	32%	85%	68%	43%	123%	130%	92%
EU10	14	~	1	130	56	8	3	928	56	20	93	8	11	7	119
%Diff.	-48%	~	-53%	48%	88%	92%	52%	147%	2%	43%	30%	12%	73%	78%	49%
BUR	0	10	~	3	0	2	0	183	0	2	7	5	2	0	0
%Diff.	0%	-26%	~	103%	0%	163%	0%	229%	-100%	102%	78%	54%	137%	0%	0%
BRA	0	0	0	0	518	0	0	~	0	0	0	0	20	0	2
%Diff.	0%	0%	0%	0%	4%	0%	0%	~	0%	0%	0%	0%	-1%	0%	-12%
CHL	1	1	0	0	0	0	0	7	2	20	0	0	0	0	0
%Diff.	41%	47%	0%	0%	0%	0%	0%	-9%	-35%	-8%	0%	0%	0%	0%	0%
USA	15	1	77	0	~	41	4	5	0	66	305	0	0	13	285
%Diff.	24%	27%	12%	0%	~	-2%	-14%	-14%	0%	-14%	-21%	0%	0%	1%	-11%
CAN	0	0	0	0	30	~	13	0	0	0	0	0	0	0	1
%Diff.	0%	0%	0%	0%	4%	~	-13%	-15%	0%	0%	0%	0%	0%	0%	-12%
MEX	0	1	0	0	15	0	~	0	0	8	1	0	1	0	2
%Diff.	40%	31%	0%	0%	4%	0%	~	-15%	0%	-16%	-23%	0%	-2%	0%	-12%
RSA	0	0	0	0	0	1	1	0	29	7	~	0	5	0	0
%Diff.	0%	0%	0%	0%	0%	18%	3%	0%	-30%	0%	~	0%	17%	0%	5%
IND	0	0	0	0	17	1	0	1	0	0	0	~	7	0	3
%Diff.	0%	0%	0%	0%	1%	-4%	0%	-19%	0%	0%	0%	~	-5%	0%	-15%
CHN	0	0	0	0	0	0	0	0	0	0	0	0	~	83	6
%Diff.	0%	0%	0%	0%	7%	0%	0%	-50%	0%	0%	0%	0%	~	2%	-12%
JAP	0	0	0	0	4	1	0	232	0	0	7	9	62	0	14
%Diff.	0%	0%	0%	0%	10%	5%	0%	-12%	0%	0%	-19%	9%	4%	7%	-8%
ACP	0	61	0	0	0	0	0	3	0	0	0	65	0	0	0
%Diff.	0%	23%	0%	0%	0%	0%	0%	-23%	0%	0%	0%	-4%	0%	0%	0%
ROW	0	0	0	5	21	16	0	0	4	86	0	67	0	285	~
%Diff.	0%	0%	0%	-10%	7%	3%	0%	0%	-39%	-13%	0%	7%	0%	5%	~

Source: CAPRI model (Biofuel branch), 07.06.2010 (RSA=Rest of South America; CHN=China; RBU=Russia, Belarus, Ukraine; ANZ=Australia and New Zeeland; BUR=Bulgaria and Romania; ROW=Rest of World)

Table 10: Global bilateral trade of ethanol in kton (Scenarios 3)

BIOE	SC3 (no EU support)														
IM/EX	EU15	EU10	BUR	RBU	USA	CAN	MEX	BRA	BOL	ARG	RSA	IND	CHN	ANZ	ROW
EU15	~	745	2	23	34	9	3	421	49	13	52	7	9	5	82
%Diff.	~	-68%	-79%	-77%	-78%	-78%	-76%	-77%	-66%	-76%	-75%	-78%	-78%	-78%	-76%
EU10	9	~	0	21	7	1	0	89	19	4	19	2	1	1	20
%Diff.	-67%	~	-79%	-76%	-78%	-77%	-76%	-76%	-65%	-75%	-74%	-77%	-77%	-77%	-75%
BUR	0	20	~	2	0	1	0	56	5	1	5	3	1	0	0
%Diff.	0%	41%	~	2%	0%	-1%	0%	1%	50%	6%	11%	-3%	-2%	0%	0%
BRA	0	0	0	0	485	0	0	~	0	0	0	0	21	0	2
%Diff.	0%	0%	0%	0%	-2%	0%	0%	~	0%	0%	0%	0%	1%	0%	11%
CHL	1	1	0	0	0	0	0	8	6	22	0	0	0	0	0
%Diff.	36%	34%	0%	0%	0%	0%	0%	-2%	64%	2%	0%	0%	0%	0%	0%
USA	17	2	65	0	~	43	5	6	0	84	452	0	0	13	351
%Diff.	38%	37%	-6%	0%	~	2%	9%	5%	0%	10%	17%	0%	0%	0%	9%
CAN	0	0	0	0	27	~	16	0	0	0	0	0	0	0	2
%Diff.	0%	0%	0%	0%	-3%	~	8%	5%	0%	0%	0%	0%	0%	0%	10%
MEX	0	1	0	0	14	0	~	0	0	11	1	0	1	0	3
%Diff.	50%	41%	0%	0%	-3%	0%	~	10%	0%	11%	20%	0%	0%	0%	10%
RSA	0	0	0	0	0	1	1	0	60	6	~	0	3	0	0
%Diff.	0%	0%	0%	0%	0%	-17%	-10%	-11%	47%	-8%	~	0%	-17%	0%	-8%
IND	0	0	0	0	17	1	0	2	0	0	0	~	8	0	4
%Diff.	0%	0%	0%	0%	-1%	4%	0%	9%	0%	0%	0%	~	3%	0%	13%
CHN	0	0	0	0	0	0	0	0	0	0	0	0	~	81	7
%Diff.	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	~	0%	11%
JAP	0	0	0	0	3	1	0	276	0	0	11	8	60	0	16
%Diff.	0%	0%	0%	0%	-4%	0%	0%	5%	0%	0%	18%	-2%	-1%	0%	9%
ACP	0	69	0	0	0	0	0	4	0	0	0	64	0	0	0
%Diff.	0%	39%	0%	0%	0%	0%	0%	4%	0%	0%	0%	-4%	0%	0%	0%
ROW	0	0	0	5	18	15	0	0	12	107	0	60	0	264	~
%Diff.	0%	0%	0%	3%	-5%	-2%	0%	0%	73%	8%	0%	-4%	0%	-3%	~

Source: CAPRI model (Biofuel branch), 07.06.2010(RSA=Rest of South America; CHN=China; RBU=Russia, Belarus, Ukraine; ANZ=Australia and New Zeeland; BUR=Bulgaria and Romania; ROW=Rest of World)

In general, all calculated scenarios result in a decrease of 1st generation production in Europe, only the absolute level is different. Thus, in all scenarios a decrease of biofuel feedstock demand for traditional agricultural crops can be observed. Table 11 gives detailed information of the changes in feedstock demand as well as all market balance positions for most affected agricultural crops. Based on these changes Table 12 summarises the resulting price shift for agricultural products which is of high interest with respect to the recent discussion on rising food prices resulting from biofuel support measures.

Table 11: Market balance of important 1st generation feedstock in EU27 (Scenarios)

EU 27		Baselline					SC1 (high SECG)					SC2 (no EU tariffs)					SC3 (no EU support)				
	Unit	PROD	BIOF	FEED	IMPT	EXPT	PROD	BIOF	FEED	IMPT	EXPT	PROD	BIOF	FEED	IMPT	EXPT	PROD	BIOF	FEED	IMPT	EXPT
Cereals	kton	316905	25854	175988	18508	44925	312699	18579	177912	17977	45288	313511	18154	178419	17840	45752	310656	9701	181798	17031	46595
	%Diff.						-1%	-28%	1%	-3%	1%	-1%	-30%	1%	-4%	2%	-2%	-62%	3%	-8%	4%
Wheat	kton	143810	8516	55481	5565	22319	141906	6130	55609	5503	22538	142284	6009	55820	5470	22745	140910	3222	56440	5287	23131
	%Diff.						-1%	-28%	0%	-1%	1%	-1%	-29%	1%	-2%	2%	-2%	-62%	2%	-5%	4%
Rye	kton	7458	2179	3181	1961	1269	7213	1619	3348	1901	1315	7265	1573	3406	1899	1339	7188	917	3766	1820	1418
	%Diff.						-3%	-26%	5%	-3%	4%	-3%	-28%	7%	-3%	5%	-4%	-58%	18%	-7%	12%
Barley	kton	63763	6698	39092	3318	10957	62787	4818	39866	3228	10957	63105	4699	40175	3209	11041	62737	2638	41585	3138	11171
	%Diff.						-2%	-28%	2%	-3%	0%	-1%	-30%	3%	-3%	1%	-2%	-61%	6%	-5%	2%
Oats	kton	13867	1000	10661	232	1446	13811	726	10822	214	1483	13888	713	10871	203	1513	13939	367	11176	182	1578
	%Diff.						0%	-27%	2%	-8%	3%	0%	-29%	2%	-12%	5%	1%	-63%	5%	-22%	9%
Maize	kton	78056	5876	59074	2481	5324	77203	4152	59661	2386	5438	77123	4070	59517	2365	5534	76049	1953	60047	2155	5675
	%Diff.						-1%	-29%	1%	-4%	2%	-1%	-31%	1%	-5%	4%	-3%	-67%	2%	-13%	7%
Oth. Cereals	kton	9952	1586	8497	4951	3609	9779	1136	8605	4746	3557	9847	1091	8629	4694	3581	9833	605	8783	4450	3621
	%Diff.						-2%	-28%	1%	-4%	-1%	-1%	-31%	2%	-5%	-1%	-1%	-62%	3%	-10%	0%
Vegetable oils	kton	15622	10445	712	13061	1635	15427	8088	1136	11865	1712	15614	10307	735	12980	1641	15103	3568	2449	10063	2006
	%Diff.						-1%	-23%	59%	-9%	5%	0%	-1%	3%	-1%	0%	-3%	-66%	244%	-23%	23%
Rape oil	kton	6280	6328	284	5172	621	6126	5226	529	4708	639	6272	6262	297	5140	621	5871	2758	1492	3960	765
	%Diff.						-2%	-17%	86%	-9%	3%	0%	-1%	5%	-1%	0%	-7%	-56%	426%	-23%	23%
Sunf. Oil	kton	3377	1397	82	1079	169	3302	1030	129	913	170	3375	1379	85	1068	168	3171	336	228	600	185
	%Diff.						-2%	-26%	56%	-15%	1%	0%	-1%	3%	-1%	0%	-6%	-76%	176%	-44%	9%
Soya oil	kton	3210	829	225	507	736	3244	607	356	484	794	3212	815	231	505	743	3311	232	612	511	947
	%Diff.						1%	-27%	58%	-4%	8%	0%	-2%	3%	0%	1%	3%	-72%	172%	1%	29%
Palm oil	kton	64	1891	0	5940	0	64	1225	0	5398	0	64	1852	0	5905	0	62	242	0	4631	0
	%Diff.						-1%	-35%	0%	-9%	0%	0%	-2%	0%	-1%	0%	-3%	-87%	0%	-22%	0%
Sugar	kton	17397	3994	50	8407	2938	16975	3375	51	8198	2926	17437	3386	53	7948	2973	16384	1808	55	7396	2911
	%Diff.						-2%	-15%	2%	-2%	0%	0%	-15%	5%	-5%	1%	-6%	-55%	10%	-12%	-1%

Source: CAPRI model (Biofuel branch), 06.06.2010 (PROD=Production; BIOF=Biofuel feedstock demand; FEED=Feed demand; IMPT=Import; EXPT=Exports)

Table 12: Price changes for affected agricultural products (Scenarios)

EU 27		Baselline		SC1 (high SECG)		SC2 (no EU tariffs)		SC3 (no EU support)	
	Unit	PPRI	PMRK	PPRI	PMRK	PPRI	PMRK	PPRI	PMRK
Cereals	€/ton	100.90	101.41	99.92	100.39	99.44	99.89	97.53	97.96
	%Diff			*-0.97%*	*-1.01%*	*-1.45%*	*-1.50%*	*-3.34%*	*-3.40%*
Wheat	€/ton	122.36	123.7	121.66	123.04	121.16	122.58	119.31	120.77
	%Diff			*-0.57%*	*-0.50%*	*-0.98%*	*-0.87%*	*-2.49%*	*-2.34%*
Rye	€/ton	102.59	101.5	100.67	99.45	99.99	98.77	97.01	95.76
	%Diff			*-1.87%*	*-1.98%*	*-2.53%*	*-2.65%*	*-5.44%*	*-5.62%*
Barley	€/ton	98.28	97.54	97.46	96.77	97.01	96.33	95.21	94.6
	%Diff			*-0.83%*	*-0.79%*	*-1.29%*	*-1.24%*	*-3.12%*	*-3.01%*
Oats	€/ton	76.94	76.18	76.15	75.37	75.76	74.95	74.26	73.43
	%Diff			*-1.03%*	*-1.06%*	*-1.53%*	*-1.61%*	*-3.48%*	*-3.61%*
Maize	€/ton	95.68	96.16	95.03	95.53	94.75	95.28	93.4	93.96
	%Diff			*-0.68%*	*-0.66%*	*-0.97%*	*-0.92%*	*-2.38%*	*-2.29%*
Oth. Cereals	€/ton	109.57	113.5	108.57	112.17	107.95	111.41	105.99	109.24
	%Diff			*-0.91%*	*-1.14%*	*-1.48%*	*-1.81%*	*-3.27%*	*-3.72%*
Sugar	**€/ton**	**402.74**	**402.4**	**402.43**	**401.96**	**401.61**	**401.17**	**399.13**	**398.47**
	%Diff			***-0.08%***	***-0.10%***	***-0.28%***	***-0.30%***	***-0.90%***	***-0.97%***
Vegetable oils	**€/ton**	**626.06**	**589.99**	**592.33**	**558.72**	**624.72**	**588.74**	**538.81**	**510.14**
	%Diff			***-5.39%***	***-5.30%***	***-0.21%***	***-0.21%***	***-13.94%***	***-13.53%***
Rape oil	€/ton	578.91	548.5	534.15	506.42	576.63	546.29	457.34	434.5
	%Diff			*-7.73%*	*-7.66%*	*-0.39%*	*-0.39%*	*-21.00%*	*-20.78%*
Sunf. Oil	€/ton	724.8	648.3	684.9	612.81	723.51	647.21	623.11	561.66
	%Diff			*-5.50%*	*-5.48%*	*-0.18%*	*-0.17%*	*-14.03%*	*-13.37%*
Soya oil	€/ton	604.83	567.5	567.7	533.11	603.53	566.24	514.45	484.07
	%Diff			*-6.14%*	*-6.05%*	*-0.21%*	*-0.21%*	*-14.94%*	*-14.69%*
Palm oil	€/ton	595.71	595.7	582.55	582.55	595.22	595.22	560.33	560.33
	%Diff			*-2.21%*	*-2.21%*	*-0.08%*	*-0.08%*	*-5.94%*	*-5.94%*
Biodiesel	**€/ton**	**734.29**	**1250**	**629.43**	**1070.89**	**726.66**	**1237.02**	**491.34**	**807.37**
	%Diff			***-14.28%***	***-14.35%***	***-1.04%***	***-1.06%***	***-33.09%***	***-35.42%***
Ethanol	**€/ton**	**844.92**	**1082**	**812.39**	**1039.89**	**806.07**	**1037.3**	**778.86**	**994.6**
	%Diff			***-3.85%***	***-3.91%***	***-4.60%***	***-4.14%***	***-7.82%***	***-8.09%***

Source: CAPRI model (Biofuel branch), 06.06.2010 (PPRI=Producer Price, PMRK=Domestic market price)

In Scenario 1, feedstock demand decreases by 28% for aggregated cereals and by 23% for aggregated vegetable oils. This reduction leads to an only marginal decrease of domestic production by 1% for aggregated cereals and vegetable oils, which can be explained by the fact that the lower demand is partially compensated by an increase of feed demand as biofuel by-products (e.g. DDGS) automatically decline and the substitution effect for traditional feeding products (like cereals) is significantly reduced. In the case of vegetable oils, this compensation effect is only marginally due to the fact that these products are hardly used for feeding purposes. Even though the percentage change signalises a strong increase in feed demand for vegetable oils (over 50%), the absolute numbers are small. Thus, in contrast to the different cereals, a stronger decrease in EU imports can be observed because overall demand for vegetable oils decreases more than overall demand for cereals. This situation can also be identified by looking at Table 12, which displays the resulting price changes for agricultural products. While cereal prices only change marginally, by app. -1%, producer (PPRI) and market (PMRK) prices for aggregated vegetable oils decrease by over 5%. The price for rape oil is particularly affected decreasing by nearly 8%.

Scenario 2 shows a decrease in biofuel feedstock demand of 30% for aggregated cereals and of only 1% for aggregated vegetable oils. This results form the already described stronger impact of the abolished biofuel tariffs on the ethanol market. Due to the similar decrease in cereals demand, the shifts in all market balance positions for different cereals are nearly equal to Scenario 1. The decrease of feedstock demand for vegetable oils by 1% does not lead to notable impacts within the market balance and thus also no notable price changes for vegetable oil products occur. More significant results show Scenario 3. The already described highest decrease in 1st generation biofuel production leads of course to a significant decrease of feedstock demand which is similar for vegetable oils (-66%) and cereals (-62%). On the cereals market, domestic production decreases at an average of 2%, whereas imports decrease by 8% and exports increase by 4%. The higher feed demand leads to a partially compensation of the lower biofuel feedstock demand. As this compensation effect is not so strong on the vegetable oil market (with respect to the absolute numbers), domestic production decreases more significantly than in the case of cereals, at an average of 3%, whereas imports decrease by 23% and exports increase by 23%. Thereby, the highest effects occur on the rape oil market. These significant changes in the market balance positions also lead to significant price decreases. Cereal prices decrease at an average of 3.4% and vegetable oils at an average of 13.5%. Here, also rape oil is most affected with a price decrease of more than 20%. These observations are of high interest as they indicate which impact the sum of all envisaged biofuel support measures until 2020 might have on agricultural product prices and, thereby, also on food prices and farmers income.

The impacts on European environment addressed in this paper only take into account shifts in agricultural production activities within Europe. This is true for both groups of indicators which will be investigated: (1) Green House Gas (GHG) and N2O emissions (in kg/ha) caused by agricultural production activities and (2) the absolute land use (in 1000 ha) and land use share of different cropping activities (%) which indicate land use changes and biodiversity in used arable land.

As already described, changes in domestic production of agricultural commodities resulting from shifts in biofuel feedstock demand are rather marginal. From this it follows that environmental impacts of crop production caused by biofuel processing within the EU can only be observed on a very marginal level. Table 13 shows the arable land used by the respective crop activity and the crop share in total cropping activity with respect to the land used (Density) for the EU27.

Table 13: Land use and emission indicators differentiated by cropping activity (Scenarios)

		Baselline				SC1 (SECG)				SC2 (no tariffs)				SC3 (no support)			
		Land use	Den-sity	GW-PT	N2O	Land use	Den-sity	GW-PT	N2O	Land use	Den-sity	GW-PT	N2O	Land use	Den-sity	GW-PT	N2O
		1000 ha	*%*	*kg/ha*	*kg/ha*	*1000 ha*	*%*	*kg/ha*	*kg/ha*	*1000 ha*	*%*	*kg/ha*	*kg/ha*	*1000 ha*	*%*	*kg/ha*	*kg/ha*
EU27	**Soft wheat**	21065	11.2	1063	3	20,814	11.04	1,059	3.42	20,890	11.1	1,057	3.41	20,756	11.1	1,050	3.39
	Diff.					*-251*	*-0.14*	*-4*	*-0.01*	*-175*	*-0.08*	*-6*	*-0.02*	*-309*	*-0.13*	*-13*	*-0.04*
	Durum wheat	3531	1.87	551	1.78	3,526	1.87	550	1.77	3,530	1.88	549	1.77	3,529	1.88	545	1.76
	Diff.					*-5*	*0.00*	*-2*	*-0.01*	*-1*	*0.01*	*-2*	*-0.01*	*-2*	*0.01*	*-6*	*-0.02*
	Rye	2146	1.14	430	1.39	2,093	1.11	424	1.37	2,109	1.12	424	1.37	2,099	1.12	420	1.36
	Diff.					*-53*	*-0.03*	*-6*	*-0.02*	*-38*	*-0.02*	*-6*	*-0.02*	*-47*	*-0.02*	*-10*	*-0.03*
	Barley	13493	7.16	673	2.17	13,298	7.05	671	2.16	13,377	7.11	670	2.16	13,328	7.1	667	2.15
	Diff.					*-194*	*-0.11*	*-2*	*-0.01*	*-116*	*-0.05*	*-3*	*-0.01*	*-165*	*-0.06*	*-6*	*-0.02*
	Oats	4342	2.3	591	1.91	4,337	2.3	587	1.89	4,375	2.32	585	1.89	4,421	2.35	578	1.87
	Diff.					*-4*	*0.00*	*-4*	*-0.02*	*34*	*0.02*	*-6*	*-0.02*	*79*	*0.05*	*-12*	*-0.04*
	Maize	9643	5.12	1141	3.68	9,564	5.07	1,131	3.65	9,564	5.08	1,130	3.64	9,480	5.05	1,117	3.6
	Diff.					*-79*	*-0.05*	*-9*	*-0.03*	*-79*	*-0.04*	*-11*	*-0.04*	*-164*	*-0.07*	*-24*	*-0.08*
	Oth. Cereals	2766	1.47	787	2.54	2,727	1.45	780	2.52	2,751	1.46	780	2.52	2,761	1.47	776	2.5
	Diff.					*-39*	*-0.02*	*-7*	*-0.02*	*-16*	*-0.01*	*-7*	*-0.02*	*-6*	*0.00*	*-11*	*-0.04*
	Rape seeds	5618	2.98	1642	5.3	5,534	2.94	1,640	5.29	5,612	2.98	1,641	5.29	5,486	2.92	1,630	5.26
	Diff.					*-84*	*-0.04*	*-3*	*-0.01*	*-6*	*0.00*	*-2*	*-0.01*	*-132*	*-0.06*	*-12*	*-0.04*
	Sunf. seeds	3659	1.94	435	1.4	3,624	1.92	433	1.4	3,657	1.94	434	1.4	3,599	1.92	429	1.38
	Diff.					*-35*	*-0.02*	*-2*	*0.00*	*-2*	*0.00*	*-2*	*0.00*	*-60*	*-0.02*	*-6*	*-0.02*
	Soya beans	602	0.32	1328	4.28	608	0.32	1,325	4.28	604	0.32	1,328	4.28	619	0.33	1,319	4.25
	Diff.					*6*	*0*	*-3*	*0.00*	*2*	*0.00*	*0*	*0.00*	*18*	*0.01*	*-9*	*-0.03*
	Sugar beets	1599	0.85	1851	5.97	1,562	0.83	1,840	5.94	1,604	0.85	1,845	5.95	1,513	0.81	1,835	5.92
	Diff.					*-37*	*-0.02*	*-11*	*-0.03*	*5*	*0.00*	*-6*	*-0.02*	*-86*	*-0.04*	*-16*	*-0.05*
	New energy crops	4554	2.42	22	0.07	5,641	2.99	22	0.07	4,554	2.42	22	0.07	3,715	1.98	22	0.07
	Diff.					*1087*	*0.57*	*0*	*0.00*	*0*	*0.00*	*0*	*0.00*	*-838*	*-0.44*	*0*	*0.00*

Source: CAPRI model (Biofuel branch), 06.06.2010

The changes in the crop density are smaller than 0.15% over all scenarios, of course with the “highest” changes in Scenario 3. This corresponds to the marginal changes in the land used by the respective crop activities. The same is true for the GHG potential (GWPT) and N2O emissions (N2O) caused by agricultural production activities as also displayed in Table 13. The changes in N2O emissions over all scenarios are smaller than 0.1 kg/ha and the GHG potential does not change above 25 kg/ha on EU27 level. Thus, the emissions and the crop shares caused by agricultural production activities in the baseline do not changed notably over all scenarios. Taking into account the observations on shifts in biofuel as well as biofuel feedstock trade caused by the different scenarios and the observations on corresponding shifts in European crop production, it can be supposed that the main environmental effects caused by European biofuel consumption occur outside the EU, in particular in those regions which produce biofuel feedstock.

5. CONCLUSIONS

Coming back to the initial questions stated in the introduction, the results of the scenario analysis highlight the following summarised findings. The impacts of the EU 2020 biofuel target on global and European biofuel as well as agricultural markets are notable. This becomes obvious in particular by looking at the results of Scenario 3. Compared to a situation without any biofuel support, European biofuel production declines by approx. 70-80% which leads to a share of biofuels in overall fuel consumption lesser than 1.8%. Also global biofuel trade is strongly dependant on the European support regime. In a situation without European biofuel support, imports of ethanol (mainly from Brazil and the US) decline by more than 70% and biodiesel imports (mainly from the US and Argentina) decline by approx. 90%. The resulting effects on the agricultural product markets are also significant. However, the substitution effect of traditional feeding crops by biofuel by-products on the feed market leads to a partial compensation of the additional demand quantities for agricultural crops caused by biofuel production. As this effect is stronger in the case of cereals, demand effects are more significant in the case of vegetable oils. While the feedstock demand increase shows a notable impact on feedstock prices, especially in the case of rape oil (+20%), domestic crop production is only affected marginally because the in- or decreasing demand is mainly compensated by shifts in import or export flows. Consequently, environmental effects caused by agricultural production activities do not change notable with or without the consideration of European biofuel production. This is true for the land used by individual cropping activities as well as for GHG emissions caused by those activities over all scenarios. Thus the suggestion can be made that significant environmental impacts caused by the European biofuel consumption or production will occur outside the EU, especially in those countries which are important producers of biofuel feedstock.

A more rapidly increase in 2^{nd} generation biofuel production leads to decreasing biofuel prices and then to a slightly higher share of biofuels in total fuel consumption. However, the most notable effect is the substitution of 1^{st} generation biofuels by 2^{nd} generation biofuels, which leads to a decrease of 1^{st} generation production by 20% and consequently also to a decrease of feedstock demand between 23 - 28%. Here, the price effects (-1% in the case of cereals and -5% in the case of vegetable oils) are more significant as shifts in domestic production as the variation in feedstock demand is mainly filled by shifts in trade flows. However, the absolute changes in global import and export flows are marginal which leads to the finding that such a technology improvement mainly leads to intra-EU market changes.

The abolishment of the EU import tariffs for biofuels mainly affects the ethanol market, whereas the European biodiesel market remains largely untouched. Ethanol imports from Brazil and the US increase between (150 - 200%) which leads to a decrease of domestic ethanol production by 21%. The resulting biofuel price decrease leads to a higher share of ethanol in total gasoline consumption of 10%.

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