Chapter 3.

Costs and Benefits of Biofuel Support Policies

The preceding chapter presented and discussed the results of model-based analyses. Existing and new biofuel support policies were in the centre of the set of scenarios that were calculated using a large-scale economic modelling system Aglink-Cosimo, complemented by a stylised model on environmental implications of the policy changes, SAPIM. As for the results of any modelling system, those discussed above are subject to a certain degree of uncertainty, related to parameters and structures in the represented markets.

This chapter now aims at combining the model results with the factual information provided in Chapter 1 in order to derive conclusions on the effectiveness and efficiency of biofuel support policies. In doing so, it is important to bear in mind the limitations of the modelling approach caused by the high degree of complexity in this area.

The elaborations below will follow the list of main objectives behind public support for biofuel production and use. This chapter will hence discuss the effectiveness of support policies with respect to the avoidance of greenhouse gas emissions, to savings in fossil fuel use, and to rural development, before further exploring possible side effects including the risk of food price inflation and environmental degradation. The results shown are limited to the policies in the US, the EU and Canada, and relate to the overall impact of their policies (as opposed to policies in individual countries).

The objective of GHG mitigation – impacts and cost effectiveness

The quantitative analysis above shows that currently policy regimes and recent and envisaged policy changes have considerable impacts on biofuel markets. Indeed, on average for the 2013-2017 period, existing biofuel support policies (*i.e.* the recent US Energy Improvement and Security Act and the proposed EU Directive on Renewable Energy not included) are found to increase total supply and use of biofuels by about 13 billion litres of biodiesel and 17 billion litres of ethanol. In particular, this includes the use of a variety of feedstocks in the four regions considered in more detail here, *i.e.* Brazil, the US, Canada and the EU. While biofuel production in the US, Canada and the EU is increased through those countries' support policies, ethanol production in Brazil, based on sugar cane, is slightly reduced.

To calculate total GHG avoidance from these policy-induced quantities, we use robust ranges of values for GHG improvement rates from biofuels as discussed in Chapter 1 as well as a standard GHG emission level for a litre of gasoline or fossil diesel, respectively. These values are, as discussed above, subject to a certain degree of uncertainty and in particular will not be exact under all conditions prevailing in the different countries. The ranges given can, however, serve as proxies for average conditions and hence are appropriate for calculating total GHG avoidance figures. These global totals are particularly relevant as the reduction of GHG emissions is aiming at solving a genuinely global problem – in contrast to other issues discussed below the regional distribution is of lesser importance.

Table 3.1 shows that grain-based ethanol as well as biodiesel from vegetable oils – predominantly from rapeseed or canola oil – represent the vast majority of the biofuels boosted by support policies in North America and Europe. Ethanol from sugar cane, among the most important feedstock commodities worldwide in absolute numbers, is reduced by biofuel support policies, as support within Brazil is not fully taken into account in this analysis and as the effect of additional incentives from support to ethanol use in export destinations is largely offset by trade barriers.

Using average GHG reduction rates, the additional biofuel quantities created by public policies in Brazil, the US, Canada and the EU tend to avoid between 15 and 27 million tonnes of greenhouse gases (CO2-eq.) per year between 2013 and 2017. This compares to current global energy-related GHG emissions of some 27 billion tonnes per year, of which 3 billion tonnes of CO2-eq. are caused by oil use in the North-American and EU transport sectors. These transport-related emissions are estimated to further increase to some 3.3 billion tonnes of CO2-eq. by 2015.[1] In other words, existing support in the US, Canada and the EU is estimated to reduce transport-related GHG emissions by between 0.5% and 0.8% of transport fuel related emissions in these regions projected for 2015.[2]

Support to biofuels in the US, Canada and the EU has been estimated by the Global Subsidies Initiative to total about USD 11 billion in 2006.[3] Extrapolated for the 2013-2017 average production numbers in these three regions[4] this amount increases to about USD 27 billion per year[5] - more recent updates of the GSI data would suggest extrapolated support to be as high as USD 31 billion per year. This report does not use the GSI estimates but projects levels of support based on the OECD/FAO Aglink-Cosimo model as used for the analysis underlying the present report. Taxation and tariff measures accounted for in this analysis amount to a total of USD 25.4 billion, on average, for the 2013-2017 period, up from USD 11 billion in 2006. Using these numbers as proxies for actual support, and not taking into account other objectives targeted with the same support (see below), lowering GHG through policy support to biofuels would cost taxpayers and consumers on average between USD 960 and 1 700 per ton of CO2-equivalent avoided in those countries. This rough and average value is not only much higher than the carbon value at European and US carbon markets (CO2-futures for 2012 at the European Trading Scheme have been floating between EUR 22 and EUR 26 per tonne until late March 2008 and have increased somewhat thereafter, while futures for 2014 traded around EUR 31 per tonne in mid April[6]), but also above most of the avoidance costs calculated in the GSI studies (ranging from USD 250 to USD 5 500 per tonne CO2-eq for ethanol and from USD 250 to USD 1 000 per tonne CO2-eq. for biodiesel in the three regions considered here). The main reason is that here only the extra biofuel quantities actually generated by the public support are taken into consideration, as opposed to total biofuel output accounted for in the GSI studies. Much of the projected biofuel production is linked to support that has been provided in the past.[7]

Table 3.1. Impact of current biofuel support on GHG savings through ethanol and biodiesel production, 2013-2017 average

	Biofuel production			GHG emissions				
	Base	No support	Difference	Fossil standard	Average reduction		Avoided	
	Million litres per year			kg/l	from %	to %	from kt	to kt
Ethanol from wheat	7 405	803	6 602	2.682	30	55	3 558	6 524
Ethanol from coarse grains	54 274	42 109	12 165	2.682	10	30	2 186	6 557
Ethanol from sugar cane	36 093	38 546	-2 452	2.682	80	90	-3 525	-3 965
Ethanol from sugar beet	1 288	524	764	2.682	40	60	549	824
Biodiesel from vegetable oil	16 270	3 723	12 547	3.017	40	55	12 113	16 655
Total Five biofuels	115 331	85 705	29 626	n.a.	n.a.	n.a.	14 881	26 594

Source: Aglink/Cosimo Simulation Results; standard emissions based on EC (2008), p. 56; average GHG reduction rates based on Chapter 1 of this report; OECD Secretariat.

These figures obviously need to be read with great care given the large uncertainties around several parameters in the calculation, and should therefore be taken as indicative only. In particular, they do not account for possible improvements in the environmental performance of biofuels over the decade to come. With shrinking crude oil reserves the environmental characteristics of fossil fuels may worsen in the future, improving the relative performance of biofuels. The figures discussed here also do not account for any effects from land use changes triggered by the expanded biofuel production. As discussed in Chapter 1, the conversion of natural habitats can generate substantial emissions of greenhouse gases, while conversely the use of marginal land for extensive energy production such as short rotation coppice may increase carbon sequestration.

The Aglink-Cosimo simulations indicate that biofuel support is responsible for more than one fifth of the 27 million hectares expansion of the area globally used for cereals, oilseeds and sugar crops between 2007 and 2017. Some of the increased land use, however, reflects a slowing of area reduction trends rather than actual expansions, so the risk of environmental damage from this land use change is likely to be small.[8] This concerns in particular the United States and the EU where a combined 2.5 million hectares would additionally go out of crop production without biofuel support. Area expansion is accelerated, however, in large parts of Latin America, Asia and Developing Africa, affecting about 3 million hectares. Some of that land may be covered by agricultural crops not considered in this analysis, such as permanent crops, fruits and vegetables, but most of this land is not likely to be converted into arable land as these former uses are generally of higher value and hence less likely to become converted. Assuming that the land were mainly converted from permanent grassland, the (relatively low) values in the German SBO draft (see Chapter 1) would suggest that the conversion would result in carbon losses of about 15 t per hectare, equivalent to 55 t of CO2. Conversion of 2 million hectares – this consequently assumes a certain share of the additional land not to come from non-agricultural land types – caused by biofuel support would hence result in an additional one-off emission of 110 Mt of CO2 – roughly five times the annual GHG avoidance created by the support. Converting more sensitive land such as forests or savannahs would create substantially higher emissions than the 55 t per hectare.

Again, these numbers have to be read with great care, as they represent no more than an indicative figure. With increased awareness about climate change issues and the link between land use changes and GHG emissions, as well as with increased consideration of land use change related effects in biofuel policy frameworks, it can be hoped that in most cases sensitive areas will be excluded from crop land expansions. Efforts are being made to convert marginal land in Africa and Asia to produce Jatropha for biodiesel, and although the related quantities are not expected to become large relative to global biofuel or crop production, this conversion may actually create additional carbon sinks and improve GHG balances beyond the pure LCA improvement rates. In any case, however, great care has to be taken in the design of biofuel support policies – and in fact in a more general policy framework to reduce global GHG emissions – to avoid land use change related emissions to the largest extent possible.

An elimination of import tariffs for biofuels – mainly ethanol – could have already significant effects on the amount of GHG avoided via biofuels. Using the same approach as above, a tariff elimination alone would reduce the production of grain- and sugar beet-based ethanol by more than the increase in sugar-cane based ethanol. Due to higher GHG reduction rates for cane-ethanol, however, total GHG avoidance would increase by between 3.5 and 6 Mt of CO2-equivalent per year – about 20% of the GHG savings expected to result from existing support policies. Again, of course, these gains would have to be balanced against potential emissions from additional land use changes: In particular, about 0.8 million ha would additionally go into crop production in Latin America for the 2013-2017 average, with a potential one-of carbon release of some 44 Mt of CO2-equivalent, using the same figures as above. On the other hand, lower cereal and oilseed prices would reduce the area expansion in Asia and Africa by more than one million ha, potentially offsetting the increased land use in Latin America. Clearly, more in-depth analysis about the land types affected in the different regions is necessary to assess the impact the land use changes could have on global GHG emissions.

Second-generation biofuels clearly have the potential to reduce land pressure if feedstock biomass can be produced on ecological low-value land. In particular the use of degraded land, covering increasing areas in a number of regions, would offer to improve the GHG performance of biofuels beyond the levels found in LCA studies and could create substantial benefits in non-GHG environmental issues. Biomass yields in these areas, however, tend to be substantially lower than on more productive land, a fact that is unlikely to change even as varieties are being developed that are more resistant against dry, salinized or otherwise unfavourable conditions. In consequence, policy frameworks must ensure specific incentives to bring these areas into production as opposed to using environmentally sensitive land. This is particularly relevant in the context of the two major regulatory frameworks recently enacted (US EISA) or currently discussed (EU DRE). Both these frameworks take land use change related GHG emissions into account, and administrative details should ensure that the requirements are rigorously enforced for both domestic and imported biofuels – knowing that the consideration of direct and particularly of indirect land use changes is very difficult to handle.

The objective of energy savings – impacts and cost effectiveness

Reducing fossil energy use is one of the key determinants for the reduction of GHG emissions even though other elements contribute to the latter as discussed in Chapter 1. Generally, energy replacement shares are slightly lower for the various ethanol pathways than GHG improvement rates. For oilseed based biodiesel, the opposite is true due to the importance of nitrous oxide emissions.[9]

As discussed above, substituting gasoline and diesel use in the transport sector by increased shares of ethanol and biodiesel heavily depends on public support. In fact, biodiesel shares in the EU and US diesel fuel consumption would be only marginal (less than half a percent) in the medium term without support while existing support measures should maintain a considerable growth in the EU biodiesel share (while maintaining the existing US biodiesel share). With the new regulations, both countries are set to increase these shares significantly. While ethanol use probably could grow even without support in Brazil and in the US, existing support generates incentives to significantly accelerate this growth.

Given the fossil energy needed in the production of biofuels – both in agriculture and in the processing phase – the share of fossil fuels actually replaced by biofuels is, however, substantially lower than the fuel replacement at the pump. Table 3.2 shows that the EU biodiesel market is the only case where current support in North America and Europe generates a replacement of fossil fuels through biofuels by more than 2%.

On average, the existing support results in a medium-term replacement of fossil fuel worth about 0.9% to 1.3% of diesel use and about 0.1 to 0.4% of gasoline use in the three regions considered.[10]

It needs to be noted, however, that much of the fossil energy used in the production of biofuels – again both in agriculture and during processing – is not in the form of petroleum products, but in the form of coal or natural gas. As at least in some of the countries in question (notably the US and Canada, but also some of the EU Member States) both coal and natural gas are domestically available to a much larger degree than crude oil, the support to biofuels can also be seen as a replacement of (imported) crude oil by (domestic) other fossil energy.

Again, these numbers need to be put in relation to the amount of support generating this additional replacement. The total support figures as used above suggest that the US, the EU and Canada will use some USD 17.5 bn and USD 8 bn per year on average over the 2013-2017 period to support their ethanol and biodiesel industries, respectively. Using these numbers (and again not considering other objectives for the moment) suggests that the medium-term replacement of fossil fuels by supporting ethanol use would cost between USD 7 and USD 15 per litre of gasoline equivalent on average. The support for biodiesel use seems more efficient in these countries at between USD 1.20 and 1.60 per litre of diesel equivalent.[11]

The picture changes significantly when only the imported crude oil is taken into account. In this case, and making the (simplifying) assumption that no crude oil is used in the production of biofuels, oil imports are replaced by the domestic use of other forms of energy (*e.g.* coal, natural gas) using biofuels as a means to make these energy carriers combustible in transport vehicles, with average replacement costs per unit of crude oil-based fuels significantly lower than the figures shown above at around USD 2.35 per litre of gasoline and USD 0.80 per litre of diesel.[12]

Table 3.2. Impact of current biofuel support on fossil fuel savings through ethanol and biodiesel use, 2013-2017 average

		Corresponding fuel use total	Biofuel use (million litres)			Fossil fuel replacement						
			Base	No support	Difference	At pump	Net rate, % of	At pump	Net, absolute		Net of total fuel use	
		Million litre (ml) per year					From %	To %	From ml/y	To ml/y	From %	To %
US	Ethanol	603 652	55 091	49 748	5 343	3 580	7.7%	23.0%	274	823	0.05%	0.14%
	Bioduesel	275 348	1 613	726	888	710	48.3%	66.4%	343	472	0.12%	0.17%
EU	Ethanol	160 013	13406	8 295	5 110	3 424	23.0%	42.2%	787	1 444	0.49%	0.90%
	Bioduesel	231 408	13 931	1 762	12 169	9 736	48.3%	66.4%	4 702	6 466	2.03%	2.79%
Canada	Ethanol	44 119	2 905	2 206	699	468	15.3%	32.6%	72	153	0.16%	0.35%
	Bioduesel	18 587	521	760	-238	-191	48.3%	66.4%	-92	-127	-0.50%	-0.68%
Total	Ethanol	807 785	71 401	60 249	11 152	7 472	n.a.	n.a.	1 134	2 420	0.14%	0.30%
	Bioduesel	525 343	16 066	3 247	12 819	10 255	n.a.	n.a.	4953	6 811	0.94%	1.30%

Notes

"Corresponding fuel use" represents total fuel use in spark-ignition engines and compression-ignition engines in the countries' transport sectors, respectively.

"Fossil fuel replacement at pump" is calculated as the amount of biofuels generated through support policies ("Biofuel use Difference"), corrected for the lower energy content in biofuels compared to their fossil counterparts.

The net replacement rates are the net energy gains to be achieved from biofuels. These rates are calculated from the GHG emission reductions shown in Table 3.1, using the relative differences in fossil fuel and GHG reductions documented in Concawe (2006).

Source: Aglink/Cosimo Simulation Results, calculations by OECD Secretariat.

The objective of rural development – impacts on agricultural markets

Clearly expanding first-generation biofuel production is directly linked to increased demand for feedstock commodities. Maize in the US, sugar cane in Brazil and wheat in the EU are the primary feedstocks used in the ethanol industry, whereas rapeseed or canola oil currently constitutes the feedstock the bulk of biodiesel produced, particularly in the EU.

The medium-term effect of current (pre-EISA) biofuel support programs is considerable, but should not be overestimated. Without this support, international cereal prices would be about 5% to 7% lower over the 2013-2017 period than what is projected under current regimes. Prices for vegetable oils are more affected, but due to the opposite effect on oilseed meal prices (both because of decreased oilseed crush and because of lower availability of distillers grains, an important feed by-product from grain-based ethanol production replacing partly feedgrains, partly oilseed meals in the feed ratios) the effect on oilseed prices is relatively modest. Sugar prices would even be slightly higher without biofuel support – higher ethanol prices would create additional incentives for Brazil to increase its fuel production from sugar cane, leaving less cane for sugar production. In addition, a number of developing countries focus on ethanol from molasses – without their programs, incentives to produce molasses and hence sugar would decline.

These effects only partly represent the total impact of biofuels on agricultural markets for two reasons. First, even without biofuel support production of ethanol would grow in a number of countries. Were biofuel production forced to remain at its current level, prices for sugar and maize would be affected much more significantly, with medium-term levels lower by 23% and 13%, respectively. Growth in biofuel markets hence remains one of the major driving forces in agricultural markets and prices and is responsible for a significant share of the change in average historical price levels and those projected for the decade to come, as outlined in the *OECD/FAO Agricultural Outlook 2008-2017*.

Second, however, the price effect on crop markets represents an indicator for revenues of crop producers only. Livestock producers, however, face changes in their feed costs. Here, obviously, the increased biofuel production due to existing support measures drive up prices for feed grains as discussed in the previous paragraph. At the same time, costs for protein feed are lower due to the higher oilseed crush. Finally, the increased availability of distillers' grains at somewhat lower prices provides an interesting feed particularly to ruminant meat producers located relatively close to grain-based ethanol plants. This is obviously of particular relevance to the US markets due to the large quantities of distillers grains produced there and the importance of the US beef industry.

These offsetting factors together – increasing feed grain costs caused by grain-based ethanol versus reduced protein costs particularly due to increased biodiesel production – result in little change in average feed costs. Differences result in the different relative quantities of the various feedstuffs fed across countries: without the biofuel support, feed costs would be slightly higher in the US and the EU, but slightly lower in Canada as well as in countries without grain-based ethanol production. In all cases, however, these changes are modest in size, and consequently international prices for meat and dairy products change very little – with the notable exception of butter the medium-term price of which would be about 3% lower without biofuel support due to its substitution with vegetable oils.

Similar results are found for the combined implications of the US Energy Independence and Security Act (EISA) and the EU Directive for Renewable Energy (DRE), at least for the expansion of first-generation biofuels called for therein. Higher overall feed costs due to increased cereal use in ethanol production particularly in the US offset by lower feed costs due to increased oilseed crush for biodiesel leave average feed costs slightly lower than without these programmes.

In contrast, depending on the share of second-generation biofuel feedstocks produced on crop land, increased cellulosic ethanol and BTL production raises prices for all crops and their derived products – in consequence, the production of second-generation biofuels tends to increase overall feed costs by about 2% in most regions, depending to the abovementioned share of feedstock biomass to be produced on crop land and on the degree to which countries are linked to international market prices. In consequence, international pork and beef prices increase by about 1 percent in the medium term – slightly more for pork than for beef as beef production is partly grass based. Income prospects therefore, while positively affected by biofuel policies for crop farmers, on average are largely unaffected on average for livestock producers by existing and new policies on first-generation biofuels; negative effects from support to grain-based ethanol are offset by positive effects from support to oilseed-based biodiesel. Second-generation fuels are reducing margins for meat and dairy producers, although changes are relatively modest in the medium term.

In addition to the effects that can be described by price and income changes, the land use for agricultural production represents an important indicator for rural development as well. The simulations suggest that the support for biofuels results in less area being removed from crop production both in the US and in the EU, in the order of 0.7 million ha and 1.7 million ha in the medium term. A more detailed analysis of the regional effects within the EU and the US would be needed to derive final conclusions on what these area effects would mean, but as less productive areas are likely to be affected more by changed economic incentives than good soils, it seems plausible to expect the existing and new support policies for biofuels to have a positive effect on agricultural activity in remote and marginal areas. While rural development obviously is much more than keeping land in agricultural production and farmers in remote areas, this constitutes an objective for a number of countries. Earlier work by the OECD[13] has shown, though, that targeted measures such as direct payment schemes are more likely to achieve such objectives in an efficient way than support via higher commodity prices, which is the path of biofuel policies affecting land use.

Clearly, the objective of rural development goes beyond the pure effects on agricultural commodity markets even though an expansion of agricultural activity can be seen as an important development in this regard. But the installation of biofuel plants, the development of the rural infrastructure and in particular the creation of additional jobs in the biofuel production and in related industries is seen by many as an important result of increased biofuel markets. This study cannot analyse the effects on rural employment and livelihood in detail. These effects depend, however, crucially on the way biofuel industries and agriculture are structured and work in the different countries. With the consolidation of biofuel companies in numerous countries and the internationalisation of the industry, both of which have started after the first years of rapid expansion of the sector,[14] the share of biofuel plants owned by farmers and other parts of the rural community is declining. Given the required technology for second-generation biofuels[15] and the related levels of necessary investments it seems likely that this development will continue.

Combined assessment of biofuel support policies in view of underlying objectives

The analysis of effects of biofuel support policies, as outlined above, is partial in several dimensions. Most importantly, attributing total policy costs to the different policy objectives individually obviously ignores the fact that, with the same set of policy measures, a range of objectives are addressed at the same time. In principle, it would therefore be necessary to attach values to each of the individual objectives addressed by biofuel support, to quantify the monetary benefits of these policies (including the unintended effects, such as those discussed below) and to compare those to the expenditures for the support. While the future prices for emission rights under the European Trading Scheme may be considered to be a (rough) proxi for the value of GHG avoidance, the value for the reduction in fossil fuel use is more difficult to assess (note that the current prices of fossil energy are not necessarily a good indicator as the support is given over and above existing market incentives which include these prices). Developing rural areas, as well as the reduction of crude oil imports considered as less secure for geopolitical reasons, has values that are even less obvious to quantify. Therefore, and while a full cost-benefit analysis of these measures does not seem possible within the scope of this report, the calculation of support costs per tonne of CO2-equivalent avoided by biofuels, or per unit of fossil energy saved, can only give a partial answer to the efficiency question raised.

More importantly, however, it seems that all these objectives seem likely to be achievable in an efficient way with policy measures that are more targeted to the problems themselves: GHG emissions, scarcity of fossil fuels and undesired fuel imports have their origins much more in the level of fossil energy used than in the lack of alternative supplies. Measures helping to reduce the overall energy use, and particularly that in the transport sector, can achieve the related objectives in a more cost-effective manner and with lower risk of negative side effects. Similarly, targeted measures to prevent depopulation of remote parts of countries and to stimulate non-agricultural economic activities in rural areas are likely to be more efficient to stimulate rural development than measures that tend to raise crop prices.

The risk of food inflation – implications for food prices and food security

The consequences of existing and new biofuel policies on agricultural commodity prices in international markets have been discussed above. Clearly, the increased production of cereal-based ethanol and of oilseed-based biodiesel causes prices for grains and vegetable oils to be higher than what they would be without this support. For livestock products the price effects differs between grain-based ethanol (resulting in somewhat higher meat and dairy prices) and oilseed-based biodiesel (lowering livestock prices) as the former creates an additional net demand for feed products while the latter increases supply of protein feed. The implications for food prices and particularly for food security are, however, much more complex than those for basic commodity prices and can be discussed here only broadly.

Food prices generally are linked to basic commodity prices to a certain degree but also include costs for manufacturing, packaging, retailing etc. These additional costs are more important in high-income industrialized countries than in many developing countries where the share of basic foodstuffs in food expenditure is higher. Furthermore, lower incomes in most cases are linked to higher shares of cereals, roots and tubers as staple food, prices of which tend to increase more strongly due to biofuel expansion, whereas the consumption of meat and dairy products – less affected by biofuels – represents lower shares in low-income populations. In consequence, food expenditure is affected much more strongly for poor population groups than for high-income populations. Given on top of this the high share of food in consumer expenditure for these groups the higher prices for basic food commodities represents a substantial threat to low-income consumers in developing countries. This is even more the case in a situation of high prices for most food commodities, with projections suggesting that prices are unlikely to come down to levels observed in the past.

On the other hand, higher prices due to biofuel expansions as well as the development of adapted biofuel production systems in developing countries can create new income opportunities for rural and agricultural communities. Differentiation has to be made between subsistence and market producers in developing countries – while the former group will be largely unaffected by higher crop prices, net sellers of agricultural produce will be able to benefit from higher prices to the degree they are connected to markets that are integrated with international trading systems. Better income opportunities might also derive for landless workers in developing countries' agriculture given the incentives to intensify agricultural production.

Finally, the production of biofuels in developing countries can in itself generate income to low-income groups. Several developing countries have specifically targeted poor households and small farms in setting up biofuel programmes.[16] As most of these programmes are still in their initial phase, the actual impact of local biofuel projects on the livelihood in these countries will need further analysis.

The risk of environmental degradation – impacts of intensification and land use changes

To give a full picture of the implications of continued support to biofuels, a range of environmental impacts other than the change in GHG emissions needs to be taken into account. Some of these have been analysed in a stylized way using the SAPIM Model.

Support for biofuels and related higher prices in particular for feedstock crops has environmental effects linked to agriculture through at least three different channels: bringing land otherwise not under crops into production; changing the crop structure within the existing arable land; and changing the intensity of variable inputs for individual crops.

Land use changes have been discussed to some degree above. Both existing legislations and new programmes to support biofuel expansion result in higher land use for cereals, oilseeds, sugar crops and, with the emergence of second-generation biofuels, biomass. Apart from related GHG emissions, these changes may have important consequences on biodiversity and natural habitats, but also runoffs of nutrients and pesticides etc. All these variables strongly depend on the occupation of the land before conversion into crop land, which in turn is likely to depend on the endowment of the different countries with alternative land types. The importance of land use changes is recognised by recent regulatory acts in various countries and is not limited to – even though accentuated by – the expansion of biofuel production. Monitoring and effectively controlling land use changes are therefore key measures in response to environmental pressures in sensitive areas beyond the current debate about biofuel support.

With changes in the crop price structure due to the biofuel use of specific commodities including particularly maize (US, Canada), wheat, rapeseed (EU, Canada), and sugar cane (Brazil), these crops are seen to expand significantly at the cost of other commodities used less in this sector. As discussed briefly above, the environmental performance can differ significantly across crops, and an expansion of wheat and rapeseed at the cost of oats tends to go along with substantially higher fertilizer and herbicide use and runoff, even though for certain environmental variables such as biodiversity there may be positive effects in some cases (see Annex C for SAPIM data for Finland). At the same time, these crops generally are associated with more intensive soil preparation, higher water use and erosion risks. Higher prices for these comparatively intensively produced commodities therefore tend to create or aggravate environmental pressures which, however, heavily depend on the local conditions. Again these problems, while potentially enforced by strong growth in biofuel production, are of more general nature, and existing and future regulatory frameworks need to ensure best agricultural practices to minimize adverse environmental effects from agricultural production. Where sufficient control mechanisms do not exist, changed cropping patterns due to market conditions changed by biofuel support may cause negative effects on the environment.

This also holds for intensification effects within individual cropping systems. Higher prices for crop commodities generally tend to increase optimal input rates of fertilizers, pesticides, irrigation etc. While in some cases this increase may be relatively small, the analysis for Finland exemplified that the aggregate impact on the environment is likely to be detrimental. Existing regulations in numerous countries explicitly take these effects in consideration as it is imperative to carefully monitor and control the environmental effects of agricultural production to avoid longer-term degradation of soils, ground and surface water.

Notes

1. IEA: World Energy Outlook (WEO) 2006 and 2007. All these numbers are projected to keep growing, although projected growth rates have been revised downwards in the 2007 edition of the WEO. As the 2007 edition does not provide transport-related emissions specifically, these were estimated using the emissions related to oil use from the 2007 WEO and the share of transport related emission in total oil use related emissions provided in the 2006 edition of the WEO.
2. Total biofuel production has a larger effect: Taking into account all biofuels produced (as opposed to those generated by future support) in North America and the EU (as we look at support in these countries only we exclude Brazilian ethanol here) during the 2013-2017 average, the reduction in GHG emissions would range from 0.9% to 1.8% of their total transport related GHG emissions projected for 2015. Not all of these reductions are caused by support over the decade to come, but result partly from support provided in the past. The values in this footnote are given here for transparency reasons but should not be read in terms of efficiency of support.
3. *Source*: *Global Subsidies Initiative* (2007). Updated on the basis of data contained in Koplow (2007).
4. The data provided in the GSI sources include an estimate of the shares of total support vary with biofuel quantities – the projections referred to here extrapolate this part using the projected biofuel quantities as published in OECD (2008a).
5. This extrapolation assumes that current forms of biofuel support remain maintained over the decade to come – as do the market projections presented in OECD (2008a) underlying the present analysis. It should be noted here that with technological advances in both existing and future biofuel chains the required support per unit of output might decline. While lower support would likely reduce biofuel output as well, the per unit support costs of biofuel-related GHG savings and, for that matter, achievement of other policy objectives might be reduced as well.
6. www.co2prices.eu accessed June 2008.
7. If the total biofuel production in those three regions were considered, the above numbers would suggest costs for taxpayers and consumers of between USD 430 and 840 per ton of CO2-equivalent avoided. These values are given here for transparency reasons but should not be read in terms of efficiency of support.
8. This depends on the fate of the abandoned land and may therefore not be true in all cases.
9. Concawe (2006).
10. Again, total biofuel use in these regions obviously has a larger fuel replacement effect, equivalent to about 1.5% to 2% of medium-term diesel use and 1% to 2.4% of gasoline use in the countries considered.

11. Taking total biofuel use into account, these replacement costs would be lower at USD 0.90 to 2.30 per litre of gasoline equivalent and USD 0.75 to 1.00 per litre of diesel equivalent on average. These values are given here for transparency reasons but should not be read in terms of efficiency of support. Due to the various cross-country effects the different support measures have, a calculation of replacement costs for individual countries is not possible in a meaningful way based on this analysis.

12. USD 0.40 per litre of gasoline and USD 0.60 per litre of diesel if the total biofuel use is considered. These values are given here for transparency reasons but should not be read in terms of efficiency of support.

13. See, for example, OECD (2002).

14. For a discussion in developments in the market structure of bioenergy industries see van Vaals, M. (2007): *Market Structures and International Investments in Bio-energy Markets*. Paper presented at the OECD Workshop on Bioenergy Policy Analysis. Umea, Sweden.

15. See the discussion on biofuel technologies and equipments in Chapter 3 of this report.

16. For information about biofuel programmes in different developing countries see FAO (2007): Recent Trends in the Law and Policy of Bioenergy Production, Promotion and Use. FAO Legal Papers Online #69. Rome: September 2007. Accessed in April 2008 from http://www.fao.org/legal/prs-ol/years/2007/list07.htm.

Table of contents

Tables

Figures

From:

Biofuel Support Policies: An Economic Assessment

Access the complete publication at:

https://doi.org/10.1787/9789264050112-en

Please cite this chapter as:

OECD (2009), “Costs and Benefits of Biofuel Support Policies”, in *Biofuel Support Policies: An Economic Assessment*, OECD Publishing, Paris.

DOI: https://doi.org/10.1787/9789264050112-4-en