11 Energy crops - biomass

Context

11.1 European Union targets for use of renewable energy are that 20% of our energy use will come from renewable energy sources by 2020. Electricity consumption in England in 2006 totalled 271,010 GWh.[1] Biomass has a lower calorific value (i.e. less energy per tonne) than coal or gas, but typically produces 77g CO_2 eq/kWhe, compared with 1054g CO_2 eq/kWhe produced by coal.[2] Even after carbon emissions associated with cultivations and fertiliser usage are calculated, greenhouse gas emissions for biomass production are significantly lower than those for fossil fuel. For example 66-99% lower than for current coal-fired power generation.[3]

11.2 Energy crops can be used in different ways: 'biomass crops' such as Short Rotation Coppice (SRC), Short Rotation Forestry, tall perennial grasses such as *Miscanthus*, and by-products such as straw from annual crops, provide carbohydrate for direct combustion; oil-bearing crops (oilseed rape, sunflowers) and carbohydrate or sugar-rich crops (wheat, sugar beet) are used to produce biodiesel and ethanol respectively, to replace hydrocarbon fuels. This chapter is concerned with biomass crops in particular. Biofuel crops that are suited to production in this country are based round grain and oilseed production and, in that respect, husbandry methods are not likely to differ substantially from production of similar crops for human or animal feed.

11.3 Between 2001 and 2007, some 5783 ha of *Miscanthus* and 1676 ha of SRC were planted under the Energy Crops Scheme in England.[4] It is not clear whether these areas have remained under energy crops after the agreement period elapsed but Defra's Farm Practices Survey (2008)[5] found that 12% of farmers surveyed stated that they were growing energy crops (which may include crops for liquid biofuel production), with 24% considering growing them in the future.

Current industry practice

11.4 SRC is planted at high density (approximately 1m spacing) and harvested at 3 year intervals. Its productive life is between 15 and 30 years (up to six harvests), after which time the roots are grubbed out.[6] *Miscanthus* is planted as rhizomes, and is harvested anually in autumn or winter from its second year onwards. It has a productive lifespan of approximately 15 years, after which it can be treated with herbicide and the land cultivated to destroy any remaining rhizomes..

11.5 Currently an increasing amount of chopped material is pelleted before transport, effectively trebling the bulk density of the material, and increasing transport efficiency.[7]

Industry trends and pressures

11.6 To provide 1500 MW of 'renewable' electricity capacity around 125,000 ha of land would be needed for energy crops.[8] Biomass crop estimates to supply future UK demand suggest that it will include 450,000 ha of SRC and *Miscanthus* (the remainder to come from 700,000 ha of oilseed rape and 350,000 ha of wheat and sugar beet).[9] Drax power station plan to generate 500 MW from biomass co-firing facility.[10] Current UK targets are for SRC area to increase to 16,000 ha which will provide 215 kt of biomass.[11] The current target area for *Miscanthus* is 5000 ha, providing 64 kt of biomass.

11.7 For current incentives, advice and regulation for production of biomass crops, see Annex I to this chapter.

Key impacts

11.8 For conventional crops, such as oilseeds, wheat or sugar beet, agricultural operations such as fertiliser and agrochemical spray applications are unlikely to differ substantially when destined for bioenergy applications. See chapters on ‘Nutrient management - crops’, and ‘Use of plant protection products’). Where conventional crops are replaced by perennial biomass crops, fertilisers and herbicides are only used at establishment, and after cutback,[12] due to the difficulties in application during other growth stages.

11.9 Depending on the scale of planting in the locality, establishment of SRC or *Miscanthus* may provide an increase in landscape heterogeneity, which has potential advantages in terms of bird and invertebrate diversity[13] (depending on the previous land use), but the overall effect would depend on the habitat that is replaced. Where grasslands are ploughed out it would potentially impact local biodiversity, soil carbon and water quality through nutrient release.[14]

11.10 The crop structure of SRC provides suitable habitat for several key UK farmland bird species and passerines (mainly tits, finches and warblers) characteristic of scrub, woodland and ruderal vegetation.[15,16] Bird species associated with open farmland habitats such as skylark and lapwings do not use SRC as breeding habitat except possibly following establishment or after the winter cut.[17] Surveys show that many of the species that use areas of SRC are concentrated round the edges of the crop.[18]

11.11 It has proven to be difficult in practice to source all the biomass required within the immediate vicinity of co-firing facilities, and as a result much has needed to be imported. Transport to end users has been shown to have very little impact on the overall GHG balance.[19]

Plate 8 Short Rotation Coppice, showing density of the growing crop

11.12 Soils under biomass crops are vulnerable at harvest time, where heavy equipment may be used under wet ground conditions.With SRC the extended period between harvests, and the development of large root systems, should allow some stability and recovery. At other times, the leafy cover and fallen leaf material are considered to be effective in reducing erosion and soil run-off.[20]

11.13 At present, the area used for energy crops has been predominantly under arable rotations, as evidenced by the lack of change in area of medium and long term grasslands.[21]

11.14 Energy crops are a relatively new element in the landscape and may have an impact on landscape character, depending on where and how they are grown. The impact of any planting will depend on the character and quality of the recipient landscape, the scale and form of the planting, and the ability of the landscape to absorb change.[22] This will often be site-specific and may be positive or negative. For example, in some open landscapes, SRC can obscure key historic features and views, whereas in lowland agricultural landscapes it has the potential to add structural diversity and interest. Enclosure, openness and landform type will all have an influence. Cultivation has the potential to disturb archaeological remains and damage can arise from planting processes, root growth, hydrological impacts and harvesting.[23]

11.15 Where crops are established in previously cultivated ground, impacts may be no greater than for conventional cereal planting, although associated works, such as the widening or removal of historic gateways, erecting new fences etc., may impact directly on archaeological remains or their setting.

11.16 Where SRC is planted, research indicates a higher water demand[24] than traditional arable crops. There is little evidence at present to suggest that this has a deleterious effect on water tables. In models of bulk planting of catchments, hydrologically effective rainfall (the rainfall that enters the catchment as runoff, or infiltrates groundwater by deep percolation) can be reduced by 75-90% by SRC or 50-60% by Miscanthus.[25]

11.17 For further factual background to this section, see Annex II to this chapter.

Summary of impacts

Biodiversity

11.18 There is little hard evidence on the wider effects that energy crops will have on biodiversity. Were a high percentage of land to be required for energy crop production, it would put pressure on some semi-natural habitats, particularly given the current concerns that the area of land used for food production should not be reduced.

11.19 Short Rotation Coppice (SRC) can contain a greater diversity of wildlife than conventional arable crops, particularly small birds - although these are more likely to be woodland species than birds of open farmland.

11.20 Where biofuels are being derived from crops such as oilseed rape and wheat, it is unlikely that there will be a major departure from current growing methods and associated impacts on biodiversity. Unless there is a mechanism which values the product on the carbon costs of production, it is likely that intensive (high input, high output) management will be the popular option.

Resource protection

11.21 Research indicates that despite the release of nitrates at establishment and ‘grubbing up’ of short rotation coppice, overall nutrient losses into the soil are less than under conventional arable cropping.

11.22 Crops such as SRC are not ploughed or harvested annually, which benefits soil structure in comparison with conventional arable land use, and their low agrochemical requirement is advantageous in terms of risk from run-off and leaching.

11.23 If non-arable land is converted to biomass crop production, this would lead to losses of soil carbon. This has implications for soil structure and erosion as well as for greenhouse gas emissions.

Greenhouse gases

11.24 The drive behind energy crops is based on reducing emissions from carbon-based fuels. There is strong debate over whether conventional arable crops for processing into liquid biofuels deliver acceptable C savings. Biomass crops have come under less scrutiny, but are targeted to provide carbon savings of over 190 kt C annually.

11.25 Low fertiliser and agrochemical requirements in biomass crops also contribute to greenhouse gas savings.

Landscape

11.26 The expansion of arable areas into *Miscanthus* and SRC production will affect the landscape, though gains and losses will depend on individual location and shape of plantation, and any infrastructure associated with the local production of biofuels, such as storage areas.

Annex I Current incentives, advice and regulation

- The UK Renewable Energy Strategy, as agreed by European Union Heads of Government in 2007, commits us to a binding target of 20% of EU's energy (electricity, heat and transport) to come from renewable sources by 2020.[26] It also has a further domestic goal to reduce carbon dioxide emissions (one of the main greenhouse gases) by 20% below 1990 levels by 2010.[27] To contribute to meeting these targets, the UK encourages delivery through the Energy Crops Scheme[28] and Energy Aid payments.[29]
- In the UK, grant funding for energy crops originally required biomass crops to be grown as close as possible to the end user, usually within 25 miles.[30] This has proven to be logistically impossible and the limit no longer applies.
- Several economic and policy drivers may lead to the development of large, relatively uniform areas of bioenergy crops. These include economies of scale, the demands of large scale users and the need to minimise transportation costs.
- The local planning system does not cover the impacts of planting bioenergy crops on the character of the local landscape. The Energy Crops Scheme (ECS), which provides establishment grants for SRC and *Miscanthus*, can be used as a mechanism for ensuring that new plantations are established with consideration for environmental issues.

Annex II Impacts on environmental sustainability of biomass crop production

Table 13 Impacts on environmental sustainability of bioenergy fuel crop production

Habitat quality and diversity	• Habitats might be affected or lost where biomass crops are inappropriately sited. This includes open farmland habitats (arable or pastoral) that are important for nesting and feeding birds, as well as more marginal, semi-natural habitats Crops such as Short Rotation Coppice (SRC) can be grown on land unsuited to other arable production (Agricultural Land Classification grades 4 and 5).[31] This could entail a higher impact on semi-natural vegetation, which has not been affected by other agricultural intensification. • Some successional plant communities can become relatively stable in long-term plantations,[32] despite current crop establishment guidelines involving relatively heavy use of herbicides.[33]
Species abundance and diversity	• SRC can contain a greater diversity of wildlife than conventional arable crops, particularly small birds[34], although the species assemblage would not be the same as for open farmland.[35] • SRC can support a relatively high diversity of flora,[36] although its establishment on species rich habitats would still be damaging.
Water level control	• High yielding biomass energy crops such as SRC use more water resources than conventional arable crops.[37] This may affect the local water table.
Sediment loads in water	• Crops such as *Miscanthus* and SRC are established or harvested over the autumn or winter period, increasing the erosion risk.[38] • Deep rooting of biomass crops improves water infiltration and reduces surface run-off.[39] • Grassy or woody crops are usually effective buffer areas against erosion from other sources.[40]

Table continued...

Nutrient loads in water	• Oil Seed Rape (OSR) grown for biodiesel and cereals for bioethanol will receive virtually the same nutrient application as conventional foods crops, with little or no change to the risk of nutrient load to water.[41] • Some cultivars of *Miscanthus* are associated with nitrogen-fixing bacteria, which can reduce substantially external nitrogen requirements.[42] Grubbing out such crops can release nitrates into the groundwater. • The normally low level of nitrogen mineralisation is increased in soils during the disturbance involved in establishment and grubbing out.[43]
Pesticide control in water	• The practicalities of spraying pesticides on a SRC crop preclude their use during most of the growing period. Some use may be made for weed control at establishment, which may potentially enter watercourses, depending on the persistence of products used.
Other pollutants	• Heavy metal contamination resulting from application of sewage sludge can be taken up by willow; ash disposal after burning requires consideration.[44] • Relatively high levels of pest damage can be tolerated, unlike in conventional arable crops.[45] This entails less pesticide application.
Greenhouse gases	• Where grassland is ploughed up to establish biomass crops, the carbon released may take decades to offset.[46] • The precise balance between the lock up of greenhouse gases within the biomass of energy crops and the release of gases from the use of inputs to grow, transport and utilise them is under debate. • Low bulk density of the chopped material is a limiting factor for all modes of transport.[47] This is offest where material is pelleted before transport. • Comparatively low demand for inorganic fertilisers leads to low overall GHG emissions per hectare of crop during cultivation.[48]
Air quality: odour	• Organic fertilisers are a common source of odour nuisance. • Application of organic manures (particularly slurry and farmyard manure (FYM) can result in high losses of N as ammonia (*c.* 40% for slurry, 70% for farmyard manure).[49]
Soil stability (erosion)	• Energy crops such as *Miscanthus* and SRC are established and harvested over the winter period. This may have detrimental effects on sloping ground or vulnerable soils.[50]

Table continued...

Soil function	•	The use of heavy machinery to harvest the biomass crops in winter can lead to problems of compaction on some sites.[51] Deep rooting of biomass crops improves water infiltration and reduces surface run-off.[52]
Landscape character	•	There is considerable opportunity to impact both positively and negatively on landscape through the design and scale of bioenergy crop planting. As yet such plantations are on a comparatively small and fragmented scale.

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