

The Potential Environmental and Rural Impacts of Biofuel Production in the UK

Report of a Stakeholder Consultation Process

Prepared by

The Institute for European Environmental Policy
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NSCA

NSCA brings together organisations across the public, private and voluntary sectors to promote a balanced and innovative approach to understanding and solving environmental problems. NSCA works in the fields of air quality, noise, land quality, local environment management, and industrial regulation. It is a registered charity with over 100 years experience of environmental campaigning, information provision, and policy formulation.

Cleaner Transport Forum

The Cleaner Transport Forum was established in 1997 to bring together organisations with an interest in transport and the environment. It has 60 members including representatives from the oil and motor industries, local authorities, retail and distribution interests, environment groups and transport consultancies.

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1 BACKGROUND: EXPLORING THE IMPACTS

The drive to promote the use of liquid biofuels in road transport is gaining momentum in the UK. Views on the potential benefits and costs of a significant change in fuel supply and land use naturally vary but are sometimes complicated by the range of assumptions made by different actors. Until recently the main topics in the debate have included the carbon balance of different fuels and the technical feasibility of their use as alternatives to fossil fuels. However, if the more commercial scale deployment of biofuels in the UK is to become a reality, there is a greater need to broaden the focus of the discussion and consider more fully the wider environmental and rural implications of producing crops for biofuels.

In the 2003 Energy White Paper, the Government undertook to carry out an assessment of biofuels as road transport fuels within one year. The Department for Transport (DfT) invited the National Society for Clean Air and Environmental Protection (NSCA) and the Institute for European Environmental Policy (IEEP) to arrange and facilitate a stakeholder/expert consultation process in support of its own internal work on this issue. The ensuing project was kindly funded by the BOC Foundation and the Department for Transport and overseen by the Cleaner Transport Forum. This report summarises the outcome of the process. It is designed to feed into the wider assessment of road transport fuels and to contribute to a national conference in Spring 2004.

The stakeholder/expert consultation process was designed to focus on the environmental and wider rural impacts of biofuel production in the medium and longer term in the UK. Impacts arising in other countries were acknowledged but were outside the scope of the exercise. Direct environmental impacts

from new crops and changes in cropping patterns and systems were the primary concern but consideration was given to employment opportunities, agricultural aspects and broader rural development issues.

The stakeholder consultation process was managed by the Institute with support from NSCA and a steering group with members drawn from a range of organisations. They advised on the principal questions of concern, the format of the consultation draft texts and other issues. A background paper was prepared utilising material from the stakeholders themselves as well as the general literature. This offered a framework and preliminary analysis of the likely scale and distribution of biofuel production and the different impacts which were anticipated. It was circulated prior to a stakeholder meeting held in London on 28 November 2003 and attended by around thirty-five individuals. They represented agricultural and forestry organisations, processors, energy industries, rural development and environmental agencies and NGOs.

This report brings together the main conclusions of the day, subsequent comments by stakeholders and the steering group and a considerably amended version of the initial background paper. In this sense, it is a synopsis of the exercise.

The consultation exercise was intended to expose areas of major uncertainty, indicate where there was broad consensus and map out some of the more contentious questions. There was no attempt to force an artificial consensus. However, it was clear that considerable common ground existed. The report sets out some of this common ground and flags up a number of more contentious issues.

Technological progress is increasingly altering the transport fuel horizon. Fuel technologies that are currently commercially viable mainly utilise either waste materials or conventional agricultural crops such as oilseed rape (OSR) and sugar beet. These crops provide feedstocks for biodiesel and bioethanol production respectively. However, gasification processes that allow woody feedstocks to be converted into bioethanol are becoming progressively less expensive and are expected to be commercially viable in the medium term. These woodier crops can produce considerably more energy per hectare and therefore are less demanding than conventional crops in their land requirements. This raises questions about how far they may come to be a commercially competitive feedstock and potentially major land use in the UK.

2.1 Potential Feedstocks

There is a range of possible organic feedstocks that can be used to produce liquid biofuels for transport. The most common of these that can be produced or sourced domestically in the UK are shown in Table 1.

There is a similarly wide range of possible production processes and end fuel types, with Woods and Bauen (2003) identifying 88 separate fuel chains in the UK, including eight

end fuel types. For the purposes of this discussion the focus is on the most likely contenders for a sizeable share of the fuel market – biodiesel and bioethanol. These can be either blended with conventional fuels with no engine modification or, with some modifications, can be used pure.

Table 1 also indicates the approximate energy yields anticipated per hectare for each feedstock prior to processing giving estimates from two different studies. These are of particular interest as they suggest that while conventional crops could supply the relatively small share of the petrol and diesel market recommended in the EU biofuels Directive 2003/30/EC (see section 3.3), a major contribution in the long-term is unlikely as the land use penalty in the UK would be prohibitive. Lignocellulosics, which include short-rotation coppice (SRC) and energy grasses (e.g. miscanthus), have yields which are considerably higher according to some studies. Depending on the yield assumptions, these feedstocks potentially could satisfy most or even all of road transport fuel demands in the UK within a much smaller land area than seemed feasible a few years ago. One estimate, probably at the higher end, suggests that about 25 per cent of the UK's agricultural land area would be needed to meet domestic demand for transport fuel (Eyre *et al*, 2002). Another with rather different, more conservative assumptions, concludes that

Table 1: Possible feedstocks for biofuel production in the UK

Feedstock	End-fuel	Technology commercially available?	Two estimates energy yield/ha/yr	
			(a)	(b)
Oilseed rape (OSR)	Biodiesel	Yes	50GJ	38.5
Sugar beet	Bioethanol	Yes	50 – 120GJ	123
Wheat	Bioethanol	Yes		58
Short-rotation coppice	Bioethanol	No	200GJ	94.5
Energy grasses (e.g. miscanthus)	Bioethanol	No		
Harvesting of existing woodlands	Bioethanol	No		
Waste oils	Biodiesel	Yes	n/a	n/a
Other organic wastes	Bioethanol	No		
Existing agricultural by-products and residues (straw, etc)	Bioethanol	No		

Source: Eyre, Fergusson, *et al* (2002) The final column gives estimates of the energy content of the standing crop, further factors have to be applied to reflect losses occurring in conversion to a useable fuel. The first column (a), is from Eyre *et al* (2002), the second (b) from Hart *et al* (2003).

indigenous biomass resources could supply closer to one third of transport fuel in 2050. (Hart *et al*, 2003).

Long-term scenarios that envisage biofuels holding a large share of the transport fuel market are nearly always based on a major contribution by lignocellulosic feedstocks. However, a range of technological, practical and financial conditions mean that they are unlikely to become a significant feedstock in the UK in the next few years. For this reason, two periods can be distinguished:

- *The shorter-term* – in which the biofuel market will be supplied mainly by conventional crops with some by-products and waste materials;
- *The long-term* – when lignocellulosics are likely to be a major feedstock for bioethanol production.

The Appendix provides preliminary environmental profiles of some of the probable major feedstocks, including two conventional crops (OSR and sugar beet) and two candidate future feedstocks (wood from forestry and SRC).

In addition to dedicated crops, there is a range of by-products, wastes and residues which are being or could be used for biofuel production. Some agricultural residues and by-products, such as straw, are already used for energy production in the UK and represent a potentially significant feedstock (Bauen, Woods *et al*, 2003). They generally benefit from a positive carbon balance, as they are by-products of a main crop. Nonetheless, their use as a feedstock will not be without environmental implications. Larger scale exploitation of co-products for energy purposes will result in the displacement of some from existing uses on or off the farm. Straw is widely incorporated into soil on arable farms and it is not clear how far farmers would wish to abandon this process unless incentives were relatively high. The implications for agriculture, the environment, energy balance etc need to be taken into account in a broader analysis.

The waste streams referred to in Table 1 are also an attractive feedstock as they are mostly low cost and their use can be expected to contribute to other sustainability goals. There is already an active market in waste oils but the future scale of exploitation is restricted as they represent a finite and relatively small source. They are therefore unlikely to reduce the domestic land demand for feedstock production (Eyre *et al*, 2002). Other organic wastes potentially represent a significant source, but the conversion technology is

generally at an early stage in commercial terms. Some stakeholders emphasise the considerable theoretical potential of wastes from a wide range of industrial, primary sector and domestic sources. Few believe, however, that they will prove as significant as dedicated crops as a feedstock.

2.2 Supply Chains

It is widely appreciated that reliance on fossil fuels in the transport sector is not an option for the longer term and serious consideration needs to be given now to the development of new strategies. Liquid biofuels are expected to have a growing role, although the likely scale of utilisation over the coming decades is not entirely clear. Their potential to reduce CO₂ emissions makes them particularly relevant to climate change mitigation strategies – but how much weight should be given to this attribute? In the short term lack of demand for biofuels at current prices is seen to be the major inhibitor to greater domestic production. In the longer term, despite uncertainties over technology, there is a general assumption that costs will be reduced, making it possible to exploit the high dry matter yields per hectare of new crops, such as short rotation coppice, which provide a better carbon balance. However, this is not universally accepted.

Stakeholders varied in their perspectives on the supply chain but there was also common ground:

- It is valuable to distinguish between the different supply chains for biodiesel and bioethanol, each with its distinctive characteristics and issues, rather than viewing them together under the general heading of 'biofuels'.
- For biodiesel, oilseed rape seems likely to be the dominant domestic feedstock for many years, with a major question about the scale of imports. There is a more limited role for by-products and wastes, such as recycled vegetable oils and animal fats.
- For bioethanol, there is a much wider range of possible feedstocks, with the major domestic sources at present being wheat and sugar beet. Yields of these annual crops could increase considerably over time in response to plant breeding work; lower protein, higher carbohydrate wheats could emerge for example. There is considerable debate about the relative merit of different alternatives, with many stakeholders seeing wheat as the most

competitive source in the short term, supplemented by sugar beet, cereal straw and a range of organic wastes.

- Higher demand for bioethanol would suck in imports from Brazil and elsewhere but some stakeholders questioned whether these would retain their cost advantage if global demand rose, driven by biofuel programmes in the EU, Japan and elsewhere.
- The speed at which these conventional crops could be displaced by lignocellulosics is also uncertain. Whilst they have clear yield advantages, considerable technological barriers are expected for a decade or so and the appeal of miscanthus, short rotation coppice and other woody crops to farmers is limited at present. Some stakeholders see the greater exploitation of existing woodland resources as a greater priority over the next few years.
- The by-products and co-products of domestic biofuel crops merit greater consideration than they usually attract. Cereal straw is a case in point (see Box). Co-products can arise in large quantities at the point of harvesting or processing, creating either market opportunities or disposal costs or both. They can influence the viability of the crop for farmers and affect the wider competitiveness of the feedstock. Consequently, co-products need to be assessed alongside the main energy feedstock for each crop and be considered systematically in economic, environmental and life cycle approaches.

Straw as a by-product

The argument was made that the significance of straw as a by-product has been underestimated by the Government and others. It should not be classified as a waste, indeed farmers earned £261 million from trading straw with other farmers in 2002. Total revenue from straw sales is around £300 million per annum and it is also used on a significant scale on farms where it is produced, partly in a chopped form incorporated into the soil. (Wessex Grain Ltd, 2003). Consequently it can be argued that the environmental costs of cereal production, such as nitrate fertilizer use, should be allocated between the cereal crop and the straw in a systematic way rather than charged entirely to the cereal crop. Such an approach has a substantial impact on the life cycle analysis for both cereals and straw.

There is considerable uncertainty about the scale on which waste products could contribute to biofuel production. Whilst they have a relatively limited market share at present, it was pointed out that the volume of waste produced annually in the UK is very large and there may be much greater potential for utilising food industry waste than is generally assumed.

3 THE POLICY BACKGROUND

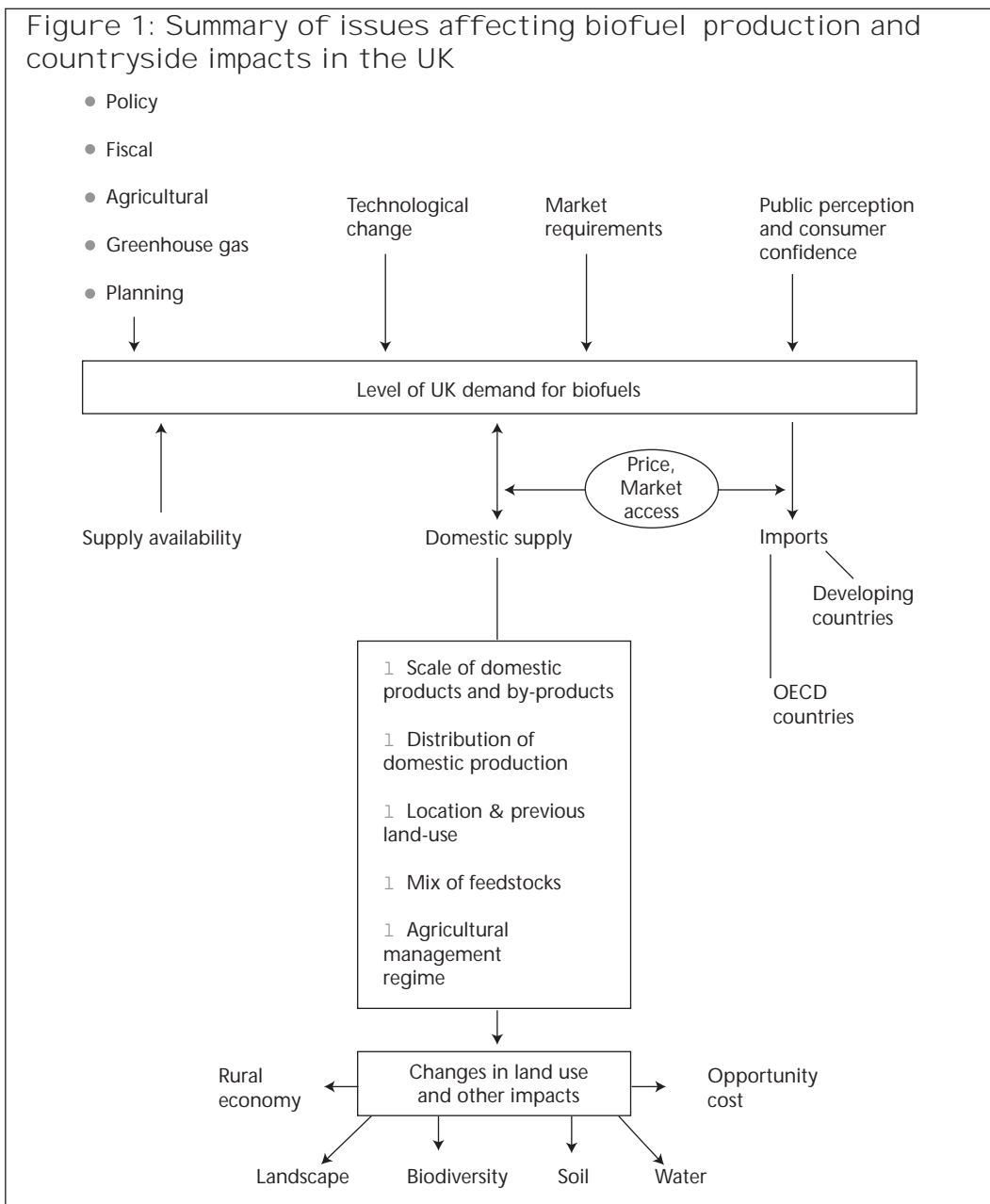
Demand for biofuels will develop in response to a range of factors, with the level of government intervention and the environmental image of the fuel amongst the more important influences. Several different policy streams already influence the biofuels agenda in the UK, including both EU (CAP, Biofuels Directive) and domestic initiatives.

Some of the expected influences on demand for biofuels in the UK, and the linkages to domestic supply and countryside impacts are shown in Figure 1. The importance of policy as a driver is immediately apparent.

3.1 Domestic Policy Issues

At a political and policy level, interest in biofuels in the UK is growing in response to:

- Domestic and international commitments to reduce greenhouse gas (GHG) emissions
- Concern about the transport sector which currently contributes one quarter of the UK's GHG emissions, of which 85 per cent come from road transport (Energy White Paper)



- Concern for the health of the rural economy and the potential for diversifying farm outputs and markets at a time of change in agricultural policy
- A vigorous lobby, mainly promoting conventional crops at this stage
- A longer term search for alternatives to fossil fuels for road transport.

The growing political interest in the area can be seen from the recent enquiry by the House of Commons Environment, Food and Rural Affairs Committee focusing on domestic biofuel production in the short-term and the UK's current support mechanisms for the biofuels industry (House of Commons, 2003). The report provides a helpful analysis of some of the current issues but gives relatively little attention to longer-term countryside impacts other than rural employment. It calls for a full scientific study to assess the effects on biodiversity of expanding the cultivation of biofuel crops.

The main policy mechanism investigated by the Committee, and indeed the focus of much of the current biofuels debate in the UK, was the fuel duty derogation for biofuels. A certain level of fiscal or equivalent support of biofuels is necessary if they are to compete with conventional fuels in the current market, as production costs remain substantially higher. EU estimates from November 2001 showed the production costs of biofuels to be around EUR 500/1000 litres, compared to EUR 200-250/1000 litres for petroleum based fuels (Platts, 2003).

The Government cut duty on biodiesel by 20p per litre with effect from 26 July 2002. In the 2003 Budget it pledged to do the same for bioethanol on 1 January 2005. This concession has been widely criticised as insufficient and has not significantly stimulated the industry to date (House of Commons, 2003). Major dedicated biofuel crop producers, such as Cargill and British Sugar, have called for a further fuel duty cut of 8p per litre before they will invest in biofuel production.

Support is available in the UK for the establishment of SRC and miscanthus plantations through Defra's Energy Crop Scheme (Defra, 2003). This is intended predominantly for the bioelectricity market where, there are shorter term opportunities to utilise these crops, but take up has been low. There is no specific scheme for the production of crops for liquid biofuels. New SRC and miscanthus plantations that are larger than 2-5ha require an environmental impact assessment. These assessments in principle should take account of the cumulative effects

of such plantations on the countryside but there is no strategic overview mechanism to mitigate against large scale impacts.

3.2 Incentives under the CAP

For some time there have been opportunities to grow crops for biofuels while claiming support under the CAP arable regime. The CAP reform that was agreed on 26 June 2003 has a number of implications for biofuel production. Central to the agreement is the decoupling of support payments for farmers from agricultural production. This is expected to make farmers more responsive to market forces and more open to diversification into new products and opportunities. The great majority of farmers will receive a new Single Farm Payment. In Scotland and Wales, this will be based on historic CAP claims by individual farms, while in England the Government has decided to move towards a system of annual area payments over an eight year transition period.

An additional aspect of the agreement was a new aid payment of EUR 45/ha for energy crops that will be paid on top of the new Single Farm Payment on an area of up to 1.5 million ha in the EU as a whole. It is not yet clear what the UK share of this area will be. Farmers must have a contract with a processor to be eligible. Mandatory set-aside for cereal producers has been retained in the reformed CAP as has the option to grow energy and industrial crops on set-aside. Quite separately, Member States will be allowed to pay national aid of up to 50 per cent of the costs associated with establishing multi-annual crops that are intended for energy production, such as SRC, on set-aside (Regulation 1782/2003, Article 107).

Thus, there are two routes for claiming CAP support and growing biofuel crops:

- At present, most industrial non-food crops, including OSR for biodiesel, are grown on set-aside. This seems likely to continue in the short term as it is permissible and represents a means of generating revenue from land that cannot otherwise be cropped. However, there are uncertainties about the future of set-aside. It will be reduced from the normal level of 10 per cent of the main arable acreage to only five per cent in 2004, because of the drought in 2003.
- Outside set-aside, energy crops seem most likely to be attractive to farmers where they have a contract with a processor and can

claim the EUR 45 top-up per hectare as well as the single farm payment. This scheme will be reviewed in 2006, but the current ceiling on the eligible area will almost certainly fall well below some of the more ambitious projections for 2006. From a farming perspective, an important advantage of growing OSR outside set-aside land is that the crop can be sold for purposes other than biodiesel if market conditions make this a preferable option.

At present a large proportion of oilseeds for biodiesel are grown on set-aside land, accounting for about 50,000 hectares. There will continue to be extensive use of arable set-aside for biofuel crops while the current rules remain in force, since it is one of the few means of producing a market return from set-aside land. However, there was general agreement that biofuel production plans could not be built on the basis of the continuation of set-aside. This would be too constraining and uncertain a foundation for an expanded industry. The proposed reduction in set-aside from 10 per cent to 5 per cent of the relevant arable area in 2004 reinforced this point. Crops for the biofuel market would need to compete with alternatives for the land available if they are to become a serious option.

For most farmers, the biofuel market has not been economically attractive in recent years, but decoupling and the introduction of new support payments may alter this balance. It is expected that prices for some biofuel crops will be lower than for conventional food crops in the short term while others are at parity. However, it is more difficult to predict the future returns from SRC and other alternative crops in a freer market. Some are predicting an increase in voluntary fallow on arable farms in Britain, particularly on poorer land and where production costs are high relative to prices. This may create more theoretical potential, but only if returns from energy crops are high enough.

3.3 The Biofuels Directive

The biofuels Directive (Directive 2003/30/EC), which was agreed in May 2003, requires Member States to take action to promote the use of biofuels and other renewable fuels in the transport sector. However, it is significantly weaker than the text originally proposed by the European Commission.

The Commission's original draft Directive contained mandatory targets for all Member States to substitute two per cent of petrol and diesel in national markets with biofuels by the end of 2005, rising to 5.75 per cent in 2010. Mandatory targets were backed by both the European Parliament and the Commission, but were dropped at the insistence of the Council. The final and agreed version of the Directive retains these targets, but as 'reference' values, which are intended for guidance and are non-binding. It is not expected that all Member States will seek to meet them. The UK Government is scheduled to announce its approach to implementation of this measure in 2004.

The Directive also contains significant reporting requirements. In their annual reports to the Commission, Member States must state their indicative targets, set out measures adopted and resources allocated to biofuel promotion, and describe the impact of these measures in terms of the effect on market share.

If demand for biofuels grows in the UK, some proportion will be met by imports rather than domestic production. Imports already supply a significant part of the biofuel market in the UK; these are mainly from large producers such as Brazil and Malaysia and are derived from crops such as palm oil, soy and sugar cane. Imports have been an attractive option for British processors in the current market, with soy and palm oil selling at between EUR 50-100/tonne less than UK produced rapeseed methyl ester, for example. Imported Brazilian bioethanol costs can be as much as 10p per litre below UK alternatives made from sugar beet and wheat according to the recent EEDA study (Bullard *et al*, 2003). However, major domestic processors British Sugar and Cargill are both confident that the British industry could compete if they are given the support that they are asking for.

Many stakeholders acknowledge that increasing demand for biofuels in the UK through a cut in excise duty would result in an increased flow of imports, at least in the short term. However, there was a lack of consensus on the future availability of imports and their likely price. Some stakeholders anticipate shortening supplies in the face of growing demand from the EU and Japan, partly driven

by the biofuels Directive in the EU case. Others expect that UK producers will face higher costs and overheads than many of their competitors over the longer term. Many would welcome some form of import protection for EU producers, although this seems an unlikely prospect in the WTO context.

One potential objection to imports is the fuel cost of shipment, particularly from distant countries. While there will be an energy cost, it should not be assumed that imports from the tropics, for example, will be unsustainable. On the contrary, there might be advantages in growing certain highly productive crops in tropical environments; efficient long distance transport is not expected to damage the energy or environmental balance significantly.

Another objection is the real or alleged social, cultural and environmental cost of production overseas, such as GM soy or palm oil derived from plantations which have displaced rainforests. Biofuel accreditation systems were seen by some as the best means of ensuring that these fuels are derived only from sustainable sources. This is an important topic of some sensitivity which was not discussed in depth.

5 PROSPECTS FOR DOMESTIC PRODUCTION

Leaving aside the issue of imports, different estimates have been made of the potential area of different biofuel crops. Many suggest that a mixture of crops would be grown, reflecting agronomic factors, variable market demand, the need to maintain the continuity of supply to a processing plant over a long season (by a combination of wheat and sugar beet for example) and existing local resources. A recent study by ADAS and others for the East of England Development Agency suggested that about 13 processing plants each drawing on a mixture of sugar and starch crops might be needed to meet 5.75 per cent of their projected demand for unleaded fuel by 2010. Ethanol plants of 100,000 tonne scale in the most favourable areas in the east of England would need 38,000 hectares of arable land each for feedstock – presumably more in lower yielding areas. To produce 1.2 million tonnes of bioethanol annually would require approximately 500,000 hectares of sugar and starch crops, or a smaller area of lignocellulosics (Bullard *et al*, 2003).

Wheat is the most attractive bioethanol crop in the short term for many farmers, partly because it is already grown on a large scale. Many stakeholders assume, however, that only a small proportion of the cereal crop will be utilised for bioethanol. The current export surplus, of around 5 per cent of the total crop, could be diverted relatively easily, providing feedstock for over 400,000 tonnes of ethanol. Beyond this, however, there is far less consensus about the likely availability of cereal crops. Wheat could be supplemented by sugar beet and a smaller volume of woody materials, including wood waste.

It is widely expected that domestic production of sugar beet may fall over the coming decade as a result of policy changes in the CAP. In principle this could release sugar for bioethanol production, but it is not necessarily the most attractive crop for this purpose in life cycle terms. The question arises whether the use of sugar for bioethanol should be encouraged specifically to take up any slack in demand, thus maintaining the total area of around 205,000 hectares. Sugar is less attractive as a break crop than oilseed rape. Views on this issue vary; both employment and environmental considerations are relevant.

In the longer term, there is a theoretical potential to convert millions of hectares of agricultural land to new crops such as short rotation coppice. Much of this would be grassland in the western half of the country where gross margins from competing farming

activities might be relatively low. However, the suitability of this land for producing such crops is subject to a range of questions.

Several stakeholders are doubtful about how far farmers would be interested in short rotation coppice and other woody crops. There are uncertainties about yields, harvesting, crop handling and storage, transport costs and overall financial returns. Take-up under the existing support scheme has been very limited. Harvesting in mid-winter can be very challenging, particularly on wetter land in the western part of the country which may in principle be available for these crops. There are major differences between growing and harvesting coppice and conventional field crops and the ability to switch between commodities from year to year would be lost. Substantially higher returns from coppice would alter the position but farmers should not be expected to see such feedstocks in the same light as field crops.

For biodiesel, the British Association for Biofuels, supported by the Country Land and Business Association, has proposed that 500,000 ha of arable land could move into OSR production to produce more than 750,000 tonnes a year as yields improve. This compares with around 80,000 hectares of OSR for biodiesel at present. Sizeable areas would be required to meet the targets in the biofuels Directive from domestic sources – perhaps 600,000 ha to meet the 2005 value of two per cent of diesel demand. Any expansion in the area of rape is likely to be concentrated on suitable land rather than spread progressively throughout the country. It may be grown more at the expense of second wheats if gross margins improve over time.

In considering net environmental impacts, it is the area of production for feedstock over and above other plantings of the same crop and its location that is of interest. It is less important whether it is a net addition to the current crop area or effectively is substituting for an alternative market that is declining with no change in overall area – as may occur for sugar beet.

The role of other biofuel sources such as waste and forestry by-products also needs to be acknowledged as they could greatly affect the scale of domestic production. However, it is difficult to estimate the commercially viable level of production in the longer term and this was beyond the main focus of the consultation.

At present a large proportion of oilseeds for biodiesel are grown on set-aside land, accounting for about 50,000 hectares (House of Commons, 2003). There will continue to be extensive use of arable set-aside for biofuel crops while the current rules remain in force, since it is one of the few means of producing a market return from this. However, there was general agreement that biofuel production plans could not be built on the basis of the continuation of set-aside. This would be too constraining and uncertain a foundation for an expanded industry. The proposed reduction in set-aside from 10 per cent to 5 per cent of the relevant arable area in 2004 reinforced this point. Biofuel crops would need to compete with alternatives for the land available if they are to become a serious option.

Set-aside provides important habitats and food sources for a range of invertebrates, birds and mammals. Displacing set-aside with industrial crops is likely to carry an environmental cost, especially if the management of set-aside would otherwise be tuned to environmental requirements. The RSPB is strongly opposed to the use of set-aside for biofuels on any significant scale.

7 ASPECTS OF PRODUCTION

If the volume of crop production for feedstocks does grow, there are several aspects of the industry which will influence the environmental outcome. These include:

- The mix of feedstocks produced
- The scale of domestic production
- The spatial pattern of domestic production
- The location of production and the previous land use
- The management regimes under which they are produced
- The volume and nature of feedstock by-products.

These variables will play a large part in determining the scale and form of countryside impacts and the threats and opportunities that may be generated by a growth in the UK biofuels market.

7.1 Feedstock Mix

In the long term, the likely feedstock mix, and therefore the impact of biofuels production, is difficult to predict. If woody crops play a substantial role, one can expect particularly profound environmental consequences as they have very different characteristics to arable crops currently grown in the UK. Nonetheless, they may compete for similar ground. Willow and, to a lesser degree, poplar seem to be particularly favoured species for SRC. Both are lowland crops planted in cultivated ground, harvested every two to four years and potentially limited to a productive life of 25 years or so, after which land can revert to conventional agriculture. The same technology will also open up the possibility of harvesting new or existing woodlands for bioethanol production. Such a development would have both direct and indirect impacts on woodland management. A large number of existing neglected woods could be brought back into active management, with major implications for biodiversity.

From an agricultural perspective, there are advantages in maintaining a mixture of crops and there are arguments for building processing plants that can take a range of feedstocks, especially given the speed of technological change.

The use of true wastes, rather than by-products, in biofuel production is a win-win

situation in terms of the overall sustainability of such a system, however their use is limited and carries modest benefits for the rural economy.

7.2 The Spatial Pattern of Production

The environmental impact will be influenced by how biofuel crops are distributed both regionally and within local landscapes. Concentration is a key variable. In landscape, and probably in biodiversity terms, the impact is likely to be more favourable if biofuel crops are dispersed over sizeable areas and a significant number of farms, forming a mixed cropping pattern with other arable crops. The concentration of biofuel crops in large-scale blocks around processing facilities, forming dense areas of monoculture, would have considerable negative environmental impacts.

However, concentration has economic advantages as it reduces transport and production costs. The EEDA study indicates that the optimal location for a new 100,000 tonne per annum bioethanol plant would be in Norfolk and that it would take 10 per cent of crops in a catchment of over 24,000 km². This would amount to nearly 16,000 ha of sugar beet and 23,000 ha of wheat. The catchment of a plant processing waste streams might be much smaller – perhaps 1,200 km² if near London (Bullard *et al*, 2003).

For plants utilising SRC, equivalent figures are difficult to predict. Guidance from British Biogen suggests that a relatively small plant generating heat from coppice drawn from 52 ha might result in 6.4 per cent of the land within a mile of the crop being planted to SRC (British Biogen and Partners, 1996a). Plant location clearly would be an important factor in affecting local land use.

7.3 Location and Previous Land Use

Land suitable for arable or coppice production is a limited resource in the UK; any expansion of feedstock production will displace previous land uses and will be at the expense of other potential competing land uses. These other land uses are critical in determining the net impact of biofuel production.

Possible land uses that could be displaced by biofuel production include:

- Set-aside
- Other arable crops
- Grasslands
- Woodland.

In the short term, most stakeholders did not expect biofuel crops to extend significantly beyond the existing arable area. The diversion of part of the annual wheat crop to the bioethanol market could occur, if there were sufficient incentives. Without incentives, most bioethanol would be imported in the view of many, including British Sugar. The use of set-aside is not regarded as sustainable, as discussed above.

In the longer term, if intensive arable systems are replaced by new biofuel crops the environmental impact can be expected to range from negligible to distinctively positive depending on the new regime that is introduced. Negative environmental impacts can be expected in cases where the previous land use was of a high nature value. This includes wetlands, and important semi-natural habitats, predominantly areas of permanent pasture producing limited agricultural returns but creating substantial biodiversity interest such as species rich grassland etc.

Opportunity costs must also be considered. Where a limited resource such as land suitable for arable production is assigned to one purpose, costs are incurred for not using it for another. Production of biofuels represents just one land use option that is competing with a host of others. For example new industrial markets for agricultural products are emerging in the same way that the biofuels market is. Advanced materials for plastics and pharmaceutical products are amongst those that can be based on current and novel crops. These also carry a range of environmental impacts; the benefits may outweigh those gained from the use and production of biofuels, by replacing plastics for example. Other forms of energy production, such as electricity from biomass sources are also in competition for similar land.

On a broader scale, there are potentially large environmental benefits to be gained from reducing the intensity of agricultural production, for example by cutting back nutrient inputs, participation in agri-environment schemes and conversion to organic agriculture. Under the UK Biodiversity Action Plan many species depend on the type of land management required by the more stringent agri-environment prescriptions for their future maintenance or recovery. The

scope for such measures will be reduced if there is a greater competition from a major intensive land use.

7.4 Feedstock By-Products

The economic attractiveness of biofuel crops for farmers and processors are not decided solely on their value as feedstock (Feehan, 2003). Crops with useful by-products, such as cereals and OSR, which also produce straw, oil cake etc, offer added value and less wastage. The total spectrum of principal and by-products need to be considered in any market or environmental analysis. Some by-products arise at the processing stage, others at farm level, eg cereal straw. The latter were identified as being of considerable environmental interest by several stakeholders.

Changes in ultimate disposal routes will of course have off-farm impacts, for example reduced straw use for animal bedding and consequent secondary impacts. The removal of residues that are normally ploughed back into the soil may have negative impacts on soil quality and biodiversity.

7.5 Agricultural Management Regimes

Whatever the crop, the way it is managed is important to the environmental outcome. Considerations such as the use of nutrients, agrochemicals and water, the overall intensity of management, the soil cultivation techniques, the choice of spring or winter sown crops and the management of field boundaries all need to be taken into account. There is some concern that the cultivation of biofuels would be subject to fewer environmental constraints than food crops because they will remain outside the food chain – at least in principle. This could suggest less demanding standards for pesticide residues for example. However, several stakeholders including British Sugar strongly rejected this argument, believing that most crops need to be saleable in either the food or fuel market and that crop management would be identical. There will be particular sensitivity to the environmental standards which novel crops have to meet especially if they are entirely outside the food chain. Recently there has been controversy about whether GMOs could be planted more readily for biofuel than food crops. Most stakeholders felt this would give biofuels a poor image with consumers quite apart from the environmental implications which would follow. However, farmers will be under pressure to minimise production

costs, particularly if market prices are below those for food crops so strategies for measuring yields and minimising labour inputs can be expected. It has been suggested that OSR for biodiesel production might fetch a price £8 to £12 a tonne lower than for conventional markets (House of Commons, quoting a report for Defra, 2003) while others argue that prices need to be similar to that for food crops in the longer term to attract growers.

Codes of good management practice for conventional crops (OSR, wheat, sugar beet) are well established, and a lot of work has already been done on SRC and miscanthus by organisations such as Defra and the Forestry Commission (eg Tubby and Armstrong, 2002). Guidelines for the sustainable management and harvesting of woodlands are also available from the Forestry Commission.

As one goal of the production and use of biofuels is the abatement of GHGs, the carbon cost of production is of particular relevance. Fertilizers and pesticides both have carbon intensive production processes; for this reason there is a double pay-off associated with maintaining low-input regimes for biofuel crop production (Anderson, Haskins *et al*, 2003), benefiting both the local environment and GHG abatement efforts.

Some stakeholders argued strongly for low input and/or organic production of biofuel crops particularly if they were to win consumer confidence. However, it was accepted that such regimes probably would not be achieved through market forces alone; instead, exploiting this opportunity would depend on measures such as accreditation schemes or agri-environment schemes that rewarded farmers for appropriate practices. There could be a substantial yield penalty for sizeable reductions in inorganic fertilizer use, although this would be particularly desirable in carbon terms. Processors tend to be sceptical about the viability of low input OSR but there was agreement on the value of a voluntary agri-environment incentive scheme to test the issue in practice.

The consultation pointed to a number of different policy tools that could help to secure good management practice on farms.

- Codes of good farming practice
- Agri-environment schemes offering incentive payments
- Cross compliance requirements under the CAP, due to be strengthened from 2005
- Voluntary accreditation schemes.

7.6 Soil and Water Management

Conventional crops can be expected to have a similar impact on water quality and supply to those that are grown for the food industry. The 'future' crops for biofuel production will have a less predictable and possibly more profound impact on water quality and supply.

Of most concern is the high water demand of SRC crops, which could, along with higher infiltration rates than conventional crops, cause the depletion of groundwater reserves. At the same time, SRC crops provide an important opportunity to abate the problem of nutrient run-off when planted along buffer zones adjacent to water-bodies. The possibility of using SRC plantings strategically in flood management remains a possibility that is often cited as a potential benefit, however there is a lack of hard evidence to establish this. These features are summarised briefly in the Appendix.

For SRC plantations, site choice is therefore an extremely important factor when trying to maximise the benefits and minimise the costs with respect to water.

The cultivation of perennial woody crops, such as SRC willow and poplar, in place of conventional annual crops, carries a number of benefits for soil (Bauen, Woods *et al*, 2003). As they are perennials, there is less soil disturbance and more soil cover, resulting in reduced soil erosion and a higher soil organic content. Furthermore, SRC crops require less fertilizer and pesticide inputs. However, if they are planted on permanent grassland the level of soil disturbance will increase.

Soil management practices will have a substantial impact upon the overall carbon balance of biofuels made from dedicated crops. For example, woody crop plantations store carbon but if they are ploughed up at the end of their productive life, it is all or nearly all released again into the atmosphere. The harvesting of SRC, which needs to take place in the winter, will need to be done with care to avoid significant soil damage.

Root crops such as sugar beet can give rise to problems of soil erosion, particularly when planted in inappropriate areas. Following good agricultural practice with regard to soil would be particularly important if the sugar beet area were to expand.

The use of residues that are normally ploughed back into the soil as feedstocks, such as OSR straw, could result in a loss of organic matter in soil, leading to soil degradation and the increased reliance on fertilizers. This is an issue that requires further investigation (Hope and Johnson, 2003).

8 OVERALL ENVIRONMENTAL IMPACTS OF BIOFUEL PRODUCTION – POTENTIAL THREATS AND OPPORTUNITIES

Many of the environmental consequences of a sizeable increase in biofuel production have been discussed in earlier sections. Only local rather than more international environmental¹ impacts have been considered but the broader global picture is also important and needs to be taken into account, especially given the potential scale of imports. Some of the more specific issues brought up in relation to individual crops are given in the Appendix.

The consultation focused on the environmental impacts of expanded biofuel crop production in the UK, particularly those on the quality and character of the countryside. Much has been written about the comparative performance of different crops in terms of climate change and total greenhouse gas emissions. Many stakeholders felt that it was essential to increase the overall level of renewable energy production in the countryside but several noted that it would be more energy efficient to use biomass for electricity or heat production than for transport fuels.

A distinction was made between the impacts of conventional agricultural crops and those arising from more novel crops. Aspects of the former to be highlighted included:

- A general perspective that a modest expansion in existing crops, particularly rape and wheat, would not raise substantive new environmental issues.
- This perception would be changed radically if GM varieties were to be planted; this would generate large scale opposition to biofuels more generally as well as the specific crops.
- There is some concern that industrial crops will add to the pressures already bearing on the limited farmland area, squeezing the scope for less intensive systems, including organic, and potentially affecting land availability for alternative uses such as nature conservation.

- The principal agricultural crops in question (wheat, sugar and rape in the short term), all have certain environmental costs. There are environmental benefits from break crops in cereal rotations; a larger area of wheat would be disadvantageous environmentally, given the relatively high level of inputs used for the crop and its lack of habitat value.
- There was a specific concern that growing a larger area of industrial crops on set-aside land would be a step backwards in terms of biodiversity.
- An enlarged area of oilseed rape would have a variety of impacts, depending on the crops it displaced. Winter sown oilseed rape in place of spring sown rape crops would be undesirable for biodiversity but still preferable to winter wheat. It was not expected that rape would take over any significant area of grassland.
- The ploughing of permanent grassland for arable cropping would be damaging for biodiversity and landscape interests in many but not all locations. Ploughing of historic sites would always need to be avoided.
- There were several proponents of a breeding programme for low input oilseed rape which could be managed with fewer inputs and sown in the spring. This could have a better carbon balance and environmental profile but might require support externally, eg through an agri-environment scheme. Organic rape was not seen as commercially viable at present.

For more novel crops, particularly willow coppice, there were potential benefits from appropriately managed and sited new planting, although this might require some additional funding through agri-environment measures for example to make the most of the opportunities. Protection of sensitive habitats and landscapes would be essential and the need for a rigorous EIA and strategic

¹ The term 'local environmental impacts' is used so as to exclude the carbon abatement benefits that the production and use of biofuels may deliver. These were beyond the scope of the stakeholder consultation.

environmental assessment for new crops on a significant scale or on semi-natural habitats must be emphasised. At present it is difficult to envisage serious environmental impacts from SRC, miscanthus and other novel crops given that the current area is so small. If it were to be expanded greatly, the cumulative effects of increasing numbers of plantations within a landscape would pose a particular challenge for EIA processes and practitioners. Coppice could have biodiversity benefits if well managed, but there is relatively little experience of commercial production in the UK. Landscape effects would be positive in some locations but negative in others, depending on the precise siting. There are concerns about the potential impacts of planting SRC or other more permanent crops on archaeological remains and historic sites. The need to adhere to land use planning

policies and develop appropriate guidelines is particularly clear in the case of landscape. One of the principal concerns about certain new crops, particularly SRC, is their heavy water demand and potential impact on aquatic systems. This topic needs further investigation.

Appropriate soil management will be necessary for both annual and more permanent biofuel crops. The latter offer advantages over conventional arable crops in reducing soil disturbance and erosion – but with some concern about damage during winter harvesting.

Much less is known about the potential impact of miscanthus. There is some anecdotal evidence and concern about the impact of a non-native species. Again, more work is required.

9 BIOFUEL PRODUCTION AND THE RURAL ECONOMY

The potential benefits that a domestic biofuels production industry could bring to the rural economy are a frequently cited argument used in favour of supporting a biofuels industry. Employment maintenance and creation in rural areas is one of Defra's objectives and has been a key reason for support by ministers. In principle, the advantages of building up a new industry, with a role in displacing imports is clear, particularly at a time when farmers need to consider ways of diversifying from traditional forms of production driven by the CAP.

There is a variety of estimates as to the number of jobs a domestic biofuels industry could create. European Commission figures suggest that between 45,000 and 75,000 jobs could be created by the biofuels industry in the EU (COM 2001(547)), while British Sugar argues that at least 20,000 jobs would be created in the UK as a result of a 5 per cent inclusion of ethanol in petrol. The EEDA report suggests that one bioethanol plant of 100 kt/year capacity would require an investment of £50 to £60 million but would create 970 jobs. The cost to the Treasury would be a duty cut of 24p/litre, potentially reduced to 18p by various multiplier effects such as assumed reductions in job seekers' allowance.

The wide range of estimates and speculation that exist in this area reflect a lack of knowledge and thus consensus of the specific benefits a biofuels industry could bring. The Environment, Food and Rural Affairs Committee identified this in their final report on biofuels and called for Defra to carry out an economic appraisal of the effect such an industry would have on farming and rural incomes (House of Commons, 2003).

Stakeholders welcomed the recent EEDA report and pointed out the importance of building up an industry in a step-by-step fashion, starting from relatively small beginnings. Confidence had been reduced by recent disappointments in the processing sector. Plants capable of processing a variety of different feedstocks would be more robust than dedicated facilities it was thought. Processing plants would most likely be located in the east of England or near existing ports; relatively small numbers of people would be employed – perhaps fifty or sixty in a new plant.

Nonetheless, new investment would generate some employment and there are benefits from displacing imported fossil fuels in the supply chain. Any increases in gross margins arising from biofuel crops would represent an economic benefit. A stronger market for wood products from new or existing woodlands would generate new revenues and employment. Assumptions about the level of biofuel imports are clearly essential in any estimation of economic impacts. In the case of sugar beet, the protection of existing jobs may be the prime consideration rather than creation of new ones.

A short profile of four of the potentially important domestic feedstocks for biofuel production in the UK is presented below. In each case there are comments on production and crop management, accompanied by a Table highlighting potential environmental concerns in one column and potential benefits/opportunities on the other. The focus is on environmental impacts in areas where the crops are produced, rather than on wider concerns, such as the overall effects on greenhouse gas emissions or the energy balance of the fuel production cycle.

10.1 Sugar Beet

(see Table 2, page 22)

Sugar beet is a widely grown high yielding root crop that can be fermented to produce bioethanol, a liquid fuel that can be used instead of or in combination with petrol.

The environmental impact of sugar beet grown for bioethanol is likely to be broadly the same as for conventional sugar beet.

Production

Sugar beet is a well-established crop in Britain and is grown as part of arable rotations, predominantly in the lowlands. It is one of the principal options for bioethanol in the short term, but there is some debate about its competitiveness in this market relative to other crops, such as wheat. Sugar beet pulp, an energy feed for livestock, is the major by-product but is not of high value. British Sugar is actively involved in the promotion of sugar beet for bioethanol production but is also engaged in trying to develop production based mainly on wheat.

There is currently a surplus of sugar beet in the EU that is exported with subsidies. Significant changes in the CAP support system are being proposed and some European output could be redirected from export into the biofuel market. Strong competition from sugar exports from tropical countries could limit domestic production, especially as market access for several countries is being increased under the "Everything But Arms" agreement. Brazil, an established exporter of ethanol, alone expects to export 790 million litres in 2004.

Crop Management

Input levels have fallen steadily over the last few years, with sugar beet now receiving less agrochemical inputs than many grain crops (Defra, 2002). Pesticide use during the crop establishment phase is relatively intense but has also been reduced over the last decade. As a spring sown crop, sugar beet has some benefits for biodiversity in an arable rotation and helps to add diversity in intensive arable landscapes.

10.2 Oil Seed Rape

(see Table 3, page 23)

Oil seed rape (OSR) is crushed and the oil is extracted. The oil is then reacted with methanol to produce glycerine and biodiesel. This is an energy-intensive process, making the carbon balance of the fuel less good than several other options, but there are by-products of value apart from the oil.

Currently, OSR varieties grown for biodiesel production are the same as those grown for the food market. Varieties more appropriate for biodiesel production are being developed and in the future different varieties will probably be grown for the two distinct markets.

Production

OSR is already grown commercially in the UK on a large scale, covering several hundred thousand hectares. The impact of additional areas of OSR is likely to be the same as that of OSR grown for other purposes, unless the biofuels market entails a change in management practices. It has been suggested, for example, that high levels of weed control may be less necessary for biofuel production, allowing the crop to support higher levels of biodiversity than are associated with current crops (Anderson, Haskins *et al*, 2003). However, others argue that farmers would need to control weeds to the same degree as they do for current crops.

If biodiesel supplies from domestic sources are to reach the reference targets set in the biofuels Directive, for example, it is likely that the OSR area would have to be increased significantly, with one estimate suggesting a 400 per cent increase on today's levels (Hope and Johnson, 2003). OSR is particularly

Table 2: The environmental concerns and benefits/opportunities created by sugar beet production for biofuels

	Concerns	Benefits/Opportunities
Biodiversity	<ul style="list-style-type: none"> - While declining herbicide and pesticide use during establishment can be heavy; decreasing invertebrate diversity and abundance and negatively affecting dependent species - If some agricultural operations, such as harvest, are poorly timed, nesting birds can be damaged 	<ul style="list-style-type: none"> - Provides nesting sites for open-field birds - Winter stubble provides food for seed-eating birds, while harvest residues do for finches, stone curlew etc - Higher abundance of broad-leaved weeds, providing a habitat for diverse invertebrates
Water	<ul style="list-style-type: none"> - As for conventional sugar beet: risk of nutrient run-off and pesticide contamination 	
Soil	<ul style="list-style-type: none"> - Soil erosion caused by mechanical removal during harvest, wind erosion and water erosion - Risk from bare soils in vulnerable areas 	<ul style="list-style-type: none"> - Sugar beet tops can be ploughed back into the soil following harvest, increasing organic content and reducing fertiliser requirement for next crop - UK has the lowest dirt tares in Europe
Landscape	<ul style="list-style-type: none"> - Production often large scale, heavily mechanised, as with most arable crops 	<ul style="list-style-type: none"> - Variation in cereal monocultures can be beneficial
Rural economy		<ul style="list-style-type: none"> - Potential lifeline for the declining sugar sector, contributing to rural development - Can be used as an effective break crop in arable rotation as it hosts different pests and diseases to other crops

exposed to competition from imports but could reach an area of about 800,000 hectares given appropriate levels of support (Turley, 2001). A 2 per cent inclusion level for biodiesel that is supplied by domestically produced feedstocks would require 200,000 tonnes of OSR, assuming waste oils supply of 100,000 tonnes (Wilder, 2003).

Management

As OSR usually has a higher nature value than winter sown cereal crops, supporting a number of specialist bird species that are in decline, it has been suggested that an increase in OSR would have a negligible to positive impact (Haskins and Hope, 2003). However, there is a danger that a large increase in OSR area at the expense of set-aside could result in increased disease and pest problems (Haskins and Hope, 2003). In general, well-managed set-aside is likely to support a larger range of species than OSR. If spring sown OSR varieties could be deployed on a commercial scale, perhaps with the aid of an agri-environment incentive, there would be potentially greater biodiversity benefits.

10.3 Short Rotation Coppice (SRC)

(see Table 4, page 24)

Short rotation coppice refers to the coppiced production of fast growing woody plant species, usually willow or poplar, in the UK. Woody (or 'lignocellulosic') crops can potentially be converted into ethanol through a range of technologies, including gasification, for example. They may also be used in the future for hydrogen production (Eyre *et al*, 2003).

Production in the UK

Although the technology exists to process woody feedstocks into ethanol, it is not currently commercially available. SRC plantations have therefore been used in Britain until now only for electricity production and on a very small scale. Planting of SRC for this purpose has grown little, despite the availability of funding under biomass grant schemes and NFFO.

Table 3: The environmental concerns and benefits/opportunities created by OSR production for biofuels

	Concerns	Benefits/Opportunities
Biodiversity	<ul style="list-style-type: none"> - Increasingly large areas may displace more valuable habitats eg some set-aside - Intensively managed arable crop, usually autumn sown - Dense structure unsuitable for some species 	<ul style="list-style-type: none"> - OSR supports relatively large and diverse invertebrate populations (Anderson, Haskins, <i>et al</i>, 2003) - Provides habitats for numerous farmland bird species, as do winter stubbles left by spring-sown crops - Autumn-sown OSR has a higher nature value than other winter crops (Hope and Johnson, 2003)
Water	<ul style="list-style-type: none"> - As for conventional OSR: risk of nutrient run-off, particularly as OSR has high nitrogen requirements, and pesticide contamination 	
Soil		
Landscape	<ul style="list-style-type: none"> - An increased area of OSR production will result in a higher pollen count, potentially affecting public enjoyment of the countryside 	<ul style="list-style-type: none"> - Differing views about the visual impact of OSR in flower
Rural economy	<ul style="list-style-type: none"> - A lower energy yield per hectare than other conventional crops 	<ul style="list-style-type: none"> - OSR straw could also be sold for either biofuel or bioelectricity production

Agricultural Management

SRC is grown in rotation and harvested in winter every 2 to 5 years. Coppices can be established at high density, approximately 1m apart, and generally have a productive life of between 20 and 30 years. They require moisture retentive soils.

During establishment weed control (with a broad spectrum contact herbicide, eg glyphosate) is important, as young trees are not good competitors. After 2 to 3 years, this is no longer necessary and the mature crop has much lower plant protection requirements than conventional arable crops, although some form of regular control is still recommended (Tubby and Armstrong, 2002). Fertilizer requirements are also considerably lower, with studies revealing minimal benefits from fertilization (Tubby and Armstrong, 2002).

SRC at different levels of maturity can provide an annual harvest as well as biodiversity, landscape and water benefits.

Potential benefits are likely if SRC is planted in buffer zones or around high input crops as they effectively filter the run-off by soaking up nutrients, protecting local water-bodies.

Both willow and poplar have high water requirements and large areas under SRC cultivation in water catchment areas may deplete groundwater supplies. Measures can be taken to minimise these risks, such as harvesting in rotation (as water use is related to age of crop) and planting numerous smaller blocks as opposed to one single large one.

Maximum benefits will be gained from SRC production by ensuring that plantations are sited in areas that are currently of low conservation value and not on areas with a pre-existing high nature value, such as wetlands or extensively managed grasslands.

Benefits for biodiversity can be maximised by:

- Planting a mix of varieties and age-classes
- Establishment of headlands and rides
- Planting hedgerows along the perimeter of the plantation.

English Nature has commented that 'SRC willow has the potential to support a wide range of species, some of which are priority species for nature conservation in the UK, although its overall value for nature conservation will depend on what kind of land use it is replacing.' (English Nature, 2003).

Table 4: The environmental concerns and benefits/opportunities created by SRC production for biofuels

	Concerns	Benefits/Opportunities
Biodiversity	<ul style="list-style-type: none"> - Excessive herbicide use may be practised, especially during establishment, reducing plant biodiversity and dependant species - Frequent mechanical weed control could damage ground nesting birds - Disease potential from intensive cropping high - Where it replaces open habitats, including conventional crops, could be detrimental for certain species, eg lapwing and skylark 	<ul style="list-style-type: none"> - Supports a high diversity and abundance of invertebrates, birds, and other species compared to conventional crops - Overall low input requirements - Plantations with a mix of age-classes would support the highest levels of biodiversity - Can provide habitat links between existing woodlands
Water	<ul style="list-style-type: none"> - Both willow and poplar have very high water requirements 	<ul style="list-style-type: none"> - Can act as a 'filter'; if planted in appropriate areas can reduce nutrient run-off
Soil	<ul style="list-style-type: none"> - Mechanical harvesting in winter may damage wet soil (eg in floodlands) 	<ul style="list-style-type: none"> - No ploughing necessary after establishment, leaving soil undisturbed - Hardy crops; can be planted on soil that is low in nutrients, and can be used in remediation of contaminated land (Beale, 2001)
Landscape	<ul style="list-style-type: none"> - SRC are tall and very visible; compared to arable crops, they can potentially damage landscape character, obscure views, etc - SRC crops are fast-growing so the rate of change of landscape is rapid (Bell and McIntosh, 2001) 	<ul style="list-style-type: none"> - Sensitively managed SRC can be an attraction, and with public access can heighten enjoyment of the countryside by providing new recreational opportunities
Rural economy	<ul style="list-style-type: none"> - Difficult harvesting increases costs 	<ul style="list-style-type: none"> - Employment, especially in the winter when harvesting is carried out and there is little other agricultural work - Sensitively managed SRC can be an attraction, and with public access can heighten enjoyment of the countryside by providing new recreational opportunities - Appropriate for development of sporting and recreational facilities, providing extra income (British Biogen and partners, 1996a)

10.4 Wood Fuels From Forestry

(see Table 5, page 25)

Wood fuel can be harvested from a variety of forestry sources ranging from upland plantation forestry, through lowland deciduous woodland, to urban forests. There is also potential wood fuel from the use of virgin fibre from the co-products (sawdust and wood chips) from sawmilling. Arboricultural arisings, potential wood fuel from tree work

on single urban trees, has also been shown to have considerable potential.

Collectively these sources of wood fuel have been calculated (McKay *et al*, 2003) to have a potential – without serious disruption to existing wood using industries – of 1.26 million oven dry tonnes per annum.

The wood should be able to be processed into bioethanol through gasification. All the major forestry organisations, led by the Forestry

Table 5: The environmental concerns and benefits/opportunities created by harvesting wood from forestry for biofuel production

	Concerns	Benefits/Opportunities
Biodiversity	<ul style="list-style-type: none"> - Excessive harvesting of woods or residues can result in the loss of habitats, and species abundance and diversity 	<ul style="list-style-type: none"> - Sustainably managed forests have a higher nature value than unmanaged forests
Water		
Soil		
Landscape	<ul style="list-style-type: none"> - Increased harvesting could lead to more clear felling, removal of old trees and planting of faster growing species - Harvest practices can be noisy and disruptive 	<ul style="list-style-type: none"> - Well managed woodland has a higher amenity value
Rural economy		<ul style="list-style-type: none"> - Much of the UK's woodland is currently under-managed as it is not economically attractive; creating a new market for forestry goods could make management profitable and bring forests back into management - Creates new employment opportunities in the forestry sector - Improved woodland management as a result of harvesting can improve the habitat quality for game species, creating new sports business opportunities.

Commission, are advocating substantial development of the market for wood fuel and there are many projects currently under development for the production of electricity and heat, both at national and local levels.

The management of forestry and woodland in the UK is subject to a number of environmental safeguards, in part self-imposed by the introduction of the UK Woodland Standard. The adoption of international forestry and woodland certification schemes is also helpful. The realisation of markets for wood fuel, especially in scattered lowland deciduous woodland, is regarded by many in the forestry community as being likely to contribute positively to the long-term future of currently neglected woodland by providing an income stream to encourage investment and active management. However, the precise impact of more intensive management and harvesting is rather less clear.

Poor management or excessive harvesting of trees or residues could damage woodland habitats. In commercial upland forestry, wood fuel would provide income streams for thinning which is essential for the long-term development of high quality final crops. Nonetheless, the RSPB is concerned that an increased use of woodland for biofuel could add legitimacy to inappropriate management of semi-natural woodland, particularly in the uplands.

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