Input to DG TREN consultation on “Biofuel issues in the new legislation on the promotion of renewable energy”

How to avoid major biodiversity loss from land use change induced by biomass production for bioenergy?

July 29, 2007

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Commissioned by the European Environment Agency

Content

Introduction and Scope

In April 2007 the European Commission launched a public consultation on “Biofuel issues in the new legislation on the promotion of renewable energy”. One of the concerns in question is how a biofuel sustainability system should be designed to avoid major biodiversity loss from land use change (proposed sustainability criterion 3). This criterion foresees that “biofuels used to fulfill the requirements of the directive should not use raw material from land that was in certain land uses before a certain date (for example, the date of the Commission proposal). These land uses would be those that are associated with exceptional biodiversity.”

The European Environment Agency in Copenhagen commissioned Ecologic and Alterra to respond to the Commission’s public consultation by focussing on sustainability criterion 3 (Avoidance of major biodiversity loss from land use change) with respect to:

- Question 1.1: “Do you think the "possible way forward" described above is feasible?“
- Question 1.5: “As described in the "possible way forward", criterion 3 focuses on land uses associated with exceptional biodiversity. Should the criterion be extended to apply to land that is adjacent to land uses associated with exceptional biodiversity? If so, why? How could this land be defined?“

Answers to both questions will be interrelated and are not given separately.

Additionally, the EEA has requested responses to some further issues, which will also be included in this analysis. Most importantly these are:

- types of land use change;
- direct and indirect impacts on biodiversity;
- potential impacts on biodiversity due to land use changes that may occur due to extended bioenergy cropping, and
- ranking of land use changes with regard to the cultivation of bioenergy crops and their impact on biodiversity.

This report is largely based on material extracted from published EEA reports, consultancy reports for the EEA, additional literature reviews and expert knowledge delivered by EEA consultants. The main reports used are:

- Elbersen. B.; Andersen; E; Bakker. R.; Bunce R.; Carey, P.; Elbersen. W; Eupen M. van; Guldemond. A.; Kool A..; Meuleman B.; Noij G. & Roos Klein-Lankhorst, J. (2005). Large-scale biomass production and agricultural land use – potential effects on farmland habitats and related biodiversity. Consultancy report to the EEA. (Contract EEA/EAS/03/004)
- EEA (2007), Estimating the environmentally compatible biomass potential from agriculture (publication expected, September 2007).
- Carey, P. A review of research into the environmental impacts of arable cropping systems for biofuels and crops used for biomass. Background report to the study by Elbersen. B. et. al. (2007). Large-scale biomass production and agricultural land use – potential effects on farmland habitats and related biodiversity. Consultancy report to the EEA. (Contract EEA/EAS/03/004)

It should be noted that this document was produced within a rather limited number of days and needs to be viewed, therefore, as an initial but not necessarily exhaustive response to the issues of concern.

Therefore, in analysing the biodiversity impacts of land use and land use changes[1] for biofuel feedstock production[2] a focus has been put on:

- impacts on biodiversity due to land use changes on agricultural land, since mainly agricultural land will be needed for the first generation of biofuels; and
- habitats, biodiversity impacts and land use changes within Europe.

However, the approach and results do aim to provide recommendations and further guidelines for a more general and international approach in the future, which will take issues other than biodiversity impacts and agricultural land uses into account.

[1] Land use change' as used here refers to the conversion between different land uses. Shifts within the category arable land refer to 'land use intensity'.

[2] The public consultation launched by the European Commission explicitly refers to biofuels. The scope of this response is therefore focused on biofuels. However, bioenergy use incorporates a wide range of different applications associated with different land use patterns and biodiversity impacts, which needs to be regarded in an integrated context. See also chapters 1 and 3.

Structure

The report is divided in four main sections.

The first section briefly outlines the link between biofuels and land use requirements. Considering current developments, it is most likely that additional land will be used for production due to an increased demand for biofuels. For the next five to ten years, this market will be largely dominated by first generation biofuels based on agricultural feedstocks; therefore, the second chapter will focus on agricultural land.

There are a number of relevant issues addressed in chapter two. Foremost, impacts on biodiversity from bioenergy cropping are comparable to impacts from traditional agricultural land uses. Those impacts will first be generally described and then specified to particular issues of bioenergy feedstock production, such as different (direct and indirect) impacts on biodiversity and the potential types of land use change induced by an increased demand for agricultural biomass cropping.

The level of impacts, however, differs depending on a range of factors, which will be outlined as well. A following section will attribute biodiversity impacts to groups of land use changes. A scenario will then show where in Europe land use changes are likely to take place. The chapter concludes with a discussion of which land uses are of highest biodiversity value and/or most vulnerable to a switch to bioenergy cropping. In this section, land use changes are ranked according to vulnerability to biodiversity loss caused by an increased demand for biomass cropping.

The third chapter builds on this analysis and suggests a way forward. The suggested approach has two pillars: One addresses the direct impacts and the other indirect impacts. As for direct impacts, a system was developed that categorises which land is suitable for biofuel feedstock production. The first category refers to land with low potential for impacts on biodiversity or even the potential to improve the baseline ("Go"-areas). Another category consists of "No-go" areas, which should not be used for biofuel feedstock production due to high biodiversity impacts ("No-go"-areas). The last category defines areas that would be suitable under a number of restrictions that are intended to set off or reduce potential negative impacts on biodiversity (Go – under certain restrictions).

Since an approach addressing direct land use changes can not be sufficient (due to leakage effects and subsequent effects on biodiversity), it is important that the "Go/ no go" approach will be part of an overall land use policy. This requires a global mapping exercise in order to determine important areas that need to be considered and protected when attributing potential areas for bioenergy feedstock production.

Furthermore, it is also land use intensity that is critical for biodiversity richness on farmland, in particular on grassland. While this is not an explicit objective of the consultation and hence not discussed in detail here, attention needs to be paid to options that could help to avoid intensity shifts associated with bio-energy production (see also EEA, 2007, forthcoming).

Finally, the fourth chapter provides some additional input to related issues with regard to questions 1.1 and 1.5. of the consultation.

1. Land use requirements for bioenergy feedstocks

Potential land use changes are one of the central conflict areas in producing biofuel feedstocks. Since biofuel feedstocks can be used to create products other than bioenergy (i.e. food, animal feed, cosmetics, bio-plastics, building material etc.), sustainability issues have to be seen in the wider context of biomass production, which is strongly influenced by general trends concerning agricultural and forestry land use. Important factors for the size of land available for bioenergy production are: population growth, changes in diet (a change towards more meat consumed will decrease land available for bioenergy production), nature conservation requirements, degradation and salinisation of currently cultivated land etc. At the same time, demand for wood products will increase world-wide.[3]

Nevertheless, within this context it is important to consider that there are many opportunities to limit land use and land use change when producing bioenergy feedstocks, most importantly:

- the use of agricultural and forestry residues;
- cuttings from grassland and other land, which in turn may even support a continued management of valuable habitats if done in an extensive manner and thus contribute to saving biodiversity; and
- more efficient use of current areas (more efficient breeds/ additional production through higher yields, use of idle land).

The potential to explore the above mentioned synergies is discussed in greater detail in chapter 4.

However, despite the potential for efficient land use, increasing demand for biofuels and bioenergy is likely to result in a higher demand for land[4] and has already lead to land use changes. Since the market will be dominated by first generation biofuels[5] produced from agricultural feedstocks for the next five to ten years, the following chapter will focus on biodiversity impacts on agricultural land and respective land uses changes.

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[3] FAO 2000

[4] EEA 2006, Ericsson and Nilsson 2006, IE 2005 - Although values of potential energy derived from biomass/land requirements in Europe differ between the studies, all studies come to the conclusion that potentials from agriculture mainly derived from energy crops exceed potentials from wastes and forestry in the long term.

[5] The various biomass feedstock used for producing biofuels can be grouped into two basic categories: the currently available “first-generation” feedstock, which are harvested for their sugar, starch, and oil content and can be converted into liquid fuels using conventional technology, and the “next-generation” feedstock, which are harvested for their total biomass and whose fibres (ligno-cellulose material) can only be converted into liquid biofuels by advanced technical processes. (WWI 2006)

2. Impacts on farmland biodiversity induced by an increased demand for biofuels

2.1. Main factors influencing farmland biodiversity

In principle, current agricultural production and management for food and feed crops has comparable impacts on farmland biodiversity as bioenergy cropping does. The following section will provide an overview of the principle factors influencing farmland biodiversity and a clarification of the terminology used.

According to the Convention on Biological Diversity biodiversity is defined as “the variety of life in all its forms, levels and combinations. It includes ecosystem diversity, species diversity, and genetic diversity”. Biodiversity conservation is a principal aim in European environmental policy[6].

In most European countries, agriculture is one of the most important land use activities and it was identified as a major impacting sector on biodiversity within the 5th Environmental Action Plan and subsequent documents. At the same time farmland hosts a large part of Europe’s biodiversity including many valuable habitats and plant and animal species listed in the Annex I and II of the Habitats Directive. All environmental pressures from agriculture are therefore also linked directly and indirectly to biodiversity. Intensification shows a heavy impact on farmland biodiversity but also abandonment of agricultural land use has an adverse effect on biodiversity (EAA, 1999 and 2005). This process of polarisation, in which abandonment of use and an increase in cropping intensity can be found within the same region, poses a threat to biodiversity, especially in semi-natural areas created by extensive livestock farming.

The wider, qualitative relationship between several farming practices such as the use of pesticides, herbicides, nutrient inputs, tillage, irrigation, changes in landscape structure on soil organisms, invertebrates, birds, plants and mammals have systematically been described in several reports and research articles[7]. From these studies it is clear that the overall increased food production in Europe has caused many negative impacts on the environment because of the associated intensification of land use[8]. This increased food production went together with a loss of very large areas of permanent grassland, dry steppe grasslands and wetlands which were replaced by arable agriculture with a huge loss of biodiversity.[9]

All in all it is clear that a decline in farmland biodiversity across Europe coincided with an increase in the intensity of agricultural production.

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[6] In the Gothenburg summit (2001) this has been reinforced by the commitment of the EU Heads of State to halt biodiversity decline by 2010. This is also reflected in several EU strategies and actions such as the Community biodiversity strategy (COM (1998); Biodiversity Action Plan (BAP) for Agriculture (COM (2001) 162 (03); EU Action plan for halting the loss of biodiversity (COM (2006) 216)).

[7] (e.g. Wadsworth et al., 2003; Boatman et al., 1999; Bignal & McCracken, 1996& 2000;)

[8] (e.g. Buckwell & Armstrong-Brown 2004; Wadsworth *et al.* 2003; Boatman et al., 1999; MAFF, 1998; Pretty, 1998; EPA, 1999; Campbell and Cooke, 1997)

[9] Carey (2005) refers to serious declines in some species associated with arable farmland in the late 20th century of which evidence is shown in many studies based on national monitoring and long-term studies of birds, butterflies, beneficial invertebrates and annual arable flowers (Birdlife International, 2004; Vickery et al., 2004; Asher *et al.*, 2001; Baillie *et al.*, 2001; Donald *et al.* 2001, 2002; Aebischer, 1991; Donald, 1998; Sotherton, 1998 etc.). Heath et al. (2000) showed for example that the decline in farmland-birds and the intensification of agriculture are correlated.

More recent trends were revealed in the IRENA study[10]. Additionally BirdLife International provided some interesting information for the New Member States, estimating that of the 571 International Important Bird Areas (IBA) in these countries 27% were negatively affected by abandonment and 33% by intensification. However, since IBAs only reflect a small share of the agricultural areas in these states this does not give a complete picture of the pressures of agriculture on biodiversity. However, in comparison to most EU-15 Member States agriculture is less intensive in the new Member States[11].

However, it should also be mentioned that in some regions of the new Member States the intensification continued or restarted because of land privatisation leading to conversion of permanent grasslands into (irrigated) arable lands, increases in input applications, irrigation, destruction of field boundaries etc.

Overall there are a couple of main conclusions to be drawn from the former:

- Biomass cropping should not lead to further intensification of farming and a continuation in the conversion of habitats of high biodiversity value to arable land as has happened in the post war period at a very high frequency in most parts of the EU.
- Economics along with the productive capability of the land will determine which changes in landuse will occur first to accommodate the needs of biomass production.
- It is clear that the impacts on biodiversity of changing some extensive land-uses to intensive arable or biomass production would be severe, but from an economic and technical point of view these changes are not always very likely to occur, e.g. changing wetlands to intensive arable is not likely because of the high cost of drainage and because of legislation to protect them. Growing short rotation coppice on wetlands would be more economically viable but in many case sites would generally still be protected by law.
- A distinction needs to be made between ancient extensive farming systems, such as the Dehesas/Montados or species-rich hay meadows of the mountains and northern Europe, and the extensive grasslands that are more recent and have occurred due to land abandonment. This second group are less valuable in biodiversity terms but if converted to intensive arable would still lose a great deal of environmental quality impacting indirectly on certain species group.

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[10] The IRENA indicator 28 (Population trends in farmland birds) shows that between 1980 and 2000 the majority of the farmland birds in the EU-15 suffered strong declines, but this decline levelled off since 1990. This is not surprising as levels have become very low already, especially in the intensively farmed areas. IRENA indicator 33 also showed that 80% of all agricultural Prime Butterfly Areas (PBAs) experience negative impacts from intensification, abandonment or both. 43% of all agricultural sites suffer from intensification, whereas abandonment is a significant problem in 47%. Both impacts occur simultaneously in 10%.

[11] Although before the 1990s because of processes of collectivisation of agriculture and industrialization in most of these countries similar agricultural trends took place with negative effects of biodiversity and landscape diversity, after 1990 inputs of fertilizers and pesticides and the area of irrigation have generally decreased. Where this happened this had positive effects on soil, air and water quality. However, abandonment has certainly increased at the same time with mostly negative effects on threatened habitats and often positive effects on more widespread species (see EEA, 2004).

2.2. Importance of HNV farmland and habitats protected under the habitats directive

High Nature Value farmland has become one of the indicators for the integration of environmental concerns into the Common Agricultural Policy. It can be defined as "farmland that comprises those areas in Europe where agriculture is a major (usually the dominant) land use and where that agriculture supports or is associated with either a high species and habitat diversity or the presence of species of European conservation concern or both" (EEA, 2004).

HNV farmland (or farming systems) are generally linked to low intensity farming approaches, which ensures that they support a high level of biodiversity. Firstly there is a high density of semi-natural habitats.[12] Secondly, the quality of the habitats is also much better ensured in HNV farming as the use of external inputs such as agro-chemicals, artificial fertilisers, concentrate feedstuffs and water (irrigation) are low.[13]

The HNV farmland areas have become an EU policy target, with the conservation of these extensively farmed ecosystems being an explicit objective of the EU's environment[14] and rural development policies[15]. In the period 2005-2007 JRC and EEA have carried out a further update of the work by Andersen et al. (2003), using a combination of European environmental datasets, including Corine Land Cover data, and additional spatial data sets such as the European soil map, mapped agricultural Natura 2000 and International Bird Areas (IBAs). The approaches have resulted in a better estimate of the location and extent of HNV farmland. In addition, the EEA has further developed lists of species and habitats from the Habitats Directive that are indicative of HNV farmland (see annex 1 for a revised list of habitats from Annex I of the Habitats Directive that depend on extensive agricultural practices).

Full implementation of the Birds Directive (79/409/EEG) and the Habitats Directive (92/43/EEG) is another major step in implementing conservation management in areas with high and special biodiversity values. The EU Habitats Directive also constitutes the core of the Natura 2000 network, a network of habitats of high nature conservation value. Within the Annex I of the Habitats Directive, all habitats of high nature conservation value in Europe

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[12] This is because there is a lack of fundamental alteration of the land on HNV farms because they are generally more constrained by location, climate and topographic factors. This can generally be regarded as a 'no choice' option rather than as a conscious consideration of the farmers to farm in a more natural way. Overall, natural constraints limit the proportion of land available for intensive utilisation while at the same time there is more space for biodiversity as it provides a larger amount of semi-natural habitats, there is larger landscape structural diversity and it facilitates a better permeability of the landscape for several species.

[13] Pollution adversely affecting habitat quality is therefore limited in these systems. The low artificial fertiliser and agrochemical input in extensive livestock systems results in a diverse invertebrate fauna (e.g. Van Wingerden et al., 1992, Siepel, 1990), in contrast to high input farming systems (Mäder *et al.*, 2002; McLaughlin & Mineau, 1995; Feber *et al.*, 1997).

[14] The European Ministers of Environment in Kyiv, in 2003, and in their final resolution (UN/ECE 2003) declared that: 'By 2006, the identification, using agreed common criteria, of all high nature value areas in agricultural ecosystems in the pan European region will be complete. By 2008, a substantial proportion of these areas will be under biodiversity-sensitive management by using appropriate mechanisms such as rural development instruments, agri-environment programmes and organic agriculture, to inter alia support their economic and ecological viability … ' (EEA/UNEP, 2004).

[15] High Nature value farming (and forestry) systems have been chosen as one of the key impact indicators for the evaluation of the design and success of national and regional rural development programmes. In addition, the Community guidelines for the drawing up of rural development programmes make explicit reference to the need for preserving such systems, in line with strategic EU environmental objectives.

have been listed for which Member States have the responsibility to conserve their quality through the designation of a protection status. The same applies for the Annex II of the Habitats Directive, in which plant and animal species are listed whose conservation should also be ensured through the designation of areas and their integration in an ecological network (Natura 2000 network).

As described above, the species and habitats listed in the Birds and Habitats Directive that are linked to HNV Farmland should be seen as areas with exceptional biodiversity and, therefore, need to be protected from land use pressures resulting from bioenergy cropping. Further attention should also be given to other species and habitats listed in both directives as far as they could be affected by indirect effects of land use changes associated with bioenergy cropping.

2.3. Direct and indirect impacts on biodiversity

The impacts of land use and land use change[16] can be divided into direct and indirect impacts on biodiversity. Direct impacts, such as habitat fragmentation, habitat diversification, changes in canopy structure and soil cover, are directly linked with biofuel cropping, whereas indirect impacts include all environmental effects, such as eutrophication, acidification, water balance effects, etc., that have impacts on broader areas including adjacent land.

The most severe impacts, however, are impacts occurring due to indirect land use change. Since part of the high energy demand in Europe has to be replaced by renewable energy (according to EU targets) and since there is limited land potential and/or it is less economical to bring additional land into arable use in Europe for biomass production, international imports of biomass play a major role. The EU Biofuel Directive proclaims that a “well-balanced relation between domestically produced biomass and biomass imports” is needed in order to fulfil biofuel targets. Therefore, in terms of biodiversity impacts, land used outside the EU, which leads to biomass imports in the EU, has to be taken into account as well.

Currently, none of the available Life Cycle Analysis, which calculate the environmental performances and Greenhouse gas performance of biofuels, consider the so called “leakage effects”. Leakage effects can be defined as “activity-induced changes in land use that occur outside the area in which the activity takes place” (Faaj et al. 2005). When energy crops are grown on any type of land, they displace former land uses. Consequences can be regional, if shifts in land uses occur on adjacent land, nearby or even global or if land limitation leads to extended land taking in other parts of the world. With the latter, domestic biofuel cropping gets an international dimension, because the replacement induces additional land requirements in other countries, given that demand for replaced products remain the same. In other words, if Members of the EU extend their biofuel cropping area, it competes with food and fodder production on the same land. When food and fodder consumption is not reduced respectively, additional amounts of products have to be imported, causing additional land requirements in exporting countries. These induced land use or land use changes might happen under unsustainable conditions, affecting biodiversity by habitat destruction or intensification of agriculture, although domestic biofuel cropping might fulfil the adopted sustainability criteria. Life Cycle Analysis remain incomplete and incorrect if such effects are not taken into account.

[16] ‘Land use change’ as used here refers to the conversion between different land uses. Shifts within the category arable land refer to ‘land use intensity’, which is often essential for actual biodiversity value, in particular on grassland but also on arable land.

Recent developments and studies show, however, that leakage effects already induce severe land use changes in terms of biodiversity impacts. For example, the enormous boost of palm oil plantations in Indonesia and Malaysia at the costs of tropical rainforest not only leads to habitat destruction and diminishing biodiversity[17] but also to high GHG emissions when rainforests are burned and peatlands are drained (WWF 2007, Hooijer et al. 2006). In Brazil, where soy (for biodiesel) and sugarcane (for bioethanol) production areas are also increasing, this leads to increased land demand at the cost of rainforest and savannah ecosystems. Both sugarcane and soy are intensive monocultures associated with high inputs of fertilisers and pesticides, negatively affecting biodiversity on cultivated and adjacent land. The international dimension of land use changes is very important, and needs to be taken into account when designing sustainability criteria in Europe.

2.4. Grouping of potential land use changes according to intensity

In this section those changes in land use and farming practices potentially associated with a shift towards biomass crop production are further described that are most likely to influence biodiversity. Previous sections have already shown that land use changes are most likely to a affect biodiversity negatively if these take place on low intensity farmland, e.g. High Nature Value farmland and farmland in Natura 2000 sites.

Changes in land use resulting from a shift towards biomass cropping, associated with negative and positive effects on biodiversity, can be grouped as follows:

1. Conversion of **extensive land use categories to arable land**. For example:

- *Permanent grass converted to arable land*. Effects on biodiversity are especially negative if this involves loss of extensive permanent grass (rough grassland or grassland with very low fertiliser input), potentially together with increased drainage and irrigation.
- *Fallow and set-aside land converted to arable land*. The effect on biodiversity will be especially large if there is a loss of long-term fallow or set aside, or a tightening of rotation that leads to generally increased use of crop protection and fertiliser.
- *Permanent crops converted to arable land.* The effects on biodiversity are especially negative if extensive permanent crops such as extensive olives and almonds and Dehesa or Montado types[18] of culture are lost and it is even worse if this land also becomes irrigated. However, if it includes the shift of intensive permanent crops (e.g. fruit trees, citrus, intensive olives and vineyards) to arable or perennial crops used for biomass purposes it could have a neutral to positive effect on biodiversity (see also next section).

[17] Friends of the Earth 2005, WWI 2006

[18] Dehesa and Montado are Spanish and Portuguese terms respectively to refer to open forests of evergreen oak species (Quercus suber and/or Q. rotundifolia) in combination with cereal growing and/or pasture (Pinto-Correia 1993). Because of the alternating tree densities, due to natural regeneration, in combination with an extensive use of the understorey, the system is highly diversified and therefore supports high levels of (often rare) species and habitat diversity (Ojeda, Arroyo et al. 1995).

- *Abandoned farmland converted to perennial biomass crops (perennial grasses or short rotation coppice) or grassland*. The effect on biodiversity would be neutral if this maintains the diversity in the landscape and a low input approach is used.

2. **Shifts within arable land**. For example:

- *Increased growth of 'intensive' crops for bioenergy purposes that need greater inputs of crop protection chemicals and fertilizer*. Examples of such changes would be changes from spring to winter cereals, from cereals and oil seed crops to root crops. If cereals are replaced by oilseed rape, higher inputs can be expected, resulting in negative impacts on the affected land. Biodiversity would also be affected, both on the arable land itself and possibly on adjacent land if runoffs are strong due to bio-physical conditions. Growing maize instead of other crops usually increases erosion rates on arable land, with side-effects on associated flora and fauna. Another relevant aspect is crop rotation. Every crop is grown in certain rotation with other crops, which often differ significantly between regions or even between different farming systems. As there are substantive differences in terms of biodiversity between varied crop rotations and mono-cropping practices, tendencies towards less frequent rotations when shifts in bioenergy cropping are made have to be avoided. Generally, the ecological net effects have to be measured if shifts in cropping are made, comparing former and future crops in relation to the site conditions of the respective land.
- *Increased growth of 'extensive' crops that need lower inputs of crop protection chemicals and fertilizer*. Examples include shifts from root crops to cereals and oil seed crops, or arable crops to short rotation coppice (SRC) and perennial biomass grasses are usually beneficial to environmental resource protection. However, for biodiversity aspects a wide arable rotation and increased overall crop diversity are potentially better[19] than large scale SRC or energy grass plantations and will depend on scale and management.
- *A change from dryland to irrigated farmland, or from wetland to drained farmland*. Examples of the first would be a shift from cereal cropping to irrigated maize. This would put extra pressure on water resources which would have adverse effects on biodiversity in regions where water is a scarce recourse. This is certainly the case in most parts of the Mediterranean, but also in eastern Europe, where water abstraction by agriculture is already a problem (see EEA (2005), IRENA Indicator 34 and EEA, 2004). In several regions increases in irrigated agriculture have led to water scarcity, the lowering of water tables and water levels in rivers and lakes. Effects of increased water abstraction have caused salinisation and contamination of water problems, loss of wetlands and disappearance of habitats by the creation of dams and reservoirs. In general there is an important competition for (sweet) water between agriculture, urban land uses and nature in several more arid parts of Europe. The draining of wetlands for conversion into biomass crops would be even more disastrous for biodiversity as wetlands are scarce habitats of large importance for many species, especially birds.

[19] Given the state of knowledge it is difficult to say what the effect on biodiversity is of a shift from arable crops to the perennial types. The impacts of these crops on the landscape structure is quite substantial, but as long as the scale of the plantation is limited it may have positive effects on landscape diversity, especially in intensive monocultural arable landscapes. Furthermore, perennials generally require lower inputs and lower mechanisation levels than most arable crops and once established are a very good protection against soil erosion.

- *A change from irrigated farmland to dry land agriculture.* This type of conversion would generally be positive as it decreases the demand for sweet water for irrigation.

Besides the listed impacts on biodiversity that occur directly or indirectly due to land use changes, bioenergy cropping can be designed in different ways with different positive or negative impacts compared to the former/ reference land use. The main variables for this are:

- Cropping patterns (e.g. mono-cropping or diverse rotations),
- Land use practices/ management intensity/ scale of area for the energy plantation
- level of co-harvesting of residues
- Types of crops that are used (in general perennial crops can be assumed to exert lower environmental pressures then annual crops)[20]
- Use of GMOs

The choice of these management options is therefore crucial for the environmental performance of bioenergy cropping. Synergies between environmental and biodiversity conservation and bioenergy cropping are possible as well and should be supported. In the following examples of environmentally beneficial approaches, taken from the EEA Technical report (2007) "Estimating the environmentally compatible bio-energy potential from agriculture" are presented.

2.5. Practical examples of environmentally compatible bioenergy cropping systems

The three main approaches to gaining maximum environmental benefit from bioenergy cropping are[21]:

a) **combining biomass production with waste water treatment approaches**, e.g. multi-functional use of SRC willow plantations in combination with waste water treatment approaches (applications particularly suited for areas with a good water supply in the Nemoral, Atlantic North, Atlantic Central, Continental and Alpine South zones)[22]
b) **developing synergies with nature conservation via the use of grass biomass**, e.g. utilising cuttings from permanent (semi-natural) grasslands for bioenergy production[23]

[20] This however depends on the particular crop being cultivated. If clustered in groups, perennial and annual crops can be differentiated. Overall, it is clear that the biodiversity effects of the latter group is fundamentally different from arable crops. First, they can be regarded as permanent crops with a rotation time of at least 15 years; harvest of the biomass will only start after 2 to 5 years. Also, input use and machinery requirements are much more limited than with arable crops. This is generally also the case with respect to water use, especially for the Miscanthus and Switchgrass. From an erosion risk perspective, these crops provide good soil protection. Some of the varieties of these crops were even developed for this purpose (e.g. Switchgrass), at least certainly after an establishment phase. The effects of these crops on landscape structure can be significant, as they become rather tall (2-5 meters), which may have quite an impact if they are grown extensively. However, when grown as strips, they may have a positive effect on landscape diversity and may create valuable (shelter) habitats for certain mammals and bird species.

[21] as reviewed in the EEA Technical report (2007) "Estimating the environmentally compatible bio-energy potential from agriculture"

[22] Börjesson P, Berndes G. 2005, Hasselgren K. 1998; Aronsson P. 2000, Rosenqvist 2005

[23] Pötsch, 2006; Erdmanski-Sasse, 2007, EVA project (http://www.energiepflanzen.info/cms35/EVA.1594.0.html) and the North Sea Bioenergy Network: (http://www.3-n.info/index.php?con_kat=81&con_art=430&con_lang=1).

c) **innovative cropping systems** that protect water and soil resources in arable bioenery crops, e.g.
   - **Mulch systems/ minimum or no till systems:** The key factor in this system is that tillage is not applied at all or reduced to a minimum. The main result of this practice is total or near to total soil coverage all year round. This type of system is particularly well suited to biomass production where the quantity and/or the starch of the crop are more important than the quality. The main environmental gain compared to conventional rotational arable cropping systems is that it increases the soil organic matter content and the water holding capacity, as year round soil coverage and very limited mechanisation means it reduces soil erosion. If used for biomass production the requirement for pesticides and herbicide use will also be very low, as weeds constitute biomass too. Mulch practices would be particularly advantageous in maize production and seem to be gaining ground in certain countries.
   - **double cropping:** In agriculture double cropping is the practice of growing two or more crops in the same space during a single growing season. Double cropping is found in many agricultural traditions and has been adapted to modern farming systems in the last two decades, e.g. in Germany (Scheffer und Karpenstein-Machan, 2002; Heinz, 1999; Karpenstein-Machan, 1997). The systems fit in an environmentally-orientated farming system, e.g. by reducing nitrate leaching, and combining the production of high biomass quantities with a whole year green cover, limited input use and cultivation efforts. Both crops are harvested green to produce silage for biogas.
   - **Multiple cropping:** To increase the efficiency of biomas cropping systems several researchers are looking into multiple cropping systems which involve the growing of two or three crops simultaneously on the same land; one being the main crop and the others the subsidiaries. The main biomass output produced in this system is either oil or starch.
   - **Row, strip or alley cropping:** In this system, perennial biomass crops (SRC or tall biomass grasses) are grown in linear strips in arable agricultural landscapes, e.g. around fields and along rivers and canals. They deliver ligno-cellulose material for different bioenergy purposes (e.g. gasification, bio-electricity, Fischer-Trops biofuels). The main environmental advantages of creating such strips is that they increase landscape diversity which will enhance biodiversity in farmlands, they help to prevent (wind) erosion and decrease nitrate leaching to surface waters. The prevention of wind erosion may also lead to crop yield increases.[24]

2.6. Allocation of land use changes within Europe

The consultancy study for the EEA of Elbersen et al. (2007) shows that the pressure on different land use categories to be converted to biomass cropping is distributed very differently over Europe. The study assumes that farmland released from agriculture, the fallow and set-aside land is more likely to be used first for biomass production than farmland that continues in agricultural production. On the latter land category biomass crops will first need to compete with feed and food crops and this will probably only happen if oil market prices increase making biomass more attractive as an energy source and/or policy measures are taken to support the production of biomass crops through tax exemptions, or CO2 permit prices or obligatory bio-energy targets. Building on this assumption this study shows that in Northwestern countries of Belgium and The Netherlands, where practically no land is expected to be released from agriculture in the next 15 years, biomass crops are more likely

[24] Research into these systems was carried out by the Agroscope (SAFE) project in the Swiss Federal Research Station for Agroecology and Agriculture. A specific application of this system suggested for the Mediterranean is creating strips of holm oak. Further information can be found at: http://www.montpellier.inra.fr/safe/

to exchange present (already intensively cropped) arable crops or may take the place of grazing lands. This will only happen if biomass crops become competitive with feed and food crops. But if this happens a land use switch takes place which will probably not affect biodiversity drastically since practically all land is already used intensively in these countries. Therefore there is little risk for biodiversity loss in Belgium and Netherlands on arable land. However, when permanent grasslands would be converted to arable this would have negative biodiversity effects, as these often have an important function for meadow and wintering birds.

In countries like Denmark, Ireland, France, Sweden, Germany and the UK much land is expected to be released from agriculture over next 15 years and there is also much more land available in set-aside and fallow. Biomass cropping is therefore more likely to be fitted on the released, set-aside and fallow land categories which are usually the types of land with an already low productivity and low intensity. With a shift to biomass cropping the intensity of these lands is likely to increase which will certainly have implications for biodiversity.

In the new Member States the picture is very diverse. In countries like the Czech and Slovak Republic, Estonia and Slovenia hardly any land is expected to be released from agriculture so most biomass crop area should either replace agricultural land presently in use for feed and food production and/or take abandoned or under-utilised land into use again. If this does not need to go together with a further intensification of the cropping practice, or the ploughing-up of extensive semi-natural grasslands the effect for biodiversity is likely to be limited. In Hungary, Lithuania and Poland the opposite is expected to happen as the biomass area requirement is likely to fit in released and/or set-aside land and this increases the risk for intensification of presently still relative extensive land use categories. But also for these countries it is clear that there is a large area of abandoned or under-utilised land which could benefit from biomass demand if extensive forms of biomass removal through shrub removal and grassland cutting are applied.

The study of Elbersen et al. (2007) also estimated where HNV farmland would be at highest risk of being converted to biomass cropping. This is mostly the case in the Mediterranean countries of Europe, especially Portugal, and in some regions of the new Member States, especially Baltic States, Poland, Romania and Bulgaria. The reason for this higher chance is logically connected to the relative high HNV farmland share in these countries. Another reason is, since in these countries because of pedo-climatic and topographic factors the total proportion of land well suitable for arable cropping is limited, the chances for a conversion of less suitable land categories to biomass cropping increase, which are often part of HNV farmland.

In the following section a more systematic overview is given of potential land use changes and related effects on biodiversity.

2.7. Land use changes and potential impacts on biodiversity

Effect of biomass cropping on biodiversity depends mainly on the types of land use changes induced and the type of biomass crops used. Building on the consultancy report by Elbersen et al. (expected 2007) 15 land uses can be discerned which can shift to biomass. They have been clustered in 4 main groups according to intensity of land use and present state of biodiversity (see Table 1). To describe the potential effects of such shifts a distinction was also made between biomass crops in the rotational arable category used for starch, sugar and oil production and the perennials used for ligno-cellulosic biomass production, e.g. perennial biomass grasses and short rotation coppice (SRC) varieties.

Group 1: Very intensive land uses

This land use group includes the most intensive cropping practices. Land in this category does not have any overlap with HNV farmland and will certainly not contain any Annex I habitat. The conversions of the land use types in this group towards biomass production would therefore not be likely to have major biodiversity impacts and might even improve the situtation, since generally the biodiversity value of these present land uses is rather low. Switching to biomass crop production may have a positive indirect effect on biodiversity through improvement of water and soil quality, thus on the quality of non-farmland habitats. Direct positive effects will be more difficult to reach as biodiversity cannot always be brought back if already disappeared e.g. plant diversity and soil organisms. The creation of so-called pockets of more extensive farming for biomass production in these farmlands would however create opportunities for improving the connectivity and permeability of the landscape, certainly in cases where these intensive farmland practices have led to featureless landscapes which are poor habitats for birds and other species. On the other hand, from an economic perspective it is not very likely that these land use types will really shift towards biomass production unless drastic changes occur in both the agricultural markets and the energy markets.

Horticulture

Horticulture, including soft fruits such as strawberries, flower bulbs, flowers, vegetables is a very intensive form of agriculture carried out throughout the EU27. If converted to rotational biomass crops positive benefits to biodiversity are likely to occur, especially if converted to perennial biomass grasses and SRC. The literature review (Carey, expected 2007) shows that benefits would arise because tillage would be reduced and levels of fertiliser, herbicides and pesticides would all be reduced. These changes would lead to direct benefits for water and soil quality and would therefore lead to benefits for all taxonomic groups. Water and soil quality would increase especially if horticultural fields were converted to SRC or energy grasses.

However, there is a very low likelihood of high value horticultural crops being converted to either rotational arable biomass crops, and even less to perennial biomass crops, under current farm economic conditions.

Table 1: Possible land use groups to be converted to biomass cropping

Grouping according to intensity		Present land use	Examples of crops in this land use category	Overview of Annex I Habitats (Habitat Directive) occurring in this land use category
Group 1	Very intensive land uses	Horticulture in Glasshouses Polytunnels	Flowers, vegetables	..
		Horticulture	Strawberries, flower bulbs, flowers, vegetables	..
		Root Crops	Potatoes, sugarbeet	..
Group 2	Land under intensive arable and permanent crops	Sugar, starch and oil crops and intensive fodder crops	Winter wheat, barley, maize, rice, rye, oilseed rape, sunflower, temporary grass etc.	..
		Permanent Crops (Intensive)	Fruit orchards, nuts, olive groves and vineyards (if irrigation is high)	..
Group 3	Medium to low intensive land uses	Permanent Grass (Intensive)	Grass	..
		Fodder Crops - with short term fallow	triticale, alfalfa, etc.	..
		Short-term set-aside (intensive)	..	..
		Extensive arable	Spring wheat, barley, rye, etc.	
		Extensive permanent crops	traditional orchards (highstem)	
Group 4	Extensive land uses	Agro-forestry	Cork oak, cereals	8 Annex I habitats (see explanations below)
		Long-term set-aside	..	
		Traditional + long-term fallow		12 Annex I habitats (see explanations below)
		(Mediterranean) scrub, moors and heathlands		12 Annex I habitats (see explanations below)
		Permanent grass (extensive)		30 Annex I habitats (see explanations below)
		Wetlands		At least 3 Annex I habitats (see explanations below)

Root Crops

Root crops are grown throughout the EU but a large concentration is found in only a few countries (e.g. Poland, Romania, The Netherlands, Belgium, France and Germany). Conversion of land from root crops to other arable crops will generally have a positive effect on the environment because inputs of fertiliser and pesticides are reduced, tillage is not as severe, erosion risks decrease and irrigation will be reduced in drier areas. Conversion of root crop production to biomass production is likely to have large benefits on soil and water quality. A low share of root crops can be very beneficial for land use diversity, however, which is generally beneficial to farmland biodiversity.

Horticulture under glass or plastic

Horticulture under glass (and plastic) is the most intensive form of agriculture and would if converted to arable biomass have large beneficial environmental benefits across all taxa. However, this is a land-use change that will not occur because it would be totally uneconomical to do so.

Group 2: Land in intensive arable and permanent crops

In this group high to medium intensive arable and permanent land uses are involved. This group covers crops grown on the majority of all specialised arable farms in Europe with a high share of cereals in their rotation, including winter wheat or barley, maize, rice, but also specialised permanent crop farms with high intensity olive groves, vineyards, fruit orchards and citrus. In central and southern parts of Europe these land uses are using much irrigation and other inputs. In general the biodiversity value of these types of land uses is already low as it has been diminished or completely disappeared already in the last couple of decades. In general switches to biomass crops on these types of land use categories will only be beneficial for biodiversity if these involve the introduction of perennial biomass crops or rotation arable biomass crops that go together with farming practices applying lower input and mechanisation levels than applied for the production of food and feed in conventional farming. Again, like with the first group, the creation of pockets of less intensive biomass crop production would be beneficial for the connectivity and diversity of the landscape.

Intensive winter cereals

Intensive winter cereals are grown throughout the EU-27 but are more prevalent in the EU-15 and especially northern Member States. This land-use is one of the least diverse of all in Europe and is likely to continue as such if this land category is switched from food to rotational arable biomass crops to be used for first generation biofuels production. Consequently, there will generally not be any impacts of the shift to rotational biomass crops on these monocultural cereal landscapes, an exception could however be if intensive winter cerals are exchanged for intensive sugar beet cropping for bioethanol production. Conversions to perennial biomass crops is likely to have positive benefits for biodiversity however. Indirectly through positive effects on water and soil and directly as soil organisms will benefit from less tillage and there is some evidence of birds and mammals using the perennial biomass crops as shelter and breeding site.

Maize

Maize and other C4 plants were included as separate category because of the different season in which they grow in summer and autumn. These tall crops may provide shelter of animals in the autumn whereas cereal crops do not. In other respects they are similar to other intensive arable crops. So when switched to rotational arable biomass crops it would be advisable from a biodiversity perspective to use crops with similar shelter capacities. When switched to perennials it is very likely that this is beneficial to biodiversity.

Intensive permanent crops

This land-use is particularly associated with orchards, nuts, olive groves and vineyards. The distribution is strongly concentrated in the Mediterranean. The major pressure from converting these crops to rotational arable biomass crop production will come from increased tillage which will have major impacts on soil and water quality and subsequently soil organisms. However, there will be some positive benefits, certainly if the conversion is to perennial biomass grasses or SRC. Pesticide use will change and will probably decrease and we perceive that the landscape will become more diverse.

Group 3: Medium to low intensity land use categories

In this group the medium to low intensity land use categories appear, including the more intensive permanent grasslands, short term set aside and the more extensively grown food and feed crops. These land use types can clearly be associated with certain types of farmland biodiversity values (e.g. farmland birds and mammals). So some part of the HNV farmland categories, certainly those important for specific bird populations, are overlapping with part of this group and some habitats included the Annex I of the Habitats Directive (see Table 1). The switch to biomass crops and the effects on biodiversity can be both positive and negative depending on the taxa involved. The indirect effects on biodiversity through improvement of water and soil quality will come when switched to perennial biomass crops.

Intensive permanent grassland

Intensive permanent grassland is found mostly in the northern states of the EU-15 and some parts of central and eastern EU. The current biodiversity levels associated with this land-use are moderate to quite low and the inputs of especially fertiliser can be be higher than on intensive arable agriculture. The impacts of ploughing permanent grassland will have negative impacts on biodiversity and especially ground nesting birds e.g. lapwing[25]. Conversely some species of birds associated with arable agriculture may increase as rotational arable and/or other biomass crops are introduced, e.g. grey partridge[26].

Extensive fodder-fallow land

The fodder crops referred to are crops associated with short-term fallow systems in the Mediterranean and Steppic grasslands, rather than fodder maize or beet grown with high livestock units across the rest of Europe. The major impact of this land-use change would be on threatened bird species such as the Great Bustard and other steppic birds (see Habitats Directive) but the evidence suggests that this will depend on the mixture of irrigated land and that which is managed traditionally, so the low input HNV farmland. We assume that the conversion of land to rotational arable biomass crops and also the other perennial biomass crops will tip the balance to the negative side of the mixture. Although for overall biodiversity and the environment the effects are not too negative the impacts on the rare birds is likely to

[25] Although not the aim of this assessment there is a first important reason not to plough up permanent grassland for bio-energy feedstock production as this could potentially lead to an enormous release of soil carbon which could fully off-set the potential mitigation effect of using renewable energy from biomass as compared to non-renewable energy (see e.g. Vellinga, et al. 2005; Freibauer et al., 2004 & and Vleeshouwer & Verhagen, 2002).

[26] Vickery et al 2004

make protection of this land-use imperative. However, this land is only marginally productive for rotational arable biomass crops without the introduction of irrigation which is dependent on government/EU subsidy to make it economically viable and the development of agricultural and energy markets. The land maybe more economically suited to growing the perennial biomass grasses and SRC that would not require (as much) irrigation. The latter would substantially alter the current cropping and landscape patterns and in most cases destroy the quality of the habitat for steppic birds.

Intensive short-term set-aside

This land-use was created by the CAP and is totally dependent on it. Studies across Europe have shown that for many wildlife groups it is better than intensively grown arable crops. The biodiversity impacts of removing set-aside and putting it back into rotational arable biomass crop production will therefore be negative. The conversion of set-aside to perennial biomass grasses of SRC will have positive impacts on the water and soil, soil organisms and many animals. Only arable weeds will suffer and the animals that depend on them. This set-aside category is the category of land that is very likely to be used at large scale for biomass cropping, and this is already happening in countries like Germany and France. This land-use change will therefore be the major cause of biodiversity impacts across the EU.

Extensive arable

This land-use is found on poor soils where there has been low economic growth in the past decades throughout the EU, but especially the new Member States. The effects of converting to the production of biomass crops, all come from the overall pressure to intensify this form of agriculture. The biodiversity impacts will be severe in the same way that they were from the 1960s (and especially the 1980s) onwards in the EU-15, certainly if the conversion concerns rotational arable biomass crops. Common birds (e.g. skylark) and cereal weeds (e.g. poppies) will decline so that they become threatened species. The indirect effects on water and soil will be severe, especially if the switch is towards rotational arable biomass crops. Extensive arable is not very likely to occur in most parts of Northwestern Europe but it may still be significant in certain regions of the Mediterranean and the new Member States.

Extensive permanent crops

This land-use is found mostly in the Mediterranean where it concerns the low intensity olive groves, nut trees (e.g. almonds, chesnut etc.) and vineyards. These low intensive lands all correspond to HNV farmland areas. The effects of converting to the production of biomass crops, all come from the overall pressure to intensify this form of agriculture. The biodiversity impacts will be severe, both if the conversion concerns rotational arable biomass crops or perennials.

Group 4: Low intensity land use categories

This is the group that includes all the extensive land use types high in farmland biodiversity, mostly coinciding with HNV farmland in Europe and most of the agricultural Annex I habitats of the Habitats Directive are situated here. Any change in use and management may put valuable farmland biodiversity at risk. There is however one exception and that is where these land use categories include biodiversity that depends on low intensive traditional farm practices threatened by abandonment and/or underutilisation. The continuation of extensive management through the removal of biomass could be a good option for maintaining the natural richness of the systems.

Agro-forestry

This land-use is characteristic of the Mediterranean, especially the south and includes Dehesas and Montados. It is well known for a very high biodiversity and especially birds.

There are also eight different Annex 1 habitats of the Habitats directive occurring[27]. It is now generally found on shallow infertile soils with limited economic potential. Most of the Dehesas and Montados on the better soils were already converted to (irrigated) arable lands in the 1970s and 1980s. Should this land-use change to biomass production it would have seriously negative biodiversity impacts. However, the quality of the soil makes the potential use of this land for growing arable crops limited without serious investment. Perennials could be grown, but only if there is a real economic incentive.

Long-term set-aside

This land-use comes artificially from CAP reform in the 1990s and normally consists of new grassland with no inputs of fertiliser and pesticides. The biodiversity levels are often not as high as in semi-natural habitats that have existed for centuries but any return to arable agriculture would have negative impacts. Conversion to biomass would be a negative impact, depending on the nature of the piece of set-aside involved. This land use only covers a small area of the EU-15 and none in the new Member States, so the impacts will be localised if the change did occur.

(Mediterranean) Scrub, moors and heathlands

The scrub land-use has often arisen from the abandonment of agricultural land that was previously grazed or under long-term arable fallow. It mostly occurs on the low hills and occasionally on the plains. Moors and heathlands are grazed extensively in many parts of Europe, but they have also become abandoned in many places. The economics of farming on this poor land are generally bad and the chances of it being used for biomass production are low. If the land was used the impacts would be large as undisturbed areas of scrub that have high animal and to a lesser extent plant biodiversity would be totally destroyed. 12 different Annex I habitas of the Habitats Directive can be found on this land use category[28].

Long-term fallow

This is found in dry areas in the southern Mediterranean and is occasionally grazed or cultivated and has very limited crop potential. The cultivation occurs occasionally (every 5-10 years) and is often achieved by burning to prevent scrub growing. Like the previous category of Mediterranean scrub the chances of this land being used for growing rotational biomass crops or even biomass grasses and SRC are low. Should the conversion take place the biodiversity impacts would be severe.

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[27] 6530 Fennoscandian wooded meadows; 9070 Fennoscandian wooded pastures;2180 Wooded Dunes of Boreal or Atlantic or Continental region; 9020 Fennoscandian hemiboreal natural old broadleaved decidious forests rich in epiphytes; 6310 Sclerophellous grazed forests (Dehesas) with evergreen Quercus suber and/or Quercus ilex

[28] 2310 Dry sand heaths with *Calluna* and *Genista;* 2320 Dry sand heaths with *Calluna* and *Empetrum nigrum;* 2330 Inland dunes with open Corynephorus and Agrostis grasslands; 4010 Northern Atlantic wet heath with Erica tetralix; 4020 Temperate Atlantic wet heath with Erica caliaris and Erica tetralix; 4030 European dry heath; 4040 Dry Atlantic coastal heath with Erica vagans; 4060 Alpine and Boreal heaths; 4090 Endemic oro-mediterranean heath with gorse; 5120 Mountain *Cystus purgans* formations; 5420 *Sarcopoterium spinosum phraganas*; 5430 Endemic *Phryganas* of the *Euphorbio-Verbascion*; 6430 Eutrophic tall herbs.

Extensive Permanent Grassland

This land-use is very variable and is associated with the semi-uplands and uplands of northern Europe and the high mountains of Europe, low-lying wet and peat areas across the EU-27 and also dry grazing areas, such as the more open Dehesas. In biodiversity terms this is the most important land-use as traditional hay meadows and grazing areas are included. Large parts of the HNV farmlands consist of this type of land use and many important Annex I habitats. Extensive grazing and hay meadows are already threatened by a decline in rural livelihoods. In some areas these grasslands could be converted to arable or biomass production e.g. the Mediterranean and in large areas of the new Member States could be affected. Conversion in Mediterranean would be totally dependant on government/EU subsidy for land improvement or irrigation systems. The impacts on biodiversity will be disastrous if this land-use change is allowed to take place. This category contains the highest number of Annex 1 habitats; at least 30[29]

Wetlands

This land-use is found in low-lying areas and is associated with high and threatened biodiversity throughout the EU but locally concentrated. The chances of this land use being converted to arable production are slim because of the need for expensive drainage systems but the growth of perennials is more of a threat. Should the land-use change occur the impacts on biodiversity would be extremely serious. Most larger wetlands are protected by current environmental designations but small-scale sites could be at risk of conversion to SRC willow plantations such as some Annex I habitats that already have some occasional grazing[30]

[29] 1330 Atlantic salt meadows; 1340 Inland salt meadows; 1530 Pannonic salt steppes and salt marshes; 21AO Machairs; 2330 Inland dunes with open Corynephorus and Agrostis grasslands; 2340 Pannonic inland dunes; 5130 Juniperus communis formations on calcareous grasslands; 6140 Selicious Pyrenean Festuka eskia grasslands; 6110 Ripiculous calcareous or basophilic grasslands of the Alisso-Sodium albi; 6120 Xeric sand calcareous grassland; 6150 Selicious alpine and boreal grasslands; 6160 Oro-Iberian Festuca indigesta grasslands; 6170 Alpine calcareous grasslands; 6190 Rupicolous pannonic grasslands; 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco Brometalia); 6220 Pseudo-steppes with grasses and annuals of the Thero-Brachipodietea; 6230 Species rich Nardus grasslands on silicious substrates in mountain areas; 6240 Sub-Pannonic steppic grasslands; 6250 Pannonic leoss steppic grassland; 6260 Pannonic sand steppes; 6270 Fennoscandian lowland species-rich dry to mesic grasslands; 6280 Nordic alvar and precambriam calcareous flatrocks; 62A0 Eastern sub-Mediterranean dry grasslands; 6410 Molinia meadows on calcareous or peaty soils; 6420 Mediterranean tall humid grasslands of the Molinio Holoschoenion; 6430 Eutrophic tall herbs; 6440 Alluvial meadows of the cnidion dubii; 6450 Northern Boreal alluvial meadows; 6510 Lowland hay meadows; 6520 Mountain hay meadows.

[30] 1530 Pannonic salt marshes; 7140 Transition mires and quaking bogs; 7230 Calcareous (and alkaline) fens

3. Prioritisation of land use changes most vulnerable to biodiversity loss

Building on the analysis of chapters 1 and 2 an approach is suggested that addresses both direct land use changes (bioenergy cropping replacing any other land use) as well as indirect land use changes.

3.1. Positive/ Negative list (“Go/ No Go”)

In the previous sections, land uses that are most and least vulnerable to biodiversity loss were identified and prioritised. The most intensive land uses (Groups 1 and 2) with the lowest biodiversity value would show the lowest biodiversity impact of changes to bioenergy cropping, while the opposite is the case for Group 3 and especially Group 4. These last two groups of land uses also overlap most strongly with HNV farmland and contain many of the Annex I habitats of the Habitats Directive. However, it also became clear that shifts from Group 1 and Group 4 land uses to biomass cropping would be less likely to happen than in Groups 2 and 3.

The EEA study on ‘Estimating the environmentally compatible biomass potential from agriculture’ (EEA, expected July 2007) does not preclude the option of using extensive farmland categories for biomass production. Instead, suggestions are given to search for synergies between biomass production and the longer term maintenance of certain extensive farmland categories, e.g. by using biomass cuttings from trees or grass for energy production. Following this advice, we suggest to group land use changes as follows:[31]

1. **“Go”** - Land use types in this category can be converted to biomass cropping with low risk of biodiversity loss. These land use categories would include all intensive land use classes in Group 1 and all intensive arable cropping land in Group 2. Conversion of permanent crops to biomass crops could have a negative indirect effect on soil biodiversity, as it could lead to increased tillage and mechanisation. A shift to perennial biomass crops would not have this effect however.
2. **“Go (with restrictions)”** – “Go, under certain restrictions” implies that a shift to biomass cropping will have adverse effects on biodiversity, but if specific measures are taken that give guidance to this shift, the use of this land for biomass production could still be allowed. The restrictions have to be defined on local level since they should be adapted to site characteristics. Principally restrictions can concern a) land use practices/ management intensity/ scale of the energy plantation, b) obligations/ limitations to certain crops and/ or crop rotations and/or c) a limitation to the use of residues/ cuttings for bioenergy use (potentially combined with a maximum number of grassland cuttings per year/ limitation to certain time periods). Table 2 summarises suggestions on the specific restrictions that could be applied per specific land use.
3. **“No, go”** - This “no go” implies that no conversion would be allowed. However, in certain cases the removal of biomass after cutting and pruning would still be an option for most of these land use categories. This “no go” option should be applied to permanent grassland,

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no matter whether it is intensive, extensive or semi-natural, and to all other land uses in Group 4.

Table 2: Overview of land use classes that can be converted to biomass cropping, and classes for which preventive measures are needed to prevent biodiversity loss when converted.

Grouping according to intensity		**Present land-Use**	**Conversion to biomass crops?: Go; Go under condition; no go**
Group 1	Very intensive land uses	Horticulture in Glasshouses Polytunnels	Go
		Horticulture	Go
		Root Crops	Go
Group 2	Land in intensive arable and permanent crops	Sugar, starch and oil crops and intensive fodder crops	Go
		Permanent Crops (Intensive)	Go, but only perennial biomass crops
Group 3	Medium to low intensive land uses	Permanent Grass (Intensive)	No go, but grassland cuttings can be used, no ploughing up of grassland allowed
		Fodder Crops - with short term fallow	Go, under the condition that bioenergy crops have similar characteristics as the replaced fodder crops (i.e. alfalfa, lupine etc)
		Short-term set-aside (intensive)	Go, but only if set-aside compensation areas (e.g. uncropped field margins) or a conversion to perennials is envisaged
		Extensive arable	Go, but only if extensive (no tillage etc.) crop rotations and crops of similar character are used
		Extensive permanent crops	No go, but grassland cuttings and prunings can be used, no ploughing up allowed
Group 4	Extensive land uses	Agro-forestry	No go, but grassland cuttings and prunings can be used, no ploughing up allowed
		Long-term set-aside	No go
		Long-term fallow	No go
		Mediterranean scrub	No go, but cuttings of biomass can be used
		Permanent grass (extensive)	No go, but cuttings of biomass can be used
		Wetlands	No go

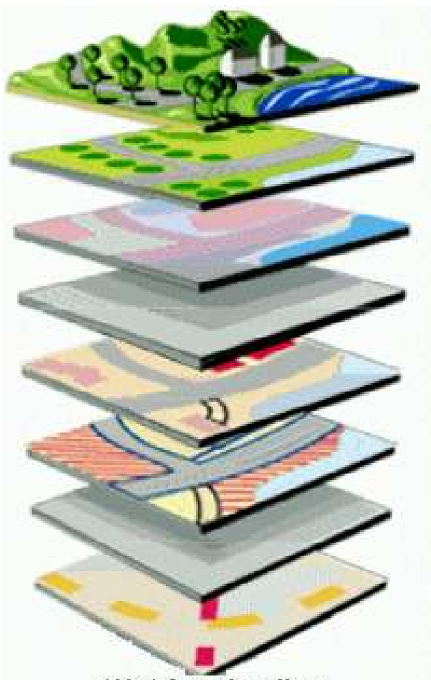
In order to apply the outlined approach it is essential that different types of land uses are mapped (particularly HNV farmland), in particular in Natura 2000 areas. We also assume that site management and legally protection rules are properly implemented.

3.2. Requirement for an effective land use planning

However, since this system only prevents direct land use changes for bioenergy cropping on areas of high biodiversity value, it cannot safeguard that the land uses replaced (even if not of a high biodiversity value) shift to another area, thereby potentially replacing other valuable land uses (leakage effects).

It is therefore is advisable that an overall **land use policy** ensures that land use planning safeguards a sustainable land use.

Considering that the EU also imports bioenergy feedstocks, this would need to apply to all countries from which the EU uses bioenergy feedstock, i.e. also non-EU countries.



Picture 1: Schematic figure illustrating functioning of layers[32]

This land use planning has to ensure that sustainability standards (see chapter 4) are respected. This would require that for each environmental criterion related to land use (water, soil, biodiversity, carbon storage, pedo-climate) a map is generated. The map layers will reflect the importance of the respective criteria (e.g. a layer illustrating which land uses are within the 15 land uses that are of importance for biodiversity, with an extra layer for Annex 1 habitats and HNV farmland).

Overlapping the different layers would then illustrate which areas are suitable for bioenergy cropping from both a sustainability point of view and have the right pedo-climatic and economic conditions.

The cascade of land use planning would include the following necessary steps:

1. Definition of sustainability standards (in consultation with stakeholders)
2. Requirement of land use policy/ land use planning system in place (including basic database on current land uses)
3. Include degrees of achievement for land-use relevant sustainability criteria into database (e.g. GIS)

[32] Source: Behörde für Geoinformation, Landentwicklung und Liegenschaften (GLL) Lüneburg, www.vermessungsseiten.de/gis/gis.html

4. Define “Go” – “No Go” -“Go (with restriction)” areas (building on the vulnerability towards bioenergy crops)
5. Define restrictions on a regional level for areas under the “Go (with restriction)” category

Even if this is a rather sophisticated approach - it seems to be a promising, and potentially the only way to avoid negative environmental impacts due to indirect land use changes (assuming that areas with high biodiversity value would be effectively protected as part of this land use planning), considering that current Life Cycle Analysis all lack the calculation of indirect effects due to land use change.

As such a system is not yet available, it will initially be important to target additional efforts to encourage the most sustainable biomass pathways through appropriate incentives, advice and support for related research / pilot projects and to avoid the most damaging conversions (recommendations see chapter 4 below).

4. Conclusions for the approach as suggested by DG TREN Consultation

The following chapter summarises the analysis above and will draw conclusions responding to the suggested approach as outlined in DG TRENs consultation on “Biofuel issues in the new legislation on the promotion of renewable energy”.

1. Extending the scope from biofuels to biomass

Despite the current concentration of political and industrial activity in the biofuels sector, sustainability concerns do not only apply to the biofuels sector, but should also be extended to bioenergy use and biomass production in general. This is due to the fact that biofuel feedstocks can be used to create products other than bioenergy (i.e. food, animal feed, cosmetics, building material etc.). A limitation to certain products, therefore, is not desirable. Moreover in terms of energy efficiency and green house gas saving potentials, biofuels have in most production ways less GHG saving potentials then the use of biomass for power and heating purposes[33].

2. Include a wider range of criteria to ensure a sustainable use

The criteria mentioned in the consultation document reflect only some of the relevant sustainability criteria (greenhouse gas savings, carbon stocks and biodiversity impacts due to land use changes). Despite the fact that these criteria are very important ones, the scope could be extended to cover more environmental criteria (water, soil, air emissions) and social criteria.

3. Link support to the existence of an effective land use policy

The Commissions incentive/ support scheme for biofuels/ bioenergy as defined under chapter 1 of consultation document (financial support, tax reductions, counting towards national targets) should be linked to an effective land use policy as outlined above. In order to apply the outlined approach it is essential that different types of land uses are mapped, particularly HNV farmland, and that Natura 2000 areas are effectively protected. This would allow to apply a kind of cross-compliance (support / tax relief would only be available outside sensitive zones).

[33] SRU 2007, EMPA 2007

4. Ensure effective use of available biomass resources

From the above, it is reasonable to conclude that there are a number of threats to biodiversity resulting from increased bioenergy cropping if connected to land use changes. However, as already mentioned in chapter 1, there are significant potentials for bioenergy feedstocks production to occur without land use changes (use of grassland/ hedge etc. cuttings, organic waste, more efficient use of land available, using breeds achieving higher yields etc.). These are also the areas with the highest potential synergies for biodiversity protection (use of grassland/ hedge etc. cuttings etc., which in turn may even ensure further maintenance of protected habitats if done in a extensive manner). Therefore, these synergies – even increasing with an extended use of second generation feedstocks – have to be analysed and promoted to a greater extent. In this context, it may also be useful to aim through an effective use of available biomass resources via a range of available policy measures.

5. Sustainable biofuels need sustainable agriculture and forestry/ Linking policies

Biomass produced for food, fodder, fibre, building material and energy depends often on similar land requirements. Agricultural and forestry land plays a particular role. All efforts towards a more sustainable supply of biofuels should therefore be closely linked to policy instruments aiming towards a more sustainable agriculture and forestry in general. This is particularly necessary, since world-wide pressures on land, biodiversity, soil etc. mainly result from unsustainable agriculture and forestry products dedicated to the provision of food, fodder and fibre and not only biofuels.

A range of policy and market measures, has been identified in EEA 2007 (see Annex 2: Possible policy measures to influence the environmental effects of bioenergy cropping) . They can be grouped in three main approaches:

a) **The introduction of minimum environmental standards that farmers have to adhere to.**

A key example for approach a) is the cross compliance policy instrument (Regulation 1782/2003) that was made compulsory with the 2003 CAP reform. It already includes a standard that limits the loss of permanent pastures and requires a certain minimum management of agricultural land. Similar to current set-aside policy, it would be possible to require a minimum percentage of 'ecological compensation areas' for certain types of farming[34].

b) **Targeted support for specific environmental management requested from farmers.**

Approach b) is the concept behind many of the rural development measures under the second pillar of the EU Common Agricultural Policy (CAP). Relevant measures with environmental objectives are agri-environment schemes, support for less favoured areas, support payments for environmental restrictions in areas designated as part of the Natura 2000 network, or support for environmental investments on farms.

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[34] One could also imagine translating the concept of Nitrate Vulnerable Zones to areas with a high proportion of HNV farmland. Such an approach could set limits to using certain intensive crops (possibly for biomass purposes) and inputs such as specific agro-chemical products and fertilisers. In Nitrate Vulnerable Zones such limits are already applicable to nitrogen fertilisers and manure management. However, such measures only maintain the status quo and do not lead to active improvement or management. In addition, they are often difficult to implement, especially where no strong economic incentive is associated with the standard to be achieved.

c) **Increasing the value added or market prices of agricultural outputs that derive from environmentally friendly farming approaches.**

Organic farming is a key example for approach c) as organic farmers are compensated for lower yields due to environmental farm management by higher market prices for their products. However, the environmental benefits associated with high nature value farming systems tend not to be rewarded on the market, if such farms do not participate in specific quality marketing schemes (such as regional quality labels or indeed organic farming). Consequently, support for development added value from the outputs of HNV farming systems could be a valuable tool, e.g. via diversification or marketing measures under EU rural development programmes. Finally, the success of a market approach depends to a large degree on consumer interest. Consequently, raising public awareness about the beneficial effects of environmentally orientated farming practices would be needed.

An important cross-cutting measure that supports all three approaches is the provision of appropriate **training and advice for farmers**, so as to enable them to improve the environmental quality of their farm management[35].

A key component of effective policy implementation is the **availability of appropriate spatial and environmental information**, which can be used to tailor and target policy instruments on the farming systems and areas of highest environmental interest.

Moreover, support for related **research** supporting environmentally compatible bioenergy cropping practices should be increased and pilot projects started.

[35] For example, the EEA carried out the CIFAS study on behalf of the European Commission to help develop farm advisory systems for supporting environmental farm management in the context of environmental cross-compliance. Further information is available on the project website: http://www.ewindows.eu.org/cifas

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Annex 1 – Revised list of habitats from Annex I of the Habitats Directive that depend on extensive agricultural practices - EEA, May 2007

For the consultation meeting in December 2006 the EEA proposed a new list of habitats from Annex I of the Habitats Directive that depend on extensive agricultural practices. This list built on a review by the EEA Topic Centre for Nature Protection and Biodiversity and revised a previous proposal by Ostermann, 1998.

Following the country consultation period the list of proposed habitats was reviewed again on the basis of country feedback, EEA internal discussions and some expert advice.

Below we present the final selection by the EEA of habitats that are characteristic of HNV farmland as they generally depend on extensive farming practices. These habitats have been grouped into two categories: those that clearly fulfil the conditions to be listed, and those where doubts exist or the relationship with extensive farming practices only holds true for part of their distribution in Europe. The latter ones are also marked with a ° and not considered by the EEA/JRC in the selection of relevant Natura 2000 sites. However, we propose that countries can take these habitats into account for national survey activities of HNV farmland.

This selection is necessarily subjective to some degree; relevant information does simply not exist for all habitats across their range in Europe. In the selection of the first category we decided that dependence on extensive agricultural land use was necessary and that an increase in the diversity or extension of the relevant habitat type was not enough. We also excluded from the final list some habitats proposed by countries that are clearly pioneer habitats (e.g. 2120 shifting dunes along the shoreline) or appeared to be climax habitats (e.g. Olea and Ceratonia forests). In addition, we were more reluctant to give those habitats a 'full status' that still underlie a more natural dynamic (e.g. coastal dunes) than those in more transformed landscapes (e.g. Pannonic inland dunes).

Notes: D – degree of the habitat dependence of the agricultural practices (usually extensive ones): f – fully dependent; p - partly dependent, the agricultural practices prolong the habitat existence on enlarge the area of distribution.

Code	Habitat name	D	Comment
1330 °	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	f *	* some types only
1340	Inland salt meadows	p	
1530	Pannonic salt steppes and salt marshes	p	
1630	Boreal Baltic coastal meadows	p	

Code	Habitat name	D	Comment
2130 °	Fixed coastal dunes with herbaceous vegetation (grey dunes)	p	* at least some sub-types dependent on grazing
2140 °	Decalcified fixed dunes with Empetrum nigrum	p	
2150 °	Atlantic decalcified fixed dunes (Calluno-Ulicetea)	p	
2160 °	Dunes with Hippophae rhamnoides	p	
2170 °	Dunes with Salix repens ssp. argentea (Salicion arenariae)	p	
21A0	Machairs (* in Ireland)	f	rotational cultivation
2310	Dry sandy heaths with Calluna and Genista	f	
2320	Dry sandy heaths with Calluna and Empetrum nigrum	f	
2330	Inland dunes with open Corynephorus and Agrostis grasslands	f	
2340	Pannonic inland dunes	f	
4010	Northern Atlantic wet heaths with Erica tetralix	f	
4020	Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix	f	
4030	Dry heaths (all subtypes)	f	
4040	Dry Atlantic coastal heaths with Erica vagans	f	
4090	Endemic oro-Mediterranean heaths with gorse	p	
5130	Juniperus communis formations on heaths or calcareous grasslands	p	
5420	Sarcopoterium spinosum phryganas	p	
5430	Endemic phryganas of the Euphorbio-Verbascion	p	
6110	Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi	p	
6120	Xeric sand calcareous grasslands	p	
6140	Siliceous Pyrenean Festuca eskia grasslands	p	
6150	Siliceous alpine and boreal grasslands	p	
6160	Oro-Iberian Festuca indigesta grasslands	p	
6170	Alpine and subalpine calcareous grasslands	p	
6180	Macaronesian mesophile grasslands	p	
6190	Rupicolous pannonic grasslands (Stipo-Festucetalia pallentis)	f	
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco Brometalia)(*important orchid sites)	f	
6220	Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea	f	

Code	Habitat name	D	Comment
6230	Species-rich Nardus grasslands, on siliceous substrates in mountain areas (and sub-mountain areas, in continental Europe)	f	except in natural alpine and sub-alpine grasslands
6240	Sub-pannonic steppic grassland	f	
6250	Pannonic loess steppic grasslands	f	
6260	Pannonic sand steppes	f	
6270	Fennoscandian lowland species-rich dry to mesic grasslands	f	
6280	Nordic alvar and precambrian calcareous flatrocks	f	
62A0	Eastern sub-mediteranean dry grasslands (Scorzoneratalia villosae)	f	
6310	Sclerophyllous grazed forests (dehesas) with Quercus suber and/or Quercus ilex	f	
6410	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	f	
6420	Mediterranean tall humid herb grasslands of the Molinio-Holoschoenion	p	
6430 °	Eutrophic tall herbs	p	some types
6440	Alluvial meadows of river valleys of the Cnidion dubii	f	
6450	Northern boreal alluvial meadows	f	
6510	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	f	
6520	Mountain hay meadows	f	
6530	Fennoscandian wooded meadows	f	
7140 °	Transition mires and quaking bogs	p	
7230	Calcareous (and alkaline) fens	p	
8230 °	Siliceous rocky slopes with pioneer vegetation	p	
8240	Limestone pavements	p	
9070	Fennoscandian wooded pastures	f	

Annex 2: Possible policy measures to influence the environmental effect of bioenergy cropping (EEA 2007)

Measure	Advantages	Disadvantages	Implementation questions
1) Environmental certification of bio-energy production	Creates incentives for behavioural change; Promotes an optimal use of resources.	May not be easy to establish; Criteria may be difficult to define.	Voluntary or obligatory? What are the precise environmental baselines and standards? Are these just input and resource saving measures; or could they also prescribe crop mixes? Who organises and pays for controls?
2) Cross compliance standards for bioenergy crops	Uses existing instrument; Could apply widely to farmers; Already has environmental scope.	Only enforces minimum standards; Effectiveness uncertain where link to economic incentives does not exist.	Existing legislation needs to be adapted and standards drawn up. Could this be linked to energy feed-in tariffs? Only to cover input use etc, or could they also fix a maximum share of certain crops?
3) Area specific standards, e.g. limiting the use of certain crops in specific areas, or prescribing a minimum share of ecological compensation areas.	Potentially a very direct and strong instrument; Protects areas of high environmental interest. Can introduce environmental elements in intensively farmed landscapes.	Most likely difficult to push through without compensation; Political resistance to be expected; Not very flexible and 'unfair' to some farmers in the areas affected.	Is a blanket ban on certain crops (in specific areas) appropriate? How to identify crops and delimit the areas? Use for Natura 2000 and/or HNV farmland areas?
4) Environmental farm advice	Increases general awareness and goodwill of farmers; Should improve input management efficiency; Can lead to longer term behaviourial change among farmers.	Effect strongly depends on farmer uptake; Implementation of advice not ensured.	Do we know enough on how to manage energy crops from an environmental perspective? How to ensure sufficient advisory capacity and outreach?
5) Favouring certain crop mixes via crop premia	Leaves some flexibility to farmers; Could have a wide-ranging effect.	Difficult to envisage how to favour certain crop mixes, appears rather complex; Effects may only be indirect.	What happens if the target crops become dominant? Use a top-up payment for high levels of crop diversity?

6) Investment support or carbon credits for specific conversion systems	Can encourage innovative, efficient approaches; May be cost-efficient if limited to start-up phase.	Environmental benefits not guaranteed if not monitored closely; Wider implementation at farm level not automatic.	Could this favour semi-natural grasslands through novel technologies?
7) Rural development measures for local 'crops to energy' networks; including LEADER approaches	Would ensure local sourcing; Could benefit bioenergy heating and electricity systems; Increases understanding among a wide range of actors at local level.	Already lots of demands on rural development policy; Can be a complex instrument to use; Impact depends on applications from potential recipients.	What measures would be suitable? Do we need to introduce additional measures in rural development programme menus? How to tackle the integrated aspect of such local systems?
8) Regional planning/ SWOT analysis	Should lead to comprehensive approach; Engages (local) stakeholders; Helps to evaluate unintended side-effects, e.g. on the tourism value of certain landscapes.	Medium to long-term approach; Implementation uncertain Depends on other instruments for implementation of decisions.	Which existing processes should cover strategic planning on energy cropping? Is there enough interest / knowledge at local level? How to combine with complementary support measures?
9) Monitoring and evaluation	Increases knowledge about environmental effects of bioenergy crops; Key to better policy (planning).	Potential impact only in the long term; 'knowing' does not equal 'acting'; Reluctance to spend money in this area.	How to design these appropriately? Which budgetary resources? How to integrate into policy decisions?