

Land Use Policy Group

*The UK statutory
conservation, countryside
and environment agencies*

Delivering environmental services through agri-environment programmes: a scoping study

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The Land Use Policy Group

The Land Use Policy Group (LUPG) of the UK statutory nature conservation, countryside and environment agencies comprises the Countryside Council for Wales, Natural England, Environment Agency, Northern Ireland Environment Agency, Joint Nature Conservation Committee and Scottish Natural Heritage.

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www.ni-environment.gov.uk

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www.jncc.gov.uk

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Darparu gwasanaethau amgylcheddol trwy raglenni amaeth-amagylcheddol.

Crynodeb gweithredol

- I. Nod yr arddodiad hwn yw adolygu'r modd y mae gwasanaethau amgylcheddol¹ yn cael eu darparu trwy raglenni amaeth-amgylcheddol ar lefel yr UE. Mae'r adroddiad yn canolbwyntio ar y gwasanaethau amgylcheddol y gall rheolwyr tir eu darparu, ac mae'n awgrymu sut y gellir darparu'r gwasanaethau hyn trwy gyfrwng rhaglenni amaeth-amgylcheddol (RhAA). Trafodir y dulliau mwyaf priodol o wneud taliadau gan ddefnyddio enghreifftiau o nifer o wledydd sy'n aelodau o'r UE, a gwledydd nad ydynt yn aelodau o'r UE, lle bo hynny'n briodol. 'Astudiaeth gwmpasu' yw hon ac felly mae'n bwysig nodi mai archwilio'r materion hyn a wna'r adroddiad yn hytrach na darparu cynigion manwl ynghylch gweithredu. Fodd bynnag, bydd yn golygu bod modd mynd ati i wneud gwaith yn y dyfodol ar ddarparu gwasanaethau trwy'r Polisi Amaethyddol Cyffredin (PAC), gan ei fod yn tynnu sylw at y meysydd hynny y gellid canolbwyntio arnynt.
- II. Gellir diffinio gwasanaethau fel 'y budd y mae pobl yn ei gael o ecosystemau'. Amaethyddiaeth a choedwigaeth yw'r mathau mwyaf amlwg o ddefnydd tir yn yr UE; maent yn cyfrif am 78% o'r defnydd a wneir o dir yn y 25 o wledydd sy'n rhan o'r UE ac felly mae'n bwysig deall sut y mae rheoli tir yn effeithio ar wasanaethau amgylcheddol. Gan fod yr holl aelod wladwriaethau'n cael eu rheoleiddio dan y PAC, dylid archwilio'n drylwyr y potensial i ddarparu gwasanaethau amgylcheddol trwy fecanweithiau'r PAC. Mae llawer o gyllid presennol y PAC ar gyfer canlyniadau amgylcheddol yn cael ei sianelu trwy RhAA, yn rhan o'r rhaglenni datblygu gwledig a ddatblygwyd gan yr aelod wladwriaethau unigol. Ar hyn o bryd, nid yw RhAA yn Ewrop yn targedu'n benodol y gwaith o ddarparu gwasanaethau amgylcheddol; fel rheol, maent yn canolbwyntio ar newid arferion rheoli ym maes amaethyddiaeth. Fodd bynnag, rydym yn awgrymu y gall RhAA chwarae rôl hanfodol yn y broses o ddarparu gwasanaethau amgylcheddol trwy amaethyddiaeth, os cânt eu cynllunio'n briodol.
- III. Rydym yn dod i'r casgliad y gall rheolwyr tir wella ystod eang o wasanaethau amgylcheddol, i amrywiol raddau; er enghraifft, gall dulliau rheoli tir wella potensial tir i

¹ Gellir diffinio gwasanaethau amgylcheddol fel "cynnyrch terfynol mesuradwy prosesau ecosystem, megis ansawdd dŵr yfed, lefelau poblogaeth adar neu erwau o dir agored mewn ardal ddinesig" (Smith, 2006, tud. 1167)

storio carbon neu ddŵr, rheoli prosesau erydu neu ddarparu cynefin ar gyfer creaduriaid sy'n cario paill. Yn anaml, fodd bynnag, y caiff gwasanaethau o'r fath eu rheoli'n gyfan gwbl gan arferion amaethyddiaeth neu arferion coedwigaeth yn unig, felly yn gyffredinol mae angen i ni ystyried yr effeithiau ymylol posibl y gall RhAA eu cynnig. Mae'r effeithiau ymylol hyn yn hanfodol, oherwydd yr hyn y mae'n bwysig ei ystyried yw'r *gwahaniaeth* mewn buddiannau a chostau o'u cymharu â sefyllfa lle nad oes RhAA ar waith.

- IV. Ar hyn o bryd, nid yw'r rhan fwyaf o daliadau sy'n cael eu gwneud dan RhAA wedi'u cysylltu'n uniongyrchol â gwasanaethau amgylcheddol mesuradwy. Yn hytrach, maent yn seiliedig ar ffactorau eraill megis arwynebedd y tir sy'n cael ei reoli mewn ffordd arbennig. Mewn egwyddor, byddai'n ymddangos yn hollol amlwg bod taliadau'n cael eu seilio ar ddarparu gwasanaethau; fodd bynnag, mewn gwirionedd mae hyn yn peri problem, yn enwedig ar gyfer y gwasanaethau hynny y mae'n anodd gweld y buddion a'r gwasanaeth a ddarperir ar raddfa'r fferm. Ar y llaw arall, ceir rhai gwasanaethau lle mae'r cysylltiad rhwng rheoli tir a darparu gwasanaeth yn fwy amlwg, megis dal a storio carbon neu gynnydd yn nifer y rhywogaethau targed, ac mae'r gwasanaethau hynny'n cynnig eu hunain yn well i ddulliau talu sy'n seiliedig ar allbwn.
- V. Yn gyffredinol, y gwasanaethau y gellir eu darparu hawsaf gan RhAA yw'r gwasanaethau hynny nad ydynt yn dibynnu ar weithredu ar y cyd ar draws tirwedd. Felly, mae'n bosibl ei bod yn haws cynnal a chadw nodweddion unigol ar y dirwedd, megis waliau neu wrychoedd, nag ydyw i leihau'r llygredd sy'n cael ei ollwng i afonydd, dyweder, gan fod hynny'n dibynnu i raddau helaeth ar recriwtio'r rhan fwyaf o reolwyr tir o fewn dalgylch arbennig. Ond, er gwaetha'r ffaith ei bod yn anodd gweinyddu a chydabod gweithredu ar y cyd, gall fod yn fanteisiol o ran darparu gwasanaethau. Rydym yn awgrymu y dylid archwilio ymhellach i ddulliau sy'n talu am gydweithredu a chysylltedd rhwng cynefinoedd.
- VI. Ar hyn o bryd, mae taliadau RhAA yn seiliedig ar y gost yr aethpwyd iddi a'r incwm a gollwyd, h.y. maent yn cymryd costau newidiol i ystyriaeth. Fodd bynnag, mewn meysydd ymylol, rydym yn awgrymu bod dadl dros gynnwys costau sefydlog hefyd. Yn ogystal â hyn, mae'r berthynas rhwng trawsgydymffurfio gorfodol a chyfranogiad gwirfoddol mewn RhAA yn bwysig (bydd y bwlch rhwng arferion ffermio safonol a'r RhAA yn newid wrth i'r safonau sylfaenol ar gyfer trawsgydymffurfio gael eu diwygio), a dylai'r berthynas honno gael ei hystyried yn ofalus mewn gwaith ymchwil a wneir yn y dyfodol.

- VII. Mae cyfranogiad parhaus gan ffermwyr mewn RhAA yn hanfodol er mwyn darparu gwasanaethau'n llwyddiannus, a dylid cydnabod y cyfranogiad hwn trwy gynnig cymelliadau addas; rydym yn awgrymu bod angen gwneud mwy o waith ymchwil i'r strwythur mwyaf priodol o daliadau. Mae hefyd yn hanfodol targedu RhAA yn well, er enghraifft rhoi mwy o bwyslais ar ffermio dwys neu ar ranbarthau sydd wedi'u diffinio'n gliriach. Awgrymir hefyd y gall systemau "dwyrradd" chwarae rôl bwysig - trwy ganiatáu ar gyfer mwy o gyfranogiad ar y lefel sylfaenol, a mwy o waith targedu ar y lefel uwch.
- VIII. Mae'r bennod olaf yn awgrymu nifer o feysydd y gellir gwneud gwaith ymchwil arnynt yn y dyfodol. Mae'r rhain yn cynnwys dulliau sy'n cydnabod cydweithredu neu'r defnydd o systemau dwyrradd sy'n cynnig gwell ffyrdd o dargedu o fewn cynlluniau y gall pawb gael mynediad iddynt. Yn gyffredinol, cesglir bod gan RhAA y potensial i wella'r modd y caiff gwasanaethau amgylcheddol eu rheoli, ond mae'r wybodaeth sydd ar gael hyd yn hyn yn aml yn ei gwneud hi'n anodd mesur yn fanwl lefel y gwasanaeth a ddarperir. Hyd nes y bydd hynny'n bosibl, bydd yn rhaid amcangyfrif hyd a lled y gwasanaeth a ddarperir, a gwneud taliadau'n seiliedig ar newidiadau priodol mewn arferion rheoli. Fodd bynnag, mae'n bosibl y bydd cynlluniau lle mae'r taliadau'n dibynnu ar ganlyniadau yn addas ar gyfer nifer gyfyngedig o wasanaethau lle gellir gweld cysylltiad uniongyrchol rhwng rheoli tir a chanlyniadau o ran gwasanaethau.

Executive summary

- I. The aim of this report is to review the delivery of environmental services² via agri-environment programmes at the EU level. In doing so it focuses on the environmental services potentially provided by land managers and suggests how these services might be delivered via agri-environment programmes (AEP). The most appropriate reward mechanisms are discussed using examples drawn from a number of EU countries and, where appropriate, beyond the Member States. It is important to note that as a ‘scoping study’ the report explores these issues rather than providing detailed implementation proposals. It will, however, enable future work on the delivery of services via the Common Agricultural Policy (CAP) to be taken forward, by highlighting those areas in which that effort might be focused.
- II. Services can be defined as ‘the benefits people obtain from ecosystems’. Understanding how land management impacts environmental services is important because agriculture and forestry are the dominant forms of land use in the EU, representing 78% of land use in the EU-25. Given that all Member States are subject to regulation under the CAP the potential to deliver environmental services via CAP mechanisms should be thoroughly investigated. Much of the existing CAP funding for environmental outcomes is channelled via AEP, as part of the rural development programmes developed by individual Member States. Currently, AEP in Europe do not explicitly target the provision of environmental services, but typically focus on changing agricultural management practices. However, we suggest that, if appropriately designed, AEP can play a crucial role in the delivery of environmental services from agriculture.
- III. We conclude that a wide range of environmental service can, to varying degrees, be enhanced by the actions of land managers; for example, land management can improve the potential of land to store carbon or water, to regulate erosion or to provide habitat for pollinators. Rarely, however, are such services exclusively controlled by the nature of agricultural or forestry practices alone, so that in general we need to consider

² Environmental services can be defined as “a measurable, end-use product of ecosystem processes, such as drinking water quality, bird population levels or acres of open space in a metropolitan area” (Smith, 2006, p.1167).

the marginal effects that AEP can bring. Marginality is essential because the significant consideration is the *difference* in benefits and costs compared to a situation in which an AEP is not in place.

- IV. The majority of AEP payments are not currently tied directly to measured environmental services but are based on proxies such as the area under a particular management regime. In principle, it would seem intuitively obvious that payments should be based on service delivery; however, in reality this is problematic particularly for those services where benefits and service provision are difficult to observe at the farm scale. On the other hand, those services where the link between management and service output can be identified more clearly, such as carbon sequestration or an increase in the number of target species make better candidates for output based reward mechanisms.
- V. In general terms the services most easily delivered by AEP are those that do not depend on collective action across a landscape. Thus the maintenance of individual landscape features, such as walls or hedges, may be easier to achieve than, say, the reduction of overall pollution load to rivers, because the latter is largely determined by recruiting most of the land managers within a catchment. Nevertheless, despite the fact that collective action is more difficult to administer and reward it can be beneficial for service delivery. We suggest that mechanisms that pay for co-operative action and connectivity between habitats should be further investigated.
- VI. AEP payments are currently based on cost incurred and income foregone, i.e. they take into account variable costs. However, in marginal areas we suggest that there is a case for including fixed costs as well. In addition, the relationship between mandatory cross compliance and voluntary participation in AEP is important (the gap between standard farming practice and AEP will change as the baseline standards of cross compliance are amended) and should be carefully considered in future research.
- VII. Continued farmer participation in AEP is fundamental to successful service delivery and should be rewarded via suitable incentive payments; we suggest that the most appropriate reward structure requires additional research. Better targeting of AEP, for instance, an increased emphasis on intensive farming or on more clearly defined regions is also essential. It is also suggested that “two-tier” systems can play an important role – allowing for greater participation at the basic level with increased targeting at the higher level.

VIII. The final chapter suggests a number of areas on which future research could be focussed. These include mechanisms that reward co-operative action or the use of two-tier systems that allow greater targeting within universally accessible schemes. Overall, it is concluded that AEP have the potential to improve the management of environmental services but the current state of knowledge often makes it difficult to accurately measure the level of service supplied. Until this becomes possible service delivery has to be inferred, with rewards based on appropriate changes in management practice. Payment by results schemes may, however, be suitable for a limited number of services where a direct link between land management and service output can be determined.

Chapter 1: Delivering environmental services through agri-environment programmes

Project context

- 1.1 Nature provides human society with a diversity of benefits that contribute to a healthy and biodiverse environment including, for example, food, clean water and healthy soil. Though our well-being is totally dependent upon the continued flow of these 'environmental services', they are predominantly public goods with no markets and no prices, so are rarely detected by our current economic compass (Anon, 2008). As a result environmental services are often difficult to value in the traditional sense (i.e. to attribute a monetary value), meaning that the broader value of services has often been overlooked or ignored. The complexity of service valuation also means that designing payment mechanisms to reward service provision is far from straightforward. Consequently biodiversity is declining and ecosystems are being continuously degraded.
- 1.2 Typically markets fail to recognise the economic value of the public benefits from agricultural management, e.g. biodiversity preservation. In contrast, markets assign value to the private services (e.g. food production) that originate from agriculture, many of which result in ecosystem damage. The relationship between agricultural management and environmental services is complex; the sustainable management of environmental services from agricultural production systems is particularly important, since agriculture is the dominant land use at the EU level. Agriculture and forestry represent 78% of land use in the EU-25, ranging from 50% in Malta to 95% in Poland; in 2005, agriculture utilised 172 million hectares in the EU-27 of which 61% were dedicated to arable crops, 33% to permanent pastures and 6% to permanent crops (European Union Directorate-General for Agriculture and Rural Development, 2007). As a result, agricultural management is one of the major drivers of environmental outcomes and service provision throughout Europe.
- 1.3 The publication of the global Millennium Ecosystem Assessment has stimulated considerable scientific and policy interest in the assessment of environmental services and their importance for human well-being (MA, 2005). It found that around 60% of the environmental services considered, including several services that related to agriculture, were currently being degraded or used unsustainably. More recently the 'Potsdam Initiative: Biodiversity 2010' instigated a study on the 'The Economics of Ecosystems & Biodiversity'. This study will evaluate the costs of the loss of biodiversity

and the associated decline in environmental services worldwide, and compare them with the costs of effective conservation and sustainable use. The initial interim report, published in 2008, concluded that there were a number of common messages for developing the economics of ecosystems and biodiversity. These highlighted the importance of measuring the costs and benefits of services, rewarding those services that are currently unrecognised and ensuring that the costs of ecosystem damage were accounted for, by creating new markets and promoting appropriate policy instruments (Balmford et al., 2008).

- 1.4 Given that all Member States are subject to Common Agricultural Policy (CAP) regulation the potential to deliver environmental services via CAP mechanisms should be investigated. Many agricultural practices can maintain high-value biodiversity; yet, without suitable recognition, for example, through payments for environmental services, there is a risk that good management practices will disappear due to limited economic viability. Much of the existing CAP funding for environmental outcomes is channelled via agri-environment programmes, as part of the rural development programmes developed by individual Member States. The mid-term review of CAP reform in 2003 and the subsequent introduction of the 'Single Farm Payment' (SFP) substantially decoupled direct agricultural support payments from production decisions and had immediate implications for agri-environmental payments. The on-going CAP Health Check will fine-tune the 2003 reforms and contribute to the discussion on future priorities in the field of agriculture (see also Chapter 2: Background and policy framework). However, recent trends in CAP reform indicate that a combination of direct income support payments (Pillar I) coupled with a range of more targeted support for social and environmental goods (Pillar II) are likely to persist beyond 2013.
- 1.5 Currently, the SFP can be considered, at least to some extent, to cross subsidise the production of environmental services, in as much as failure to comply with cross compliance regulations can result in reduction or loss of SFP. As it is likely that this direct support will be reduced in the future, new ways will need to be found for encouraging the sustainable management of resources for which there are currently few if any market rewards, e.g. environmental services such as water or erosion regulation. Appropriately designed agri-environment programmes can play a crucial role in the delivery of these environmental services from agriculture and have the potential to become a vital tool for service delivery.
- 1.6 There is a clear need to recognise that farming can generate environmental benefits which are valued by society but whose value is not reflected in market prices.

Conversely, there is no doubt that there are a number of inherent difficulties in determining which environmental services should be paid for from the public purse, and the price that society should pay. Despite this recognition it has been suggested that “it does not automatically follow, however, that farmers should receive financial rewards for the environmental public goods that their activity helps to provide” (House of Lords European Union Committee, 2008, p.22). Although, without this financial support the incentives for farmers to supply those services that do not have a traditional market value are limited.

- 1.7 It is proposed that if the CAP can genuinely be directed towards encouraging and supporting sustainable agriculture it has the potential to bring substantial benefits for sustainable resource management. Therefore, the ambition for the future CAP should “not simply be to reduce the externalities associated with agriculture but to shift them from the negative to the positive end of the spectrum” (IEEP, 2007, p.32).
- 1.8 This scoping study was commissioned by the Land Use Policy Group, which has been invited by the EU Agriculture Commissioner to identify potential strategies for the delivery of environmental services via the CAP. It also fits within the broader remit of the Group through its support for research into policy-led land management strategies. Given present scientific and policy relevance of environmental services, this scoping study is therefore timely.

Aims and objectives

- 1.9 The aim of this report is to review the potential delivery of environmental services via agri-environment programmes. More specifically it has:
 - Focused on the environmental services potentially provided by land managers and considered how these are affected by current land management practices;
 - Considered the management options needed to deliver environmental services via agri-environment programmes and suggested how these might be achieved;
 - Examined the methodology available to reward land managers for the provision of environmental services and the applicability of these for use within agri-environment programmes; suggested how these sit within the current Green Box regulations;

- Analysed the available information and identified how this knowledge can practically contribute to the delivery of environmental services through agri-environmental schemes; and
- Identified the major gaps in existing knowledge and suggested future research and strategies to drive forward work in this area.

1.10 The issues outlined above have been considered at the EU level, although examples have been drawn from countries beyond the Member States where appropriate. It is also important to note that this is a scoping study, and has therefore, in line with that remit, scoped out issues rather than provided detailed implementation proposals. The project recommendations should enable future work on the delivery of environmental services via CAP to be taken forward with greater focus, by highlighting those areas in which that effort might be concentrated.

Structure of the report

1.11 The initial chapters of this report set the study in its political and operational context and establish the concept of environmental services. Chapter 5 moves on to discuss the current use of incentives or rewards to promote the delivery of environmental services in agricultural systems; including examples of agri-environment programmes currently in use within the EU and where appropriate from outside the EU. The issues associated with reward are discussed, such as non-market value, establishing payment level and the question of reward for outcome rather than purely for management practice. Chapter 6 details specific services from agriculture and investigates the role of agricultural management in the delivery of environmental services; delivery mechanisms are suggested. Subsequent chapters look at the appropriate spatial and temporal scale for agri-environment programmes and also propose how programmes could be monitored. The final chapter of the report identifies gaps in the current evidence base and makes recommendations for future research. It also suggests potential mechanisms for the delivery of environmental services via CAP.

Chapter 2: Background and policy framework

2.1 This section outlines the European Union Common Agricultural Policy (CAP), of which agri-environment programmes are an integral and compulsory component. The histories and present formats of both CAP and agri-environment programmes are also described.

Common Agricultural Policy

CAP - The past

2.2 Historically the CAP has supported farmers' incomes in the EU through guaranteed product prices, but by the 1980s this policy had resulted in over-production in Europe. As a result, CAP moved away from production support to direct payments for farmers (to compensate them for the resulting loss of income). Agenda 2000 reforms of the CAP officially added rural development (including enhancement of the environment) as a major policy objective. This extended the remit of the CAP beyond that of simply supporting the production of food and fibre and recognised the role of agriculture in the wider environment. Today two pillars underpin the CAP, Pillar I from which direct payments to farmers are funded and Pillar II, which supports rural development and environmental programmes. The Agenda 2000 reforms were followed by the comprehensive mid-term review of the CAP in 2003.

2.3 A major driver of the 2003 CAP reforms were the WTO trade negotiations, which resulted in the shift within the CAP from traditional market and product support to Green Box compliant schemes (Box 1). In principle payments to farmers are now decoupled from production in the Pillar I (production) category, and more funds have been shifted to the Pillar II (rural development and environmental) category.

Box 1. WTO trade boxes

Amber Box: Domestic support measures considered to distort production and trade; subject to limits on spending.

Blue Box: Agricultural subsidies that would qualify for the Amber Box but are linked to conditions to limit productivity; there are currently no limits on Blue Box subsidies.

Green Box: Subsidies that do not distort trade, or at most cause limited distortion. They must be government funded and must not involve price support; there are currently no limits on Green Box subsidies.

http://www.wto.org/english/tratop_e/agric_e/agboxes_e.htm

- 2.4 Decoupling has been translated into practice with the introduction of the SFP, which effectively broke the link between direct agricultural support payments and production decisions; finally removing the perverse incentive to over produce and thus cause environmental damage. The SFP is calculated at member state level and is based on either the number of eligible hectares farmed (area basis) or on payments received during a reference period (historical basis).
- 2.5 Cross compliance regulations mean that in order to be eligible to receive their full SFP; farmers are obliged to meet a number of Statutory Management Requirements (SMR) and to keep their land in good agricultural and environmental condition (GAEC). SMR derive from EU legislation and require that farmers must meet certain public, animal and plant health standards. By 2007, components of 19 EU directives or Regulations were included in the list of SMR (House of Lords European Union Committee, 2008). In contrast, GAEC regulations are set by each member state under a number of common categories, agreed by all member states as part of the 2003 reform. Failure to adhere to cross compliance standards can result in reduction or cancellation of the Single Farm Payment (see also Chapter 4: Cross compliance, below).
- 2.6 From 2000-2006 Pillar II was funded by the European Agricultural Guidance and Guarantee Fund (EAGGF) with the guarantee section of the EAGGF providing for approximately 60% of the budget, the guidance section about 5% and the Special Accession Programme for Agriculture and Rural Development (SAPARD) around 5% of

the total. During this period it is reported that agri-environment measures accounted for 44% of the total expenditure under this Pillar, followed by Less Favoured Area support (21%), encouragement of adaptation of rural areas (11%), forestry measures (9%), investment in agricultural holding, including setting-up of young farmers and training (7%), early retirement scheme (5%), processing and marketing of agricultural products (3%) and other initiatives (1%) (European Union Directorate-General for Agriculture and Rural Development, 2007). In 2005, the only measure proposed by all Member States under Pillar II (with the exception of agri-environment measures, which are compulsory) was support for Less-Favoured Areas (LFA). Measures aiming to improve the environment through land management in the EU25, were implemented via more than 3.1 million contracts (agri-environment measures 1.9 million and LFA 1.3 million) in 2005. Consequently, appropriately designed, such schemes have the potential to deliver environmental services from agricultural systems.

CAP – Present and the future

2.7 Considerable simplification to the operation of the CAP has been introduced in the new programming period 2007-2013, as compared to the previous one. Rural Development is now financed by a single fund: the European Agricultural Fund for Rural Development (EAFRD) (European Commission, 2005). Future rural policy is to be focused on three key areas: the agri-food economy, the environment and the broader rural economy and population. The fund provides financial support for actions grouped under four 'axes', with minimum spending requirements attached to each, to ensure that Member States spend their allocated funds across all three objectives. Rules on co-financing rates (determining the relative financial contribution of the EU and the Member State) also apply. The first axis (minimum spending requirement 15%) aims to support measures designed to improve the competitiveness of the agriculture and forestry industries, whilst the second, (minimum spending requirement 25%) supports land management measures designed to enhance the environment and the countryside. The third axis (minimum spending requirement 15%) is directed towards policies that improve the quality of life in rural areas. In addition, funds (minimum spending requirement 5%) under the fourth axis are ring-fenced for LEADER initiatives that cut across the three previous axes. LEADER initiatives introduce the potential for innovative governance structures through bottom-up, locally based approaches to rural development. In terms of the potential to deliver environmental services through CAP, axis 2 is the most important.

2.8 Despite the recent reforms to the CAP, there is still a need to ensure that financial support to the agricultural sector is directly linked to sustainable land management and clearly defined environmental outcomes. This is particularly important because most of the CAP budget is spent on direct support (the SFP) to farmers and fails to address the importance of supporting rural activity beyond farming. This bias can be seen in the proposed CAP expenditure for the period 2007-2013; Pillar I has been allocated funding of €293,105 billion, whereas that for Pillar II is less than a quarter of that amount at €69,750 billion (House of Lords European Union Committee, 2008). Whilst these large discrepancies in budgetary allocation remain, the potential for the delivery of environmental services via CAP will be limited by the disproportionate impact of Pillar I measures.

Agri-environmental programmes

2.9 Agri-environment programmes (AEP) sit under axis 2 of the second pillar of the CAP and have been an important part of the rural development policy for a number of years. AEP were first taken up by the EU in 1985 in Article 19 of the Agricultural Structures Regulation (European Commission Directorate General for Agriculture and Rural Development, 2005) but remained optional for Member States. However, in 1992 AEP were identified as an ‘accompanying measure’ to CAP reform and Member States were obliged to introduce AEP under Council Regulation (EEC) No 2078/92 (European Commission, 1992). Subsequently AEP were incorporated into Council Regulation (EC) No 1257/99 as part of the Agenda 2000 CAP reform (European Commission, 1999). Currently agri-environment measures are established by Member States or regions and submitted to the Commission for approval as a mandatory part of their Rural Development Plans.

2.10 Regulation (EC) No 1698/2005 defined the purpose and scope of assistance from the EAFRD. To accompany this regulation, Decision 2006/144/EC ‘Community Strategic Guidelines for Rural Development (2007-2013)’ was published, which identified priorities for community action (European Commission, 2006). This suggested that the resources dedicated to axis 2 should “contribute to three EU-level priority areas: biodiversity and the preservation of high nature value farming and forestry systems and traditional agricultural landscapes; water; and climate change” (European Commission, 2006, p.25). The guidelines also highlighted the importance of using the measures available under axis 2 to contribute to the implementation of the Natura 2000 network, the

Goteborg commitment to halt biodiversity decline by 2010, the Water Framework Directive and to the Kyoto Protocol targets for climate change mitigation. To meet these priorities Member States are encouraged to focus on a number of key actions. In brief these are:

- Promoting environmental services and animal-friendly farming practices;
- Preserving the farmed landscapes and forests;
- Combating climate change;
- Consolidating the contribution of organic farming;
- Encouraging environmental/economic win-win initiatives; and
- Promoting territorial balance.

2.11 AEP are an essential component for the delivery of the objectives of the Community Strategic Guidelines for Rural Development, outlined above under axis 2; the Community Strategic Guidelines provide an important overview of the aims and actions that AEP should seek to address.

2.12 Member States and regions set up AEP, which comprise of a number of different schemes. Each programme or scheme is made up of a series of measures. Participation in AEP is voluntary and involvement in a scheme can be taken as a commitment to actions that go beyond the minimum standards set by cross compliance. Agri-environment programmes are diverse but may be considered as having two broad objectives: 1) reducing environmental risks associated with farming and 2) preserving nature and cultivated landscapes (European Commission Directorate General for Agriculture and Rural Development, 2005). The schemes may be designed and run at national (e.g. in Ireland), regional (e.g. in Germany) or local level. In addition, Member States can implement schemes at multiple levels, for example, Spain runs a national scheme but has regionally specific schemes for Navarra and the Basque Country. The flexibility associated with scheme design means that AEP can, in theory, be directed towards those areas (both geographical and biophysical) where they are most required.

2.13 AEP in Europe may be categorised as: 1) broad brush/light green schemes, which include a large number of farmers, cover a wide area, make modest demands with low level of payments or 2) deep and narrow/dark green schemes, which include fewer farmers, make greater demands but offer greater rewards. This approach is typified by the AEP currently in operation in England (detailed in Box 2), although it is often not the case elsewhere in Europe where AEP are often based on a single tier approach. Both

types of schemes often include measures related to productive land management (e.g. input reduction, organic farming, extensification, conversion of arable to grassland and rotational measures, under-sowing and cover crops, actions to protect biodiversity, preservation of genetic diversity, maintenance of existing sustainable and extensive systems, landscape preservation and water use reduction); and measures related to non-productive land management (e.g. management of abandoned land or maintenance of countryside and landscape).

Box 2. An example of a two-tier AEP

The English Environmental Stewardship was launched in 2005 and comprises of three strands split into two tiers.

First tier - broad brush/light green approach

1. Entry Level Stewardship is open to all and farmers choose from a wide range of options that are available.
2. Organic Entry Level Scheme is similar but recognises the benefits of organic production for the environment and is open to all organic producers registered with a certification agency.

Second tier - narrow/dark green approach

3. Higher Level Stewardship is more targeted, competitive and only those applicants assessed as delivering the best outcomes are selected to participate.

Chapter 3: Environmental services from agriculture

- 3.1 AEP in Europe do not currently explicitly target the provision of environmental services³ but, as detailed in the previous section, typically focus on changing agricultural management practices. However, understanding how agriculture management impacts environmental services, which in turn affects agricultural productivity, is important because agriculture is a dominant form of land use; globally it is estimated that 38% of land is under agricultural management. Agriculture and environmental services are interrelated: (1) agro-ecosystems⁴ generate beneficial services such as food production, (2) agro-ecosystems receive beneficial services from other ecosystems such as pollination from non-agricultural ecosystems; and (3) services from non-agricultural systems may be impacted by agricultural practices (Dale and Polasky, 2007).
- 3.2 Environmental services are benefit specific, they are tied to particular human desires or activities and are spatially and temporally explicit. However, whilst the concept of an environmental good is relatively straightforward to understand, representing something tangible like a material resource, such as a food or fibre product of an agricultural system, the idea of a service is more complex.
- 3.3 The Millennium Ecosystem Assessment (MA), published in 2005, was the first comprehensive global assessment of the consequences of ecosystem change for human well-being. It defines services ‘as the benefits people obtain from ecosystems’ and suggests a simple typology of services (Figure 1) (MA, 2005). This definition draws upon earlier definitions put forward by Costanza et al. (1997) and Daily (1997), and despite its limitations has been widely taken up by the international policy and research literature. However, this raises a question that should be addressed as we focus on the potential delivery of environmental services from AEP. Namely if services are the ‘benefits people obtain’, then should we focus simply on those services directly obtained or should we broaden our scope and include the more indirect things on which these outputs depend?

³ Environmental services are often referred to as ecosystem services; see Appendix 1 for a brief discussion on terminology.

⁴ The EEA online glossary defines agro-ecosystems as, ‘a dynamic association of crops, pastures, livestock, other flora and fauna, atmosphere, soils, and water. Agro-ecosystems are contained within larger landscapes that include uncultivated land, drainage networks, rural communities, and wildlife’. <http://glossary.eea.europa.eu/EEAGlossary/A/agroecosystem>

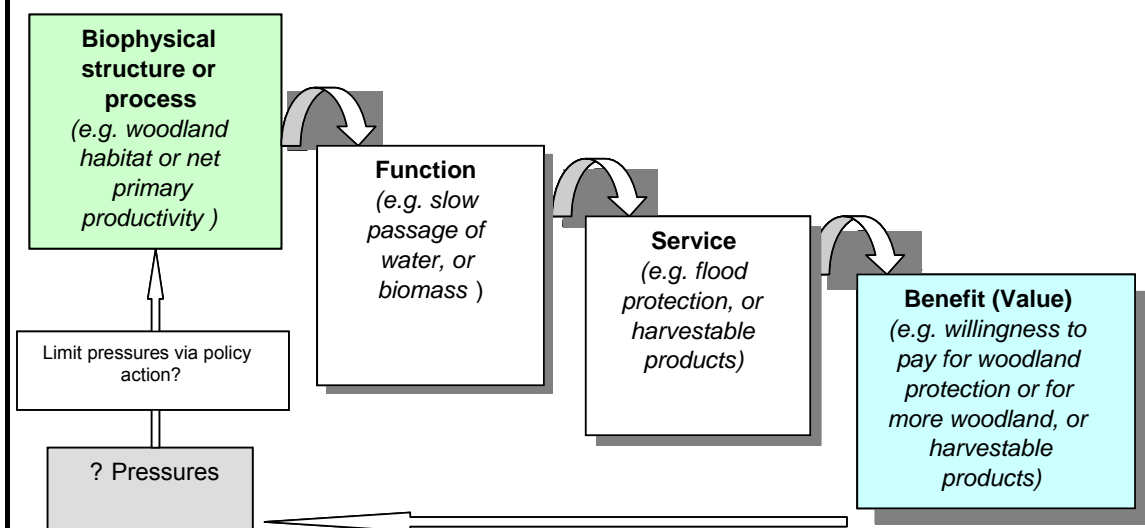
- 3.4 The biophysical structures or processes associated with ecosystems give rise to a set of functions that may provide services that are valued by people. Thus a biophysical structure, such as woodland cover, may have the functional ability of slowing the passage of precipitation and that function may in turn give rise to the service of flood protection, to which people ascribe a value. In the case of AEP this is important as it is suggested that in many cases management practices will be targeted at maintaining or enhancing the biophysical structure, rather than aimed directly at service provision.
- 3.5 Haines-Young et al. (2006) have approached the analysis of ecosystem services using the conceptual model shown in (Figure 2) and it is suggested that this framework of distinguishing between ecological structures and processes, functions, services and benefits may be an appropriate one for the present study. We suggest that the stratification of variables around this notion of a 'service cascade' is a potentially useful way of organising information. Thus while the focus of this study is on 'services' there is no reason in principle why, for instance, payments to farmers should not focus on securing some intermediate process or function, providing the outcomes of those interventions are identifiable and measurable. For a service to be sustained all the mechanisms that underpin it must be secured, and the actions of farmers may be only one, intermediate part of the process. Thus this scoping report will take a fairly broad view of the services from agriculture and suggest that this issue is one that should be taken forward and discussed in subsequent studies.
- 3.6 In order to reward farmers for the provision of environmental services, via AEP, it is clearly necessary to be able to assign a value to the service output. Banzhaf and Boyd (2005) suggest that for valuation purposes there is clearly a need to distinguish between ecosystem functions (biogeochemical flows that connect the different parts of the ecosystem) and services (these require the explicit involvement of human beneficiaries). Boyd and Banzhaf (2006, p.8) also suggest narrowing the definition of environmental services further to include only end products "components of nature, directly enjoyed, consumed, or used to yield human well-being". Using this definition, functions such as nutrient cycling or carbon sequestration are not considered services because they are intermediate to the production of the final environmental service. This is not to say they are unimportant, but, merely problematic from the point of view of placing a value on the output of environmental services to society.

Figure 1. Classification of ecosystem goods and services (after MA, 2005)

Provisioning Services	Regulating Services	Cultural Services
<i>Products obtained from ecosystems</i>	<i>Benefits obtained from regulation of ecosystem processes</i>	<i>Nonmaterial benefits obtained from ecosystems</i>
<ul style="list-style-type: none"> • Food • Fresh Water • Fuelwood • Fibre • Biochemicals • Genetic resources 	<ul style="list-style-type: none"> • Climate regulation • Disease regulation • Water regulation • Water purification • Pollination 	<ul style="list-style-type: none"> • Spiritual and religious • Recreation and ecotourism • Aesthetic • Inspirational • Educational • Sense of place • Cultural heritage
Supporting Services		
<i>Service necessary for the production of all other ecosystem services</i>		
<ul style="list-style-type: none"> • Soil Formation • Nutrient cycling • Primary Production 		

Note this is not a comprehensive list of services; those listed are indicative only.

Figure 2. The logic underlying the concept of ecosystem services (after Haines-Young et al., 2006)



- 3.7 The MA found that around 60% of the ecosystem services evaluated, including several services that related to agriculture, were currently being degraded or used unsustainably (MA, 2005). It is suggested that to address the issue of service degradation and associated loss of environmental services requires that land managers be not only rewarded for the provisioning services they provide but also the regulating and cultural services. A sustainable agricultural system will require that society appropriately rewards land managers for both the production of food as well as other environmental services. Well designed AEP, which reward the delivery of a range of services, may be one way to provide this incentive.
- 3.8 Biodiversity strongly influences the provision of environmental services. Changes in biodiversity directly affect a number of services, for example, pollination, climate regulation and carbon sequestration. Biodiversity also indirectly supports production services such as food and fibre production, by affecting ecosystem processes such as primary production, nutrient and water cycling, and soil formation and retention. As a result, the loss of biodiversity can reduce the provision of services essential for human well-being. Biodiversity can also be thought of as a cultural service; people benefit through simply knowing that a biodiverse system exists. Therefore, it is suggested that AEP should also focus on the sustainable conservation and management of biodiversity to help to maintain a number of environmental services.
- 3.9 In order to directly reward service provision it is suggested that the ability to accurately measure environmental services in a verifiable and quantitative manner is essential. However, the quantitative valuation of, for example, an aesthetic or spiritual service is extremely difficult and in these cases qualitative valuation through contingent valuation or choice modelling will be necessary. In some cases tracing the interrelationships between agriculture and environmental services is fairly direct – pollinators increase yield but in others it is more complex, e.g. wetlands reduce the load of nitrogen to surface waters from agricultural fields. To be really useful in management and policy discussions, however, we suggest that there must be a way to measure how environmental services change as a function of changing agricultural practices. This requires a thorough understanding of how ecological systems function, both under current conditions and how these functions might change with different management regimes. With this understanding we will be better able to target the delivery of environmental services via AEP making it easier to equitably reward land managers for the delivery of environmental services.

3.10 The concept of scale is often important in environmental services because many benefits may accrue over a long period or are measurable over a large area. It is suggested that this is an important consideration; to design a programme that rewards land managers for actions carried out at the wrong temporal or spatial scale would result in sub-optimal delivery of environmental services. The challenge is to move from recognition of the importance of scale, towards a mechanism that can practically reward the delivery of environmental services via AEP. To make this idea reality there is a clear need “to define operational and verifiable measures” (Dale and Polasky, 2007, p.287) and to determine how it might be feasible to equitably reward the delivery of these services from agriculture.

Box 3. Summary: Chapter 3

The key findings of Chapter 3 are as follows:

- Environmental services can be defined as ‘the benefits people obtain from ecosystems’;
- Understanding how agriculture management impacts environmental services is important because agriculture is the dominant form of land use in the EU;
- An understanding of the biophysical structures that underpin services is essential; in many cases AEP will be targeted at the biophysical structure rather than directly at service provision;
- To sustain a service it is essential that all the stages in the ‘supply chain’ are secured, therefore AEP must not be considered in isolation of environmental, economic or social drivers;
- The valuation of environmental services that may be delivered via AEP is complex; it is also difficult to measure and establish baseline service levels;
- Reward mechanisms should ensure that all types of service provision is rewarded not simply that of food or fibre production;
- Biodiversity may be considered to strongly influences service provision, in addition it is also an important cultural service; this must be recognised in AEP; and,
- The spatial and temporal scale of AEP is important for optimum service delivery.

Chapter 4: Cross compliance

- 4.1 Cross compliance is sometimes presented as the public benefit delivered in return for the Single Farm Payment. Despite the fact that cross compliance is not the focus of this scoping study it has an important role to play in the potential delivery of environmental services via CAP. Cross compliance sets the 'baseline' standard for environmental protection and has the potential to influence land management over a large area. Given that adherence to cross compliance regulations are mandatory in order to receive the SFP, the level at which cross compliance standards are set has important implications for the delivery of environmental services.
- 4.2 A recent report has suggested that cross compliance is bringing about some small improvement in basic environmental management standards but that the level of environmental protection is modest compared to the amount of subsidy provided (Silcock and Swales, 2007). In contrast a study from Switzerland reports significant benefits from cross compliance type regulations (Mann, 2005). As a non-member of the EU Switzerland is not formally subject to CAP cross compliance regulations, however, the example below is illustrative of a successful cross compliance programme.
- 4.3 Switzerland has two types of direct payments; the first general payments (80% of the budget) are subject to cross compliance and bound to hectare and animal numbers. The second are direct agro-environmental payments for extensified or idle land or for landscape elements such as hedges. Despite the fact that cross compliance regulations are set at a fairly high level, 90% of farmers qualify for direct payments. There are, however, strong incentives to comply, as between 2000 and 2002 the average agricultural income in Switzerland was 56,000 Swiss Fr, of which 43,000 Swiss Fr were from direct payments. Similarly, ecological effectiveness has shown to be high and it is reported that, for example, excess phosphorus in ground water in Switzerland has decreased by two-thirds since 1990 (Mann, 2005).
- 4.4 As Good Agricultural and Environment Conditions (GAEC) standards are largely established at the discretion of individual Member States so variation in scope means that cross compliance may be more or less effective in different states. In addition, it has also been suggested that the introduction of cross compliance may alter the minimum standards set for AEP (Kristensen and Primdahl, 2006). In particular, Member State design of GAEC may lower or raise the dividing line between cross compliance and agri-environment schemes. In turn this then alters the dynamic between what a farmer is obliged to do in order to receive their full Single Farm

Payment, and what the farmer volunteers to do in order to receive a compensation payment for participating in an AEP. The gap between standard farming practice and AEP will change as the baseline standards of cross compliance are lowered or increased. This balance between AEP and cross compliance regulations requires careful consideration so that the attractiveness and uptake of AEP is not reduced. It is also essential that measures under AEP and cross compliance can easily be distinguished from each other to avoid confusion and/or duplication.

- 4.5 The focus of cross compliance is also important, as regulation will not support all environmental services equally. Cross compliance may be complemented by specifically targeted AEP that focus on particular environmental services in specific areas. In agreement with Farmer et al. (2007) it is suggested that the extent to which the two approaches are complementary and maximise the environmental benefits that can be delivered by farmers requires further careful consideration. This should be taken forward in future investigations as it is considered that the synergy between cross compliance and AEP is a critical determinant of the delivery of environmental services.
- 4.6 The focus of the present study is on the potential delivery of environmental services via AEP but it may be sub-optimal to target all services through AEP. For example, it could be argued that cross compliance measures might be directed towards maintaining basic supporting functions, while an AEP aims at delivering additional benefits over and above the minimum that are necessary. Should the standards of cross compliance be raised in order to increase the delivery of environmental services from land managers as a whole? Alternatively should AEP be made more attractive to land managers so that a larger proportion of land managers will take them up?
- 4.7 Statutory Management Requirements (SMR) are a central component of cross compliance, which will remain important drivers of agricultural practice even if the requirement for cross compliance is removed under subsequent reforms to the CAP. This means that SMR have a potentially important role in the delivery of environmental services. However, it is difficult to argue that the inclusion of SMR within cross compliance brings any significant environmental benefit, given that existing legislation is merely reinforced.
- 4.8 Cross compliance has an essential part to play in the delivery of environmental services via CAP. The synergy between the actions required under cross compliance and those that a land manager voluntarily agrees to under AEP needs careful

consideration. If AEP are to be successfully utilised to deliver environmental services then they must not be considered in isolation from other policies or regulations.

Box 4. Summary: Chapter 4

To review, cross compliance legislation is important for the delivery of environmental services via CAP for the following reasons:

- Cross compliance has an important role to play in the delivery of environmental services, setting the baseline for environmental protection;
- The level at which the baseline is established will raise or lower the dividing line between cross compliance and AEP, altering the dynamic between what a farmer is obliged to do in order to receive SFP and what they volunteer to do in order to receive AEP;
- Cross compliance could be supported by specifically targeted AEP, which focus on those services that cross compliance fails to support; and,
- The synergy between cross compliance and AEP is a critical determinant of the delivery of environmental services and requires further investigation.

Chapter 5: Reward for environmental services

- 5.1 Agri-ecosystems are arguably the most important managed ecosystems in the world. (Foley et al., 2005). However, the distinction between cultivated and undisturbed land is not always easy to make and farms lie on a spectrum between lands completely free of human impact and completely built environments. Farmers' management decisions both affect and are affected by the biophysical and economic setting in which they operate. The type of land management at a site influences the provision of environmental services, whereas the provision of environmental services to a site is shaped by activities both on and off site. Given the predominance of agricultural land use at the EU level it is important to consider how those managing this resource can be best rewarded, for the provision of services demanded by society. Because they account for a large share of total land use agricultural lands are a prime target in any strategy aimed at slowing, halting or reversing the loss of environmental services.
- 5.2 The present focus of agriculture is food production, and a key feature of agricultural intensification is an increasing reliance on technology and external inputs to improve agricultural productivity – e.g. fertiliser, pesticides etc. These are often substitutes for services that would, in part, have originated from a 'healthy ecosystem'. As a result farmers may perceive that nature has little value for them, and believe that they are easily able to manipulate the agro-ecosystem to maximise outputs (Donaldson, 2003). However, in order to ensure the long-term sustainability of agricultural landscapes for food production and for other environmental and social benefits it is desirable to expand the focus of agricultural systems beyond food production to include the supply of a wide variety of environmental services (MA, 2005). To that end it should not simply be assumed that environmental services that can be supplied by land managers are those demanded by consumers. As Smith (2006) suggests societal demand, rather than service supply, should be the driver in designing strategies for the public purchase of environmental services via AEP. AEP should not simply be based on what land managers can supply, but must also consider the demands of the population that will benefit from the resulting service.
- 5.3 Thus one way to broaden the focus of agriculture beyond that of simply food or fibre production is through carefully targeted and attractive AEP that reward farmers who adopt a more holistic approach to land management. AEP currently reward land managers for income foregone or for costs incurred, as a result of environmentally beneficial agricultural management. AEP are calculated on the basis of costs incurred

and income foregone, with the option of adding up to 20% for transaction costs. This formula is needed to comply with Green Box regulations (Box 1) but fails to recognise the value of the environmental benefits delivered. Consequently, the ability of Green Box payments to effectively deliver environmental benefits is limited by WTO rules that place restrictions on how environmental payments can be calculated. This means that at present there is typically no link between the provision of environmental services and the subsequent level of payment. In addition, as Green Box payments are based on income foregone this makes it easier to compensate farmers for reverting from damaging practices than for maintaining positive management. The subsequent sections of this chapter will outline the potential to reward land managers for their output of environmental services via a number of payment mechanisms.

Rewarding the provision of non-market environmental services

- 5.4 Compared to natural ecosystems, agriculture and forestry have much readier potential to expand their supply of non-market environmental services for “three reasons: (1) much is known about biophysical input-output relationships in the system, (2) there exist precedents for economic incentives that could induce greater environmental service supply, and (3) the past performance of agriculture suggests strong capability to supply goods and services in response to attractive incentives” (Swinton et al., 2006, p.1160). However, to support the transition from commodity based subsidy policies to policies based on efficient mechanisms for the provision of environmental services from farmers, policy makers will need to design cost-effective AEP. In order to do this, they will need to determine estimates of the environmental and economic costs of service provision. This estimation is not simple, for instance, the US 2002 Farm Bill created the Conservation Security Program with an estimated cost (over ten years) of \$2.1 billion, which rose to an estimate of \$8.9 billion two years later (Antle and Stoorvogel, 2006). Thus, much more accurate costing is needed if this approach is to be taken forward successfully in AEP and highlights one of the first challenges associated with designing an AEP to deliver environmental services.
- 5.5 It is presently difficult to accurately assess the cost of funding any service based AEP due to the limited availability of data (e.g. service quantity/quality and demand) on environmental services from agriculture. As a result, there is a need to further determine both the cost and the value of environmental services that could be delivered via AEP, both to farmers and to society, i.e. to the providers and to the beneficiaries. A growing challenge for policy makers is to decide which environmental

service to target, given the usually limited funding available. Also, to acknowledge that the links between managed agricultural ecosystems, and the natural processes embedded within them (from which services originate), can complicate AEP design.

- 5.6 The type, quality and quantity of environmental services are affected by the resource use decisions of individuals and communities. When the benefits of an environmental service accrue mainly to those who make management decisions, as in the production of crops or livestock, private markets are likely to work relatively well in inducing service provision. However, when the benefits of an environmental service flow primarily to others, such as with water purification or climate stabilization, public interests and the interests of the resource manager may be misaligned (Jack et al., 2007). This difference in private and social benefits, or problem of 'externalities', results in a classic market failure: individuals will tend to provide too little of the environmental service. The solution to the problem of providing sufficient public goods is likely to be through a system of payments for environmental services to service producers.

Externalities and public goods

- 5.7 An externality "exists whenever private and social costs differ, or put differently, when one individual's actions affect the well-being of another individual" (Gatzweiler, 2006, p.296). In a comparison of AEP in the US and the EU Baylis et al., (2008) note that the EU take a broad view of what constitute an externality, for example, the management of rare breeds and stone wall preservation. In contrast, they suggest that there is no obvious parallel in US to the EU willingness to pay for positive externalities. Instead the focus in the US is on the reduction of negative externalities not the supply of public goods.
- 5.8 A negative externality will arise when part of the cost of producing or maintaining a service is borne by an individual other than the beneficiary. Traditionally farmers have borne the cost of maintaining the provision of environmental services despite the fact that they have not been financially rewarded for this behaviour. However, the reward and incentives of a market economy are different to those from a moral economy and this behaviour may previously have been driven by cultural norms and customary practices. Whilst this may have been the case in the past, intensification has led to an increased focus on those services, which can deliver monetary reward via established market mechanisms. For example, mowing coupled with low intensity grazing regimes has traditionally maintained a range of extensive semi-natural biodiverse grasslands

across the EU. However, the production emphasis of past CAP mechanisms meant that the production of food and fibre was supported in preference to other environmental services such as biodiversity or water quality. As a result a number of the regulating, and supporting services that benefited from this management regime (mowing and extensive grazing) have been degraded.

5.9 The WTO Green Box covers support payments for reduction of negative externalities (e.g. nutrient run off) or enhancement of positive externalities (e.g. scenic beauty) from agricultural practices. This is necessary because most of these impacts of farming practices cannot be addressed through the instrument of market. As highlighted previously AEP fall into the category of Green Box payments, AEP are considered trade friendly as they provide the option of income transfer from the beneficiary to the providers of the service. In the EU, total support to agriculture classified as trade distorting (e.g. general services and public stockholding, domestic food aid, decoupled income support, insurance and relief, structural adjustment etc), has declined by €15 billion during 1996-2003 while support for environmental services has increased by €245 million over the same period (Anton, 2007). The rationale behind the support for environmental services is to internalise the external effects (environmental) of farming and land use practices. The proportion of Green Box payments accounted for by environmental payments showed an increasing trend from 1995-1998, for example in the EU rising from 15% in 1995 to 26% in 1998. Despite this increase environmental payments only accounted for 6% of Green Box payments by 1998 (Diakosavvas, 2003).

5.10 One of the main challenges for AEP is that most of the services arising from agricultural production, other than food and fibre production, can be classified as public goods, and these constitute the majority of those potentially targeted by AEP. Public goods are those without property rights (Table 1) attached and Goldman et al. (2007) suggest that they have two basic properties, firstly that they are non-rival and secondly that they are non-excludable. For example, mitigating the effects of climate change is a benefit to everyone in society and it is not possible to exclude anyone from the benefit even if they do not pay for the service. Similarly one person's benefit from climate mitigation does not affect the use by another. Goldman et al. (2007) go on to suggest that traditional markets do well in allocating private goods but less well at rewarding the maintenance of environmental services by management, which goes beyond better practice. Other authors have suggested a more complex classification of environmental services, considering the simple division into private and public goods too simplistic.

For example, Kroeger and Casey (2007) suggest that quasi-public goods are those that may be rival but non-exclusive. Gatzweiler (2006) refers to this same type of goods, i.e. rival but non-exclusive as common pool goods. The picture is further complicated by the fact that many of these public goods can only really be secured by collective rather than individual action. However, without policies to associate a positive price for non-market environmental services their supply tends to be determined by the incentives to supply marketed services (Antle and Valdivia, 2006).

Table 1. Some characteristics of private, quasi-public/common pool and public goods (after Gatzweiler, 2006)	
Non-universality	Biological resources can have private good (e.g. timber), as well as common pool and public good characteristics (e.g. carbon sequestration).
Imperfect exclusivity/subtractability	Benefits and costs accrue to the owner and others. Efforts to exclude others are usually too costly to make exclusion feasible. Actors who are not entitled to use the goods or services are free riding. Those resources which are non subtractable (e.g. scenic beauty) cannot be depleted by additional use intensity.
Imperfect transferability	Property can be transferred from one owner to another in case of private property. Other goods and services cannot be transferred or only at high cost
Imperfect enforceability	Property is usually only protected from involuntary seizure if it is private property. The enforcement of property rights and entitlements for common pool resources and public goods is much more difficult.
Rivalry	In case of common pool resources more than one user appropriates the resource and reduces the potential benefits for another user. In case of public goods and services (e.g. climate regulation) rivalry is less of a problem.

5.11 As noted, environmental services from agriculture generate both market and non-market benefits, which have both use and passive use value. The relative size of market and non-market value of agricultural lands depends on a number of factors but the non-market value may in many cases be substantial. Achieving efficient or cost-effective environmental provision from agricultural lands via AEP faces a number of challenges and market-based approaches are often advocated as tools for achieving the conservation of environmental services. The proponents of this approach argue that environmental services need to be integrated into the mainstream economy to prevent further degradation. Nevertheless, the fact that the flow of environmental services is difficult to measure, those flows are in turn difficult to value economically and the public goods nature of many of these services mean that this is not a simple undertaking for an AEP.

Multiple services and joint production strategies

5.12 As noted by Heal and Small (2002) ecosystems deliver multiple services jointly in non-separable bundles over a range of spatial and temporal scales. The concept of multifunctional agriculture is proposed as a way to capture the valuable products beyond food and fibre that come from agriculture, e.g. open space, wildlife habitats, recreation, cultural landscapes and so on (Randall, 2007). Ideally a valuation and pricing framework within an AEP would be able to deal with such multifunctionality.

5.13 Wossink and Swinton (2007) suggest that non-market environmental services associated with agriculture fall into two categories. Some non-market services provide intermediate products in the agricultural production process that have market value as they contribute directly to output or marketable products, e.g. soil nitrogen fixation or pollination by wild pollinators. On the other hand, others have no value to farmers so the authors suggest that they are produced simply as a result of farmers' preferences or as accidental by-products of food or fibre production. Wossink and Swinton (2007), therefore, propose that the production of market and non-market environmental services can, in some cases, be viewed as a joint production process. This means that given an increase in the production of the market service a parallel increase in the non-market service will occur. This will not be the case for all services as some market and non-market services will have a competitive or independent relationship.

5.14 When designing any reward scheme within an AEP it is important to consider whether land use practices that provide benefits for one particular service also have high value

for other services. High levels of congruence mean that some forms of land use will deliver cumulative benefits. For example, the establishment of mixed field-margins (containing both tree and herbaceous species) may increase infiltration capacity and therefore decrease run-off, reduce soil erosion, provide habitat for pollinator species, preserve soil carbon and increase both plant and animal species richness. However, despite the multiple benefits of some changes in land management, such as conversion of arable to grassland, these may be outweighed by the associated reduction in food output. Thus, although it may often be optimal for an AEP to target those types of land use or land management that deliver multifunctionality, and maximise the delivery of environmental services, the wider implications of this action should also be considered. In order to deal with this problem it is suggested that services should be weighted according to the level of demand or need for each service. Demand for environmental services has many drivers and annual fluctuations can be driven by factors ranging from the economy to the weather. As a result, a system of weighting would require careful consideration of service needs/demands (subject to regular review), would be likely to vary on a regional or Member State basis and would necessitate a long-term approach to both service supply and service reward mechanisms.

- 5.15 In those cases when agriculture generates non-market and market environmental services as joint products AEP may need to address these simultaneously to be efficient. One example of this is support for organic production techniques and AEP often reward organic production systems for their concurrent production of both market and non-market environmental services.
- 5.16 Organic farming may be considered as an example of a market-based mechanism for delivering environmental services. The business model behind organic farming is to rely on environmental services, particularly supporting services and less on purchased inputs. Growers suffer some yield loss but produce a product that demands a price premium. Studies have shown that the total value of the services produced from an organic system is significantly greater than that from a non-organic system. Total economic value of environmental services in organic fields ranged from \$1,610-19,420 ha¹·year⁻¹ in organic fields and from \$1,270-14,570 ha¹·year⁻¹ on non-organic fields. The non-market value of environmental services was \$460-5240 ha¹·year⁻¹ and \$50-1240 ha¹·year⁻¹ respectively (Sandhu et al., 2008). Typically organic systems have a positive effect on the production of non-market services, but such systems do not automatically improve biodiversity. For example, an organic farmer may 'improve' a hay

meadow through the application of farmyard manure and lime, but in doing so reduce species diversity. If such perverse practices (e.g. increased fertility at the expense of biodiversity) can be avoided then organic systems have the potential to deliver substantial benefits for environmental services.

5.17 The service cascade detailed in (Figure 2) can help to address the issues outlined in the previous section as it provides a simple visual representation of the systematic links between the components of the 'supply chain'. In defining the functions of an ecosystem and deciding what can be classified as a service, an understanding of whether (or not) the function is considered as a benefit by society is required.

Valuation of environmental services

5.18 Most services (particularly regulating services) occur as non-market externalities, which makes their monetary valuation difficult. The economic approach to valuing environmental services in monetary terms is based on the conceptualisation of ecosystems as capital stock. Formation of values is influenced by the robustness and accuracy of the various market and non-market based valuation methodologies in capturing the services from the ecological production functions. Understanding ecological production functions, through collaborative effort between economists and ecologists, provides information on issues critical for carrying out the valuation exercise. Some of the relevant topics include:

- State of the ecosystem and corresponding functional form of the ecological production function;
- Drivers of change, their impact on the ecosystem and the resultant change(s) in the flow of services;
- Units and measurement of environmental services;
- Additional perturbations creating changes in the flow of services (basically marginal change in ecosystem benefits as a response to marginal change in drivers);
- Spatial and temporal considerations relating to ecosystem change;
- Gainers and losers in the process of ecosystem change; and
- Property rights for environmental services.

- 5.19 The valuation of environmental services can potentially assist decision makers in designing cost effective policies. Economic valuation of environmental services contributes to the efficacy of decision-making criteria (as in Cost Benefit Analysis or Multi Criteria analysis) and thereby the choice of activities that subsequently impact on the condition and trend of the ecosystem under consideration (Kumar and Kumar, 2008). The concept of Total Economic Value (TEV) provides a generally used framework for distinguishing 'use values' from 'non-use values'. A considerable variety of valuation methods are in use to value non-market outputs from agriculture, and methods are often divided into two categories – revealed and stated preferences. Those based on evidence from existing markets include calculations based on market prices, the avoidance cost method, the replacement and travel cost methods and hedonic price analysis. Stated preference methods include contingent valuation and choice experiments.
- 5.20 Table 2 lists the available methodologies, which can be applied to a particular environmental service depending upon data availability, unit of benefits, types of beneficiaries and existing expertise in using the approach.

Table 2. Main economic valuation techniques for environmental services

Methodology	Approach	Applications
Change in productivity	Trace impact of change in environmental services on agricultural produce	Any impact that affects produced goods from the land (e.g. declines in soil quality affecting agricultural production)
Replacement cost	Use cost of replacing the lost good or service (e.g. lost N, P and K)	Any loss of goods or services (e.g. previously clean water that now has to be purified in a plant)
Travel cost method	Derive demand curve from data on actual travel costs	Recreation, tourism, landscape beauty
Hedonic prices	Extract effect of environmental factors on price of goods that include those factors	Scenic beauty, cultural benefits (e.g. the higher market value of waterfront property, or houses next to green spaces)
Contingent valuation	Ask respondents directly their willingness to pay for a specified service	Any service (e.g. willingness to pay to keep a local forest intact)
Choice modelling	Ask respondents to choose their preferred option from a set of alternatives with particular attributes	Any service
Benefits transfer	Use results obtained in one context in a different context	Any service for which suitable comparison studies are available

5.21 Economic valuation may help to inform management decisions, but only if AEP decision-makers are aware of the overall objectives and limitations of valuation. The main objective of the valuation of services is to indicate the overall economic efficiency of the various competing uses of a particular ecosystem. The underlying assumption is that ecosystem resources should be allocated to those uses that yield an overall net gain to society, as measured through valuation in term of the economic benefit of each use adjusted by its costs. The net gain to society from AEP may, for example, be the

enhanced effectiveness of conservation (agricultural biodiversity and scenic beauty) or reduced damage to the productivity of soil.

- 5.22 Gatzweiler, (2006) suggests that because of the diverse nature of environmental services, the institutions and governance engaged in allocating them should also be diverse. He argues that one governance type alone is not generally well equipped to efficiently allocate services with private, common pool and public good characteristics. As a result he proposes the following governance modes: traditional markets (for private goods such as food or fibre), private-public partnerships (for common pool goods, e.g. land) and government (for public goods, for instance pollination or water regulation services).
- 5.23 One of the major drawbacks of AEP that reward via market-based mechanisms is that at present we do not have sufficient knowledge of all the environmental services that originate from agricultural systems. As a result it is impossible to accurately measure or attach a price to these environmental services. This suggests that although market-based approaches are potentially useful, they do not as yet allow us to construct an 'economically efficient' market for environmental services. However, markets are not the only kind of economic incentives that can be used to encourage the production of environmental services. Direct government subsidies in the form of competitive programmes, subsidies etc, can also be effective mechanisms.
- 5.24 A recent report for the Department for Environment Food and Rural Affairs (Defra), focused on the valuation of England's terrestrial ecosystem services (O'Gorman and Bann, 2008)⁵. The assessment was limited to the benefits of England's ecosystem services at one point in time and included a valuation of non-market benefits from environmental services. A consideration of the potential negative effects of any services and trade-offs were, however, outside the remit of this project. Service valuation was based on Total Economic Valuation (TEV) with TEV being equal to the market value plus the consumer surplus. Consumer surplus was defined, as "the difference between what an individual is willing to pay for a good or service and what they actually pay" (O'Gorman and Bann, 2008, p.168). As the authors suggest the "concept of consumer surplus is particularly important when estimating the benefits of environmental goods and services that have a low, or no, market price; these are referred to as non-market benefits" (O'Gorman and Bann, 2008, p.168). Therefore, in situations when a good has no market price, the consumer surplus effectively

⁵ <http://www.defra.gov.uk/wildlife-countryside/natres/nr0108.htm>

represents the TEV of the good. This will often be the case for cultural services, for example, a scenic view has no market value and can typically be enjoyed free of charge. However, consumers, if asked, are often willing to pay for this view and in this instance, where there was no original cost, the consumer surplus will equate to the willingness to pay. The report suggests that a significant limiting factor in this assessment was the “lack of clear information on the benefits arising from some services” (O’Gorman and Bann, 2008, p.151). The primary reason for this was identified as a lack of knowledge of the biophysical relationships between the ecosystem and the realization of final benefits. As a result, the report concluded that total valuation was not useful in considering the implications of policy related changes, given the gaps that remain in the knowledge base and the fact that supporting services can not be included within the framework.

5.25 The challenge is to design AEP that provide an incentive to land owners to produce environmental services at socially efficient levels. In agreement with Kroeger and Casey (2007) it is suggested that this requires a regulatory framework that defines the units for environmental services, provides a mechanism to quantify service levels and entails public payments for farmers providing services that generate public benefits. Antle and Stoorvogel (2006) present a conceptual framework for the analysis of environmental service supply which shows that the supply function is derived from the spatial distribution of environmental services and the spatial distribution of the opportunity cost of providing those services through changing agricultural land use and management practices. However, significant further investigation will be needed to operationalise such techniques before they can become useful tools in AEP design due to the current lack of information with regard to, for example, the spatial distribution of service distribution.

Box 5. Summary: Valuation of environmental services

It is currently difficult to accurately value environmental services, although progress is being made towards this goal. This has a number of implications for the effective implementation of AEP and is an important limiting factor for scheme design:

- Assessment of the funding required to deliver environmental services via AEP is complex due to the limited availability of data; research is needed on service quantity/quality and service demand;
- Given the likely budget limitations for AEP more research is needed into which services to target. It is suggested that this could be based on societal demand for services or on some established need for a particular service;
- Many of the environmental services that can be potentially targeted by AEP can be classified as public goods and thus do not have a market value;
- Land management strategies that result in the provision of multiple services should be further investigated so that, where possible, AEP can be targeted towards those strategies;
- AEP should be designed to provide an incentive to farmers to produce environmental services at socially efficient levels;
- A number of valuation techniques exist that can be used to value environmental services; the underlying assumption is that resources should be allocated to those uses that yield an overall gain to society; and,
- Currently it is difficult to accurately value environmental services and additional investigation is needed to more fully establish valuation techniques.

Payment for environmental services

- 5.26 The mechanism of payment or compensation to land managers will depend on the nature of the service. If farmers are asked to follow tillage practices that prevent soil erosion but impact on crop productivity, then compensation should be commensurate with the loss of income. However, the environmental services from agro-ecosystems may often be treated as externalities from the farmers' perspective, and even if identified and acknowledged services (other than food or fibre production) tend to be under-produced and undervalued. Thus a well-designed payment mechanism for service supply by the service beneficiaries to the providers for their incremental effort is necessary.
- 5.27 Recently, 'payments for environmental services' (PES) has emerged as a policy solution for realigning private and social benefits resulting from decisions related to the environment. The PES approach is based on a theoretically straightforward proposition: pay individuals or communities to undertake actions that increase the levels of desired environmental services. Central to this approach is the idea that external environmental services beneficiaries make direct, contractual and conditional payments to land managers in return for adopting practices that secure ecosystem conservation and restoration (Wunder, 2005). However, as Smith (2006) suggests that there is little evidence that existing AEP payment programmes reward the provision of environmental services; it is more accurate to say land managers are paid for environmentally friendly agricultural management. The implicit assumption typically being that this type of management will result in increased service delivery, which should be rewarded via AEP payment mechanisms.
- 5.28 Wunder (2005, p.4) uses five criteria to describe the payment for environmental services principle and states that a "payment for an environmental service is: a *voluntary* transaction where a *well-defined* environmental service is being 'bought' by a (minimum one) environmental service *buyer* from a (minimum one) environmental service *provider*; and if and only if the environmental service provider secures environmental service provision (*conditionality*)". That is to say that user payment should be contingent upon the service being continuously provided.
- 5.29 In theory, incentive-based mechanisms can deliver the same environmental benefits as direct regulation. When marginal benefits are constant, the first and subsequent units of, for example, carbon sequestered will have the same benefit. This will be the case despite the source or location of the sequestration and there is no dependence on

initial conditions. As a result, a simple trading scheme can probably be used to obtain any given environmental target. In contrast, for most environmental problems, the marginal environmental benefits are not constant but depend on source, location, and initial conditions. This has important implications for the design of AEP where the level of service delivery is very much dependent on site-specific conditions such as soil type and structure.

- 5.30 Incentive-based policies frequently tie the incentives to a proxy for environmental benefits that is easy to measure and relates to the level of benefits provided. For example, in The Netherlands the agri-environment scheme 'Subsidy Agricultural Nature' rewards farmers for an increase in biodiversity. Under the option 'Diverse Pasture Management' at least 20 indigenous plant species per 25 m² are required (the proxy for increased biodiversity). If this requirement is not met within six-years of the agreement then a 30% reduction in payment penalty is imposed (Franks and McGloin, 2007). Conversely, many PES are based on the assumption that changes in land management strategies will result in certain outcomes (e.g. an increase in forest area will increase water infiltration), despite the fact that there may be little specific evidence to support this assumption. As monitoring of environmental services is difficult or costly this change in management practice may be sufficient to qualify for payment under PES. This is the currently the case with many AEP where it is often sufficient simply to change land management practice in order to qualify for reward payments, the outcome of that change is often not explicitly measured, simply inferred.
- 5.31 Proxy measures of environmental services go beyond rewarding simply for action and move towards reward for outcome. Devising appropriate proxies demands an understanding of how activities, such as planting trees, relate to ecosystem functions, such as carbon storage, and ultimately to environmental services, such as climate stabilisation (Jack et al., 2007). In line with Jack et al. (2007) it is suggested that the long-term viability of PES schemes may depend, in part, on advances in techniques to estimate environmental services from easily observable ecosystem properties. This clarification of the link between management strategy and service provision would allow AEP to equitably reward land managers for varying levels of service provision.
- 5.32 Payment by results may only be a realistic option for AEP where there is a relatively close link between actions and outcomes and where outcomes can be measured with relative ease. This could be, for example, to re-introduce a specific bird species or plant species to an area or region. Where causal links are less explicit, this type of reward is likely to be less appropriate and reward payment is expected to remain linked to

management strategies. In addition, there is a need to further investigate how incentive-based mechanisms can account for potential trade-offs and synergies in the production of multiple environmental services.

5.33 The next pages detail three case studies (Boxes 7-9), which despite the fact that the studies are not drawn from EU AEP still offer many insights that can be used in designing AEP that deliver environmental services.

Box 6. Summary: Payment for environmental services

It is suggested that the following points should be considered in the design of AEP that operate via PES:

- Careful targeting is essential so that levels of the desired service are increased;
- A baseline level should be set in order to determine PES additionality, failing to do so can waste all PES funding by paying for things that would have happened anyway. Environmental services must be produced at a level over this baseline to qualify for payment, the emphasis must be on identifying and rewarding the 'additional services';
- Payments should be sufficiently long-term to avoid reversion to previous damaging practices;
- Payments should be set at a level that ensures that land managers are sufficiently rewarded for changed management practices to prevent dis-incentives to uptake;
- Payment should be more than the value of the benefit provided (or it would not be worthwhile to provide the service or participate in a voluntary scheme);
- AEP should not lead to perverse incentives;
- Monitoring should be carried out to ensure that the desired increase in environmental services is actually occurring or appropriate proxies developed;
- If possible, reward by output not simply for changed management practices. However, most existing PES programmes implicitly or explicitly base payments on the opportunity costs of the main alternative land use and, therefore, the identification of opportunity costs is essential. If output cannot be attributed to an individual, reward all those responsible for the increase equitably.

Box 7. An example of performance payments from Sweden

In 1996 the Swedish government implemented a performance payment strategy to attain and maintain stable populations of wolverines (*Gulo gulo*), Lynx (*Lynx lynx*) and wolves (*Canis lupus*) that are a threat to the reindeer (*Rangifer tarandus tarandus*) herded by the indigenous Sami people. The focus of these performance payments is strictly on outcome; the actions that led to the conservation outcome are not relevant (Zabel and Holm-Muller, 2008). Conservation performance payments are made to the Sami people based on carnivore offspring and the amount is calculated to offset all the future damage that the animals are expected to cause.

As it is difficult to attribute conservation outcomes to an individual the payment is made to the Sami villages (not to individuals), which decide on the use and internal distribution of the money. Zabel and Holm-Müller (2008) suggest that in densely populated areas with small plots or unclear property rights paying groups of people for performance outcome may be more practical than schemes based on individual payments. The challenge is to allocate the payments in a manner that ensures each herder has an incentive not to kill the carnivores. This is not simple and it has been reported that area based payments for environmental services have been confronted with situations in which elites pushed out poor less influential people (Pagiola et al., 2005).

In this example, payment is purely on outcome, in contrast to most AEP where payment is based on changes in management practices. Payment purely on the basis of outcome is unlikely to be feasible for the majority of environmental services due to the difficulty in fully documenting the service 'supply chain'. However, for those services where this link can be made explicit this example documents some of the challenges that are likely to be faced. It also highlights the issue of collective reward for service provision, which should be further addressed in AEP design.

Box 8. An example PES programme from Costa Rica

- Sierra and Russman (2006) investigated the efficiency of programmes supporting the conservation of forest resources and services through payment for environmental services in Costa Rica. Costa Rican Forestry Law 7575 recognises four environmental services, mitigation of green house gas emissions, hydrological services, biodiversity conservation and provision of scenic beauty for recreation and eco-tourism (Sierra and Russman, 2006). It was hoped that PES would provide these through “protecting primary forest, allowing secondary forest to flourish and expanding forest cover through plantations” (Sierra and Russman, 2006, p.134).
- The goal of forest conservation was met through contracts with small and medium sized farm enterprises. Three different contracts types were implemented; the first ‘forest protection’ had a five year duration and paid US \$210 per hectare over 5 years, the second, ‘sustainable forest management’ had a fifteen year duration and paid, US \$327 per hectare over that time period. The final contract ‘reforestation’ had a fifteen to twenty-year lifespan and paid US \$537 over five years. Between 1997 and 2003 5500 PES contracts were agreed covering an area of 375,000 hectares with a cost of US \$96.2 million. Of the three contract types it was reported that 87% of the area was under the ‘forest protection’ contract type.
- A comparison of land use decisions of non-PES and PES farmers showed that the PES scheme had a limited effect on forest conservation. Although the scheme seemed to accelerate the abandonment of agricultural land resulting in gains in service it was suggested that this would have happened anyway, albeit more slowly in the absence of PES. This example highlights the importance of carefully targeting PES payments so that they are focussed where they are most needed, not simply where they are most wanted. This is an important consideration for the design of AEP as it emphasis the need to ensure additionality in scheme design; farmers should only be rewarded for additional service provision.
- In this example, the majority of participants signed-up for the short-term PES scheme. Given that participants in the scheme had no long-term obligation to retain converted land as forest this meant that the benefits of this scheme were largely short-term. To avoid reversion to previously damaging practices AEP should ensure that payments are sufficiently long-term to reward or establish better management practices.

Box 9. An example PES programme from Nicaragua

- Pagiola et al. (2007) examined direct PES undertaken as part of 'The Regional Integrated Silvopastoral Ecosystem Management Project', financed by the Global Environment Facility. This project piloted the use of PES to induce adoption of traditional silvopastoral practices, which "combine fodder plants such as grasses and leguminous herbs with trees and shrubs for animal nutrition and complementary uses" (Pagiola et al., 2007, p.375). In recent years these have been replaced by extensive pastures that are characterised by low levels of services; little biodiversity, low carbon sequestration, and adverse impacts on hydrological flows. Compared with extensive pastures silvopastoral management improves pasture productivity and associated tree 'products', supports higher levels of biodiversity especially birds and invertebrates, sequesters carbon at a deeper and more permanent level and results in a reduction in surface runoff and soil erosion. However, the low profitability of silvopastoral practices from farmers' perspective and the opportunity costs from time lags before the systems become productive act as deterrent to the uptake of these practices. As a result the project sought to increase the adoption of silvopastoral practices by paying farmers for the expected increase in biodiversity conservation and carbon sequestration services that these practices would provide.
- In common with most PES programmes, the approach followed in the Silvopastoral Project involved paying for the adoption (or retention) of land uses that were thought to generate the desired services. Payments were correlated to service provision and the annual payment received by the landowner over the four-year period was based upon their net increase in Environmental Service Index points (ESI – created by combining indices of biodiversity conservation and carbon sequestration under different land use).
- Initially, land users were to be paid only for the increase in ESI points over the pre-project score (US\$75 per incremental ESI point per annum) but it became clear that this "would create perverse incentives" (Pagiola et al., 2007, p.379). As a result, the initial plan was modified to include a one-time payment of US\$10 per point for baseline conditions, meaning that landowners were rewarded for existing trees as well as those planted as part of the scheme. The avoidance of perverse incentives should be a priority in the design of AEP, in this example, land owners were prepared to cut down existing trees to qualify for reforestation payment. Reward mechanisms should be carefully designed to avoid the inadvertent inclusion of such perverse incentives.

Box 9. (Continued from previous page)

- Ideally, AEP would pay for actual service delivery although in practice this is often unworkable. To verify that the desired environmental services are actually being generated, biodiversity and carbon sequestration in the Silvopastoral Project are being monitored in all land uses. In this regard, the Silvopastoral Project differs from most other PES programs, which have “generally been content to assume that the land uses they support are generating the desired services” (Pagiola et al., 2007, p.381). AEP should include sufficient monitoring of outcomes to ensure that the desired service is actually being produced.
- The Silvopastoral Project has resulted in a reduction in degraded pasture and an increase in pastures with high tree density, however, ensuring that these changes are sustainable is challenging. As with the previous example the importance of longer-term payments is highlighted if beneficial land management strategies are to be maintained.

Reverse auctions

5.34 Although reverse auctions and land retirement programmes cannot be classified as PES under the terminology set out by Wunder (2005) they are included as alternative methodologies that could be used to reward service provision. Reverse auctions may not be suitable for non-competitive AEP but could be a useful mechanism for selecting participants for competitive AEP, or where funding is limited. In contrast, land retirement options could be introduced into AEP as a replacement for set-aside.

5.35 Reverse auctions (multiple sellers competing to sell goods to a single buyer) have been proposed as one way to efficiently allocate available funding to achieve the greatest environmental benefit. A competitive bidding system is operated where multiple sellers compete to supply a single buyer with a specific good or service. For purchasing environmental services bids are specified in terms of cost per environmental outcome, and then ranked from lowest to highest allowing the buyer to select the most cost effective. The US Department for Agriculture piloted a reverse auction in the Wetlands Reserve Program in July 2006 (Greenhalgh et al., 2007). Two reverse auctions were used in the Conestoga Watershed to determine which farmers to pay to implement management practices that reduced phosphorus loss to local waterways that had been degraded by high phosphorus levels.

5.36 One of the problems with reverse auctions is that a number of landowners who wish to manage their land in an environmentally beneficial way will not receive funding if their bid is not competitive. Despite being economically efficient this may not be an optimum strategy for AEP where environmental concerns are paramount. However, for those schemes that take a 'deep narrow' approach they may be more appropriate for allocation of limited funding on a competitive basis.

Land retirement programmes

5.37 AEP can also deliver environmental services via land retirement schemes where production is ceased and land is allowed to revert to its 'natural' state'. Land retirement schemes mainly operate in countries such as the US, Canada and Australia. In contrast, in Europe the emphasis is much more on reducing intensification and maintaining land in production. This is partly driven by cultural perceptions in the two areas; Europeans perceive higher value in farmed landscapes as much of the rural environment, which they value, is the product of agriculture whilst the Americans prefer an unmanaged landscape. This distinction is not, however, exclusive and some re-wilding projects (outside AEP) are currently underway in the UK, which are allowing natural vegetation to return. Current EU set-aside regulations also support temporary retirement from production. The European view is also partly driven by rural development policy, e.g. The Community Strategic Guidelines (European Commission, 2006) which focus on preserving farmed landscapes. In addition, land abandonment can result in desertification and forest fires, particularly in Southern Europe and/or in the loss of habitats such as mountain pastures that are dependent on traditional management techniques.

5.38 Despite apparent success elsewhere, land retirement has received little attention in Europe in the past, but it may be a potential mechanism to deal with the impact of the proposed abolishment of set-aside land. Further research is needed to determine the desirability of including land retirement as an additional land management option in future AEP. Set-aside contributes to the supply of a number of services through the provision of habitat for bird and invertebrate species, by connecting existing habitats, buffering watercourses and other habitats and by protecting soils from erosion. Silcock and Lovegrove (2007) suggest that future AEP should incorporate specific environmental maintenance and enhancement benefits currently delivered by set-aside.

Chapter 6: Example environmental services from agriculture

Introduction

- 6.1 This chapter examines the main environmental services that are supplied from agricultural systems. For each of the services under consideration a general overview is presented followed by a discussion of the delivery mechanisms that could be used to enhance service delivery within AEP. The basis on which payment for each environmental service could be based is then proposed. Where appropriate illustrative examples are given.
- 6.2 Agricultural management can produce many environmental services beyond those of food and fibre production. Some example services are listed in Table 3 under their MA categories. Many environmental services are context dependent and their role can vary depending on location or other site-specific factors. For example, trees can improve water infiltration into the soil but may also transpire water and reduce ground water recharge. As a result management decisions will often involve trade-offs; managing a landscape for food production is unlikely to maximise, for example, water purification for people downstream. In addition, the provision of wild vegetation for pollinator habitat may also provide habitat for pest species. Partial trade-offs between services are also likely, a fast growing plantation or crop that may maximise carbon sequestration may not be particularly optimum, for biodiversity or tourism.

Table 3. Example environmental services from agriculture

Provisioning services	Regulating services	Supporting services	Cultural services
Food production Fibre production	Air quality regulation, <i>Climate regulation,</i> <i>Water regulation,</i> <i>Erosion regulation,</i> <i>Water purification,</i> Disease & pest regulation <i>Pollination</i>	Soil formation Nutrient cycling	<i>*Biodiversity</i> <i>Landscape preservation</i> Historic site preservation Recreation Aesthetic
<p><i>Italicised services are those considered within this scoping study</i></p> <p>*Biodiversity is not classified as a service by the MA, rather as the foundation of all service provision</p>			

Regulating Services

Pollination

- 6.3 Although a number of staple food crops do not require pollination (Kremen et al., 2007), pollinators are important in 35% of global crop production (Klein et al., 2007) The direct value of pollination services is to increase production of market based food, fibre etc, whereas the indirect value, may be a marginal increase of wild plants that play a role in other environmental services. The value of pollination services varies widely but has estimated from \$112 to \$200 billion annually at the global scale (Costanza et al., 1997; Kearns et al., 1998).

- 6.4 Some pollinator groups appear to be benefiting from current AEP, although this response has not been noted for all taxa or in all countries (Kleijn et al., 2006). Such trends must be looked at in terms of the overall status of this service. For example, Biesmeijer et al. (2006) have recently suggested that overall evidence suggests a

parallel declines in pollinators and insect-pollinated plants in Britain and the Netherlands (Biesmeijer et al., 2006). These workers compiled almost one million records for all native bees and hoverflies in both countries that could provide evidence of changes in abundance. Their analysis, which compared the period up to 1980 with that since, found that there was evidence of declines in bee abundance in Britain and the Netherlands, but that the pattern was more mixed for hoverflies, with declines being more dependent on location and species assemblage. In both countries those groups of pollinators with the narrowest habitat requirements were the ones to show the greatest declines.

Pollination - delivery mechanisms via AEP

- 6.5 AEP may influence pollination services through their effects on habitat and resource quality and spatial distribution. Pollination is a locally supplied service and it has been suggested that landscape mosaics best encourage pollination, yet these can be considered uncommon in agriculture where monoculture tends to dominate. Both landscape composition and configuration are important and studies have shown that agricultural practices have major impacts on wild bee populations (Kremen et al., 2004). Agricultural intensification can, for instance, alter the availability of floral resources in space and time, increase mortality from pesticides and destroy nesting sites. Kremen et al. (2004) showed that in California pollination services from native bees were significantly, positively related to the proportion of upland natural habitat in the vicinity of farm sites. In addition, they noted that the stability and predictability of pollination services increased with increasing natural habitat area. The service/area relationship was “robust over space and time, allowing prediction of the area needed to produce a given level of pollination services by wild bees within this landscape” (Kremen et al., 2004, p.1109).
- 6.6 If pollinator habitat is fragmented or if patches are too small to sustain pollinator population then AEP will not deliver improved pollination services. There is increasing evidence that conserving wild pollinators in habitats adjacent to agriculture increases both the level and stability of pollination, leading to increased yields and income (Klein et al., 2003).
- 6.7 Co-operative action is likely to be required to significantly increase pollinator services, without co-ordinated effort it can be argued that efforts to improve pollinator numbers will be unsuccessful. It is suggested that positive effects on pollinators may occur if

AEP can reward habitat heterogeneity and encourage appropriate foraging and nesting sites for pollinators. Measures that will promote this could include:

- Flower rich field margins, set aside and hedgerows to provide alternative foraging and nesting sites for pollinators ;
- Low input and extensive systems;
- Reduced fragmentation of habitat through co-ordinated action at the landscape level;
- Reward for heterogeneity through co-ordinated action at the landscape level;
- Specific planting schemes to encourage specific pollinator species; and,
- Appropriate timing of management practices to avoid disturbance to pollinator habitat.

Pollination - payment for environmental services

6.8 It is suggested that any payment for pollination services should be based on co-operative action over an appropriate scale and should be based on changes to management practices as outlined above. A methodology for direct payment for the provision of pollinator services would be complex; an increase in pollinator services would be difficult to accurately measure, although it is possible that some proxy measurement could be determined. Nevertheless, even if it were possible to accurately determine pollinator numbers it would be difficult to attribute changes in management at the farm-level to changes in pollinator number, making it tricky to equitably reward land managers for pollination services. As Kremen et al. (2007, p.300) suggest managing for pollinators and the services they provide “requires considering not only the local scale where service are delivered, but also a landscape scale that reflects both the spatial distribution of resources and the foraging and dispersal movements of the organisms themselves”.

⁶ Set aside is likely to be abolished under future CAP reforms; however, other types of low input management would also provide suitable habitat types.

Water regulation and purification

- 6.9 Water purification and regulation are two important and somewhat interlinked hydrologic services. Agriculture can both provide and damage these environmental services through runoff, which can carry pesticides, fertilisers and sediments into surface water and via the leaching of residues into groundwater. Sediment in runoff can impact on nearby water bodies, resulting in flooding, pollution or blocking. Land cover is one of the major influences on the rate of water flow through the hydrological system; woodlands are, for example, generally thought to be less susceptible to run-off than other types of land cover such as pasture and agricultural crops (Armstrong et al., 1990). However, research has determined that the structure of the overall land cover mosaic and the land use practices associated with it that may be the most important predictor of flood response.
- 6.10 One of consequences of agricultural intensification in the post-war period has been the increased eutrophication of surface and ground waters in England. A variety of factors are thought to be responsible, including increased levels of fertiliser use, higher frequency of ploughing, the shift from grassland to arable crops, the loss of permanent pasture in favour of temporary grass, and higher stocking density.
- 6.11 There are currently a number of AEP that include measures targeted at preserving water resources in the EU. However, it has been reported that uptake figures suggest relatively little farmer interest to date. This may be a result of the substantial changes to management strategies that are likely to be required coupled with the fact that water is often regarded as private rather than public good (European Union Directorate-General for Agriculture and Rural Development, 2007). Nevertheless appropriately designed AEP have the potential to substantially improve the provision of hydrologic services.

Water regulation and purification - delivery mechanisms via AEP

- 6.12 Well-designed AEP have the potential to effectively deliver both water regulation and purification services, often simultaneously. Agricultural land management can offer potentially valuable flood protection services to areas downstream. However, flood risk management is rarely an explicit aim of AEP, instead it is often a side effect of other measures designed to improve biodiversity or improve soil structure. To deliver water regulation and purification services it is suggested that AEP should promote and reward:

- Deep rooted crops, rotational grazing and no-till cropping which can help to reduce run-off via improved soil structure, resulting in improved water holding capacity;
- Well-timed cultivation practices that can minimise the risk of soil compaction and thus increase the infiltration capacity of the soil and reduce runoff;
- The establishment of buffer zones, areas of permanently vegetated land, adjacent to waterways, which can reduce run-off. These buffer zones around water bodies would prevent sediment or nutrient run-off during cultivation, fertilisation and other management operations;
- Buffer zones co-ordinated at the landscape scale, simply rewarding on a per farm basis is likely to bring limited environmental benefits. It is suggested that there is a need to design AEP to reward farmers to buffer and manage the entire land critical to water purification and flood control; support should be targeted at co-operative action not simply at individual farmers;
- Vegetated riparian buffer zones that can provide space for water during high flow events or restore wetland habitats;
- Wash-land areas that can accommodate water at time of high risk, i.e. positive creation of flood storage facilities. These should be planted with vegetation that can tolerate periodic inundation and can be designed to temporarily store water. Morris et al. (2008) suggest that these will simultaneously support winter inundation, support extensive farming and deliver environmental benefits (wading bird habitats). The authors also suggest that there is scope to design “a washland storage package, involving land purchase, easement, annual payments, or partnerships/leaseback” (Morris et al., 2008, p.379);
- Reduced stocking density to minimise the input of contaminants to water bodies; and,
- Planting of cultivation intensive crops should be minimised and grassland, woodland or agro-forestry systems should be encouraged.

Water regulation and purification - payment for environmental services

6.13 It is likely that efforts to implement the EU Water Framework Directive will be a key influence on how payments for environmental services might be taken forward in the

area of water management. In England, for example, there is the emergence of more integrated strategies for dealing with the problems of water quality that are additional to efforts to introduce codes of good practice, supported by agri-environmental and cross-compliance measures, in the form of the Catchment Sensitive Farming⁷ initiative. This has sought to create integrated approaches for dealing with a number of the problems facing land managers in river catchments across England. Forty catchments are targets for action, and within them a range of measures are being promoted to improve farm practices and reduce diffuse water pollution from agriculture, by bringing together farmers, farm advisers, conservation bodies, water companies, and other stakeholders. What is particularly interesting is that the strategies will not only attempt to deal with the management of nutrients, but also seek to promote good soil structure to maximise infiltration of rainfall and minimise run-off and erosion.

- 6.14 Another example, of an innovative strategy to reward service provision is the collaboration between the UK water company United Utilities and the RSPB. Working together United Utilities and the RSPB developed the Sustainable Catchment Management Programme (SCaMP), which aims to apply an integrated approach to catchment management within two key areas of United Utilities land, Bowland and the Peak District area. The programme aims to restore these upland areas to their natural hydrological condition, via drain blocking, resulting in improvements to water quality, regeneration of, for example, Sphagnum species and reinstatement of valuable habitats such as upland heath and blanket bog. Funding to enable and carry out the new management approaches has come from both AEP and United Utilities who work with farmers, land managers, local authorities and government to influence the management of water catchment areas. They also work with tenants and farmers to develop long-term plans that will benefit business, wildlife and water quality.
- 6.15 As with the schemes outlined above, it is likely that changed land management practice will continue to be the mechanism on which reward schemes are based. Similarly to pollination services it is complicated to reward land managers directly for the improvement of water purification services, i.e. to base payment on results. This is mainly because it is difficult to pinpoint exactly where any pollution or sediment measured in water originated, which means that equitable reward structures (based on payments by results) are challenging to design.

⁷ <http://www.defra.gov.uk/farm/environment/water/csf/index.htm>

- 6.16 Co-operative payments also need further investigation to determine the best method to reward farmers that agree to buffer land adjacent to waterways in agreement with other landowners. These agreements would reward for changes to land management rather than reward changes in outcome, as it would be difficult to determine precise relationships between cause and effect in these situations. However, it may be possible to establish some proxy measure, which would enable a more equitable distribution of payments in the future.
- 6.17 It is possible that improvements in soil structure or infiltration capacity generated via improved water management practices could be measured. These could perhaps act as suitable proxy measures for hydrologic services that could determine payment at the individual farm level. This could be further investigated to establish the feasibility of using this proxy measure as one determinant of the potential to improve both soil quality and the associated hydrologic services.
- 6.18 The establishment of wash-lands on land adjacent to water bodies for the express purpose of water regulation is one area where there is potential to make a direct link between the delivery of an environmental service and the payment for that service. Land managers could be paid to manage the water on that land rather than the cropping system on that land. As suggested earlier, there is also potential for multifunctional use of this land, which could support extensive farming when flood water had reduced, provide habitat for wading birds when flood waters were at appropriate levels and simply provide a water regulation service at other times.
- 6.19 Two further examples of incentives schemes that have recognised that farming can significantly affect water quality and result in increased costs for water purification are those in the Catskills watershed in the USA and in the 'Vittel' catchment in France. In the Catskills the watershed acts as a filter and pre-processor for New York's drinking water; from 1997 the City has made substantial payments to farmers to recompense them for using farming methods that result in lower pollution levels in the water flowing from the area (Heal and Small, 2002). The Vittel example is considered in more depth in Box 10.

Box 10. Payments for environmental services, the Vittel water example

In the early 1980s it was recognised that the intensification of agriculture in the Vittel catchment posed a risk to the nitrates and pesticide levels in the mineral water. To address this issue Vittel considered five alternative courses of action, eventually deciding that the best option was to provide incentives to farmers to voluntarily change their management practices and so reduce contamination (Perrot-Maitre, 2006). As a result, Vittel initiated a four-year multi-disciplinary research programme that aimed to determine the most effective way to run the proposed incentive programme. Negotiations were lengthy but eventually an incentive package was agreed upon, in outline this included:

- Long-term security through 18 or 30 year contracts;
- Abolition of debt linked to land acquisition;
- Subsidy of about € 200 ha⁻¹ year⁻¹ over five-years;
- Up to €150,000 per farm to cover the cost of all new equipment and building modernisation;
- Free labour to apply compost in farmers' fields; and
- Free technical assistance including annual individual farm plans and introduction to new social and professional networks.

The programme was successful and by 2004 all 26 farms in the area had adopted the new farming system. The strength of the system is that the link between environmental services and management practices was determined scientifically. In addition, a baseline was established and recommendations for management practices were based on four years of modelling and on-farm testing. Payments are not conditional on changes in the nitrate levels in the aquifer but are based on new farm investment and the cost of adopting new farming practices. Both nitrate rates and farm management are regularly monitored and recommendations for manure application are adjusted if necessary.

Box 10. (Continued from previous page)

The main conclusion from the Vittel case is that establishing payment for environmental services is very complex and requires “the consideration of scientific but also social, economic, political, institutional and power relationships” (Perrot-Maitre, 2006, p.5). In addition, it was suggested that the primary reason for the success of the scheme was trust; built up via, amongst other factors, a long-term participatory process. However, the ability to maintain farmers’ income levels and finance technological change was also important. A number of lessons could be learned from the Vittel example in relation to AEP. In particular, the involvement of farmers with scheme design and the establishment of a firm scientific baseline are essential. In addition, unlike many AEP the Vittel scheme offered land managers long-term contracts and thus a greater degree of security than that offered by the typically shorter contracts offered by many European AEP.

Climate regulation

6.20 The IPCC has predicted that global temperature could rise by as much as 5.8°C above 1990 levels due to increases in greenhouse gases (Nakicenovic et al., 2000). Forests and other vegetation could have an important role in climate stabilisation because they sequester carbon by absorbing the gas during photosynthesis (Goldman et al., 2007). But agriculture also releases carbon through the conversion of natural vegetation to cultivated land, via tillage and through the creation of cropland by forest clearance. Livestock also contribute to greenhouse gas emission via the production of methane. In addition, the manufacture of artificial inputs, such as fertilisers and pesticides, and the use of agricultural machinery also contribute to the production of greenhouse gases. To date the potential of AEP to tackle problems such as climate change has not generally been considered in the design and deployment of AEP. However, sustainable management practices can contribute to a reduction in greenhouse gas emissions and preservation of the carbon sink in soil and help to adapt to the impacts of climate change. Agriculture is also important in terms of biofuel production and hence a potential source of renewable energy.

6.21 One of the main options for greenhouse gas mitigation identified by the IPCC is the sequestration of carbon in soils (Hutchinson et al., 2007). However, carbon sequestration in soil is not permanent and so cannot be considered as an enduring

solution to the problem of enhanced CO₂ levels. Carbon sequestration can be considered a global service; one that is generated locally but which provides global benefits. A number of commentators, for example, have considered what benefits might be gained by using changes in land use and land management as one element of a broader strategy to control carbon-budgets. Since in most terrestrial ecosystems, the amount of carbon in soil is usually greater than the amount in the living biomass, much of the focus has been on the ability of soil to sequester carbon under different conditions. For example, re-forestation coupled with extensive farming practices may lead to increases in carbon sequestration.

Delivery mechanisms via AEP - carbon sequestration in mineral soils

- 6.22 A number of studies have looked at the potential of different types of land management to promote carbon sequestration. For example, Smith et al. (2000a & b) considered what the best land use change scenarios were for carbon sequestration. They found that the best single mitigation option was the production of bioenergy crops, but a mix of strategies involving woodland regeneration, extensification, limited tillage and the application of straw and manure to soils could achieve even greater levels of sequestration. However, the scale of land use change that would be required for such changes to make a significant contribution in terms of Kyoto commitments, say, probably made strategies based on these kinds of changes unrealistic.
- 6.23 In Europe the total terrestrial carbon sink is projected to decline over time with significant decreases in soil organic carbon in all climate change and land use scenarios (Zaehle et al., 2007). Consequently it is vital that substantial efforts are made to retain, restore and enhance existing soil carbon stores; given that agricultural is the predominant user of land at EU level it is clear that this land management has the ability to positively or negatively influence this trend.
- 6.24 Carbon sequestration within an AEP may be achieved by two broad strategies. The first group of strategies focus on the reduction of greenhouse gas emissions from soils by preserving existing carbon stored in soils or vegetation; whilst the second group of strategies focus on improving, creating and restoring carbon sinks to increase the removal of greenhouse gases from the atmosphere. Some options are outlined below:
- The conversion of arable land to either woodland or grassland is likely to increase soil carbon levels; a change from rotational grassland to permanent

grassland will further increase carbon sequestration potential. However, trade-offs can result and despite increasing carbon sequestration afforestation with simple monocultures will have negative effects on biodiversity. Agro-forestry systems increase above and below ground carbon and have been shown to sequester more carbon than singular systems based on forests or pastures alone (Sharrow and Ismail, 2004). However, there may be limited potential to promote these changes in land use within AEP. Despite the benefits for carbon sequestration large-scale changes to less productive land use would be likely to reduce the provisioning services from agriculture. This may be both politically and socially unacceptable and could simply result in a shift to greater imports and increased land use outside the EU.

- The optimum management strategy for carbon sequestration will not be the same for all types of land management. For example, on intensively managed grassland, rotational grazing and fertilisation sequester the most C; on extensively managed grassland, grazing intensity and frequency are the optimum management practices (Dawson and Smith, 2007). As a result, options that aim to promote carbon sequestration within any AEP will need an element of specificity to deal with this complexity.
- Re-vegetation of abandoned arable land may increase soil carbon by $0.3-0.6 \times 10^3 \text{ kg C ha}^{-1} \text{ year}^{-1}$ (Freibauer et al., 2004). However, land use and management strategies vary considerably so values can be extremely variable.
- Additional nitrogen (N) inputs may increase the amount of carbon sequestration, but this relationship is somewhat complex and difficult to manage and can lead to trade-offs such as increased nitrate leaching. In addition, the greenhouse gas emissions from the manufacture of inorganic fertiliser can be greater than the soil carbon sequestration benefit gained.
- Simply ensuring that all cereal crop residues are returned to the land either as straw or farmyard manure could also have large benefits for carbon sequestration (King et al., 2004) and would be relatively simple to promote within an AEP. However, this could lead to a growth in N_2O emissions as a result of increased organic matter content and thus mineralisable N. King et al. (2004) found, however, that changes in arable management made a significant contribution to an abatement strategy only if they involved greater use of permanent conservation field margins, increased returns of crop residues and reduced tillage

systems, but that the contribution that true soil sequestration made in the overall saving was minor. Interestingly, the main benefits were found to be due to reduced energy use, and lower N₂O emissions from reduced use of inorganic nitrogen fertiliser. Such findings open up the issue of whether payments for services in relation to carbon management should extend to encouraging changes in farm practice generally or be confined to the management of only the carbon sinks associated with the land. This is especially important in peatland as Holden et al. (2007) notes, for example, the peatland areas of England and Wales store an amount of carbon roughly equivalent to the emissions of UK greenhouse gases for three years. There is thus clearly a benefit, in terms of achieving current policy aims of reducing overall CO₂ emissions, of ensuring that overall peat loss through decomposition and erosion is minimised (Holden et al., 2007).

- A well-designed AEP should reward management practices that increase C sequestration and reduce soil erosion including minimal tillage, extensification and field margin management (Dawson and Smith, 2007).
- As field-margins will contain grassy strips, hedgerows or lines of trees they will sequester more carbon in vegetation and soil than land under arable management. A simple option to increase carbon sequestration would be to increase the width of hedgerows or field margins. Falloon et al. (2004) investigated the carbon mitigation potential of arable field margin management options for Great Britain. The authors investigated combinations of margin widths, 2, 6 or 20-metre widths with grass, grass and trees or grass and hedgerows. Twenty metre margins with trees obviously had the most carbon mitigation potential (nitrous oxide savings, above ground C storage and soil C storage). But the increase in sequestration did not increase in proportion to the increase in width. However, as the authors suggest a 20-metre margin is unlikely to be a feasible option, for example, in Great Britain this would require about 21% of the total arable area if this option were implemented (Falloon et al., 2004). Incentives that encourage the appropriate management, width and planting regime of field-margins should be further investigated.
- Land management practices such as cultivation and the use of fertilisers also contribute to the emission of greenhouse gases either directly or indirectly via the manufacturing process. It is possible that AEP could incorporate reward mechanisms that promote and support emissions from these kinds of operations.

Carbon sequestration in Peatland

- 6.25 The majority of management options outlined above are likely to be suitable for use on mineral soils. However, peat and organo-mineral soils (soils with a thick surface organic layer above mineral horizons) properly managed have the potential to sequester larger amounts of carbon. In good condition, peat will continually accumulate organic matter and will not reach an equilibrium point (where sequestration will cease) and so can act as a perpetual carbon sink. At the global scale IPCC rank the restoration of organic soils as the third most important mitigation measure available to land managers. In the short-term the rationale for peatland management is the preservation of existing carbon stocks in peat soils and the reduction of greenhouse gas emissions rather than an increase in the carbon sink.
- 6.26 Peat soils can be degraded through, for example, over-grazing, fertiliser and lime applications and drainage. To protect the existing upland peat stocks the options include re-vegetation, the removal of drainage gullies and a reduction in stocking density. Management options designed to restore peat stock must have a longer-term focus than that of many current AEP (often five-years) as the re-wetting of peat may cause increased methane emissions in the short to medium term. However, within 20 years the net effect of re-wetting has found to be positive, with greenhouse gas emissions reduced (compared to pre-restoration) and the peat becoming a net C sink once again (Augustin and Joosten, 2007). The process of lowland peat restoration is usually more rapid than for that of upland peat but often involves the removal of that land from production, which may become a reed bed or similar.

Payment for environmental services – carbon sequestration in mineral and peat soils

- 6.27 As Hutchinson et al. (2007) suggest producers will only adopt new management practices, which will increase carbon sequestration, if these are found to be economically feasible. As a result incentives schemes should be designed so that carbon sequestration is directly or indirectly rewarded at the appropriate level. However, designing a system of payments that directly link payment to sequestration rates, pose a considerable number of challenges.

- 6.28 The amount of carbon in soil is not always easy to measure as it is usually distributed unevenly throughout any sample area. This means that directly rewarding land managers for increases in soil C is not straightforward as the establishment of baseline levels is somewhat complex. However, if baselines could be successfully measured then it is possible that managers could be paid depending on either how much soil C levels are increased or on the basis of the amount of soil C retained.
- 6.29 The issue of rewarding land managers for carbon sequestration is further complicated by the fact that it might be argued that schemes should also reward those managers who have successfully retained their soil carbon through careful management. If, as suggested, the levels of soil C can reach an equilibrium level (West and Post, 2002) then these land managers may be unable to sequester additional soil carbon if soil has reached or is approaching equilibrium. In these situations, despite 'best' management practices a land manager could be unable to sequester any additional carbon. Consequently, AEP should ensure that both those who have already retained carbon through 'good management practices', and those that are restoring their carbon resource are rewarded. Initial payments should be higher for those who have maintained their carbon resource than for those who are in the process of restoring that resource. Over a number of years as resource quality is improved payment levels should reach parity; long-term payments would be based on maintenance of the resource in a 'good condition'.
- 6.30 In addition, one of the main controls of carbon sequestration is climate (temperature and precipitation) over which we have no control. Thus one of the main drivers of carbon sequestration is largely outside the scope of management influence. This could lead to the problem of decoupling increases in sequestration rates originating from management practices from that which has occurred purely as a result of the climate.
- 6.31 AEP that reward farmers for changes to management practices, which promote increased carbon sequestration, will be simpler to design than those that base payment on the amount of carbon sequestered. It is suggested that this should include reward for the adoption of minimal or zero tillage coupled with minimal fertiliser or other inputs and low stocking rates. These changes will directly reduce C lost from the soil but will also reduce indirect C emissions caused by machinery operations and the manufacture of inorganic fertiliser or pesticides. Such management practices are also likely to result in improved soil structure, decreased N leaching and reduced soil erosion.

- 6.32 As described above an increase in field margin width can result in increased carbon sequestration, especially when planted with an appropriate combination of trees, hedgerow and grass. This would require an incentive that went beyond the typical five-year duration of an AEP if carbon sequestration or retention was to be maximised.
- 6.33 For peat management it is suggested that carbon sequestration should be an explicit goal of any AEP. This is likely to mean that specific strands of AEP should be available to those land managers in peatland areas in both upland and lowland regions. Given the problems described above it is likely that the reward mechanism will also be based on changes to management practices that are known to result in increased sequestration. Also as the initial aim of any reward scheme may simply to retain existing soil C the reward structure should reflect this aim. The AEP should focus on the management practices that will result in re-wetting of peat areas, the establishment of appropriate vegetation and minimal or withdrawal of any production focused activities. As suggested previously these strategies need to be long-term to achieve optimum results.

Erosion regulation and soil quality

- 6.34 Soil is a fundamental resource for agricultural productivity, providing resources for plant growth and nutrition and water storage. Soil is also effectively a non-renewable resource and one for which there is rarely a suitable substitute. As a result most AEP include elements that aim to improve soil quality or reduce soil erosion. For example, in Italy both planting hedges and organic farming techniques have been found to reduce soil erosion, whereas in Austria direct sowing resulted in 40% reduction in soil erosion and in Belgium green cover reduced soil erosion by 50% (European Union Directorate-General for Agriculture and Rural Development, 2007).
- 6.35 There is no acknowledged or agreed definition of soil quality as this is largely dependent on the purpose for which the soil is being managed. However, important components of soil quality may be considered as soil nutrient status (N, P, K), level of soil organic carbon, minimal level of contaminants and structural composition. All these factors may be influenced by management practices, so improvements may potentially be delivered via AEP.

Erosion regulation and soil quality - delivery mechanism via AEP

6.36 Improvements in components of soil quality can be effectively delivered via AEP in a variety of ways, which include:

- Ensure cultivations are appropriately timed; avoid mechanical operations when fields are waterlogged to preserve soil structure, time fertiliser application to plant requirements to minimise leaching and prevent water pollution;
- Incorporation of crop residues should be encouraged to maximise the return of nutrients to the soil;
- Encourage cover cropping to reduce the erosion risk from bare soil and incorporate into soil to recycle nutrients;
- Under-sow or inter-crop with leguminous crops to maximise nutrient use efficiency. Although this is practiced in some organic system the use in non-organic systems should be further investigated;
- Retain and plant hedgerows and use minimal tillage practices to reduce the risk of soil erosion; and
- Minimise the use of artificial fertilisers and pesticides to reduce the number of cultivations, which can damage soil structure and contaminate soil and water bodies.

Erosion regulation and soil quality - payment for environmental services

6.37 As with a number of services discussed earlier it can be difficult to establish the baseline level of soil erosion. This means that although it would be preferable to reward land managers for a quantifiable reduction in erosion levels (i.e. payment by results) this might be difficult in practice. However, as methodologies develop for determining soil erosion levels it is likely to become easier to establish a direct link between management practices and erosion mitigation outcomes. In the meantime it is suggested that landowners should be rewarded for adopting management practices that are known to reduce erosion levels such as those listed above.

6.38 The establishment of cover crops or inter-crops could be directly measured and it is possible that these could be directly linked to payment levels. Payments could be made based on established knowledge of the efficiency of such crops in terms of erosion control and/or nutrient delivery. However, the efficiency of these crops would vary considerably depending on a number of factors that would vary at individual farm level.

- 6.39 Hedgerow planting is already frequently rewarded in AEP and is likely that any payment would be based on hedgerow position, length and management regime. For hedges planted as erosion control mechanisms position is crucial and any payment mechanism should not be based purely on hedgerow presence and management regime.
- 6.40 The conversion of arable to grassland and grassland to permanent pasture can also reduce soil erosion and improve soil quality. This should be encouraged and rewarded in areas that are at the highest risk of erosion.
- 6.41 Soil organisms are an integral part of the soil and influence ecosystem processes that contribute to the provision of a wide range of essential environmental services (Barrios, 2007). The cycling of nutrients is an essential environmental service, which takes place within the soil environments and is mediated by soil organisms; these also play an essential role in the modification of soil structure. However, it has been suggested that the key limitation to the full recognition of these soil based environmental services “has been the difficulty of showing these linkages under field conditions” (Barrios, 2007, p.281). Incentives to preserve greater soil biodiversity would be an interesting additional option with AEP and this area should be further investigated.

Waste regulation and purification

- 6.42 The ‘waste processing’ capacity of ecosystems and their ability to ‘purify’ air or water is often emphasised as an important regulating service. Soils under grassland, crops or other kinds of vegetation can, for example, play a role in the remediation of wastes because of the naturally occurring microbial populations that are found within them, which can metabolise, transform, and assimilate waste constituents. Ultimately elements can be reincorporated into natural biogeochemical cycles.
- 6.43 Currently, 3-4 million tonnes of biosolids (treated sewage sludge) (Water UK, 2006), around 90 million tonnes of farm manures (Williams et al., 2000) and 4 million tonnes of industrial ‘wastes’ (Gendebien et al., 2001) are applied (on a fresh weight basis) annually to agricultural land in the UK. The volume of biosolids, which are a by-product of the wastewater treatment process, has grown since 1991 with the progressive implementation of the EU Urban Wastewater Treatment Directive, the increased levels of treatment needed to meet EU regulatory and policy requirements, and the increased numbers of households and businesses connected to the sewerage network.

6.44 The application of organic materials to land is subject to a number of regulations, which, for example, ensure that the application rates of specific heavy metals and their concentrations in soils are not exceeded. The regulations also ensure that the disease risks to stock and humans are minimised and that applications match the requirements of crops. Indeed, the acceptance that the application of livestock effluent to land can have a valuable role as a fertiliser has meant that it falls outside classification as a waste, under the EU Waste Framework Directive.

Waste regulation and purification - delivery mechanisms via AEP

6.45 AEP have not traditionally been used to deliver waste regulation and purification services, although farmers are required to adhere to the regulations for sewage sludge set out in the SMR in order to receive their SFP. Biosolids provide useful quantities of nitrogen and phosphate, but only modest amounts of potash and magnesium because these elements are quite soluble and are washed out in the treated water. Like other types of organic manures, biosolids also help to replenish soil organic matter. The use of waste products as a source of fertiliser could be encouraged in AEP for suitable cropping systems via a series of incentive mechanisms.

6.46 Land with a limited productive capacity could be used purely to provide a waste assimilation service if there was sufficient societal demand for this service.

Waste regulation and purification - payment for environmental services

6.47 Disposal of biosolids and similar organic materials through assimilation by soils is potentially the most cost-effective economic and environmental option, compared to the disposal by landfill or incineration. For that reason the inclusion of options within AEP that reward this resource should be given serious consideration. Preliminary estimates from the ADAS ALLOWANCE Project suggest that about 8-9 million ha of agricultural land in England and Wales is potentially available for the spreading of organic manures, of which 2-3 million ha is already used for farm-generated manures and excreta deposited during livestock grazing (ADAS, 2007). In the case of biosolids, the available land-bank is more limited due to restrictions linked to cropping regimes, soil metal levels and pH. However, if we deduct the area already used for farm wastes, then preliminary estimates suggest that in the UK there is capacity of around 6 million

ha available for spreading other organic materials such as biosolids, composts and paper crumble. Options might include, payment per unit of biosolid or organic material utilised or for the percentage of fertiliser from biosolids or other organic material.

6.48 The exploitation of the assimilative capacity of agricultural land for the organic materials generated by Society is clearly a matter of public choice. However, it is clear that providing future strategies take account of the biophysical limits of ecosystem function and the risks associated with any new technologies, there are opportunities to develop new uses for the assimilative services that ecosystems can potentially provide.

Cultural services

Biodiversity

6.49 The placing of biodiversity with the service typology is complex. The MA does not categorise biodiversity as a service but considers it to be the biophysical structure or process from which ecosystem functions and subsequently environmental services originate. Whilst the LUPG, similarly, regard biodiversity as an important function underpinning much of the broader delivery of environmental services, they also recognise biodiversity as an important cultural service. Biodiversity is a fundamental driver for a number of environmental services and The Community Strategic Guidelines for Rural Development highlight the importance of using axis 2, of which AEP are an important component, to contribute to the 2010 Biodiversity Target. However, the target of halting biodiversity loss on farmland by 2010 is unlikely to be reached without changes to AEP (Whittingham, 2007).

6.50 Biodiversity is important for the delivery of a number of environmental services for agriculture, for example, pollination services and soil micro-organisms. Nevertheless, the protection of wildlife and habitats are also important cultural services in their own right. In addition, it is important to note that animal and plant species also have 'intrinsic value', totally unconnected to their role in service provision. The cultural service that biodiversity provides is in the value that people place on biodiversity simply 'being there'. In terms of AEP the creation of diverse habitat and increased species richness is often an explicit aim of many programmes. For example, the Welsh AEP Tir Gofal includes aims that increase the cover of typical heath-land species. This is achieved through altering farming practices, burning, mowing and scrub control. However, in the

context of AEP biodiversity is also significant through the contribution it makes to the provision of other services, such as pollination.

6.51 As participation in AEP is voluntary the distribution of land benefiting from the programme is often not optimal in terms of biodiversity enhancement. AEP are often applied to very small patches of land which are scattered and unconnected. This creates a mosaic of habitat of varying quality and limits the effectiveness of AEP for improving biodiversity. For example, an AEP may be designed to improve conditions for a particular target species, but management for this species may occur in areas where the target species is absent. As Whittingham (2007) suggests, AEP are clearly most likely to be effective when applied to areas in which target species already occur. For example, the Cirl Bunting (*Emberiza cirius*) in Southwest England increased by 83% under Countryside Stewardship, in an area which the birds were already present, but increased by only 2% in areas that they did not already inhabit. As a result it is suggested that AEP operated at regional scales, or at least with some regional targeting, may be more likely to yield benefits than those applied uniformly across a country.

6.52 Kleijn et al. (2006) evaluated the biodiversity effects of AEP in five European (Germany, Spain, Switzerland, Netherlands and the UK) countries and found that in all countries except for the Netherlands some measures of biodiversity were higher on fields in AEP compared with conventionally managed fields. They suggest that the high land use intensity in the Netherlands, even on fields under AEP, may create conditions that are only marginally suitable for wildlife. However, overall their results suggested that the management prescriptions in the five AEP primarily benefited common species and had limited usefulness for the conservation of endangered and uncommon species of farmland wildlife. Box 11 details two AEP from Switzerland, which have also recorded some beneficial effects on biodiversity as a result of AEP.

Box 11. Two examples from Swiss AEP

A number of studies have investigated whether AEP incentives help to maintain biodiversity. Two illustrative cases from Switzerland are detailed below and emphasize the importance of basing AEP on sound scientific evidence. In addition, Box 16 gives further information on a specific strand of the Swiss AEP, which has been designed to address spatial disconnectivity.

Knop et al., 2006

- Although Switzerland is not part of the EU AEP have evolved in a similar way and farmers have benefited from direct payments for ecological measures since 1992. In addition, since 1999 Swiss farmers can manage at least 7% of the farmland as ecological compensation areas (ECA) in order to receive a basic direct payment.
- ECA consist of a variety of habitats such as traditional orchards, hedges and field margin strips but the most important is extensively managed hay meadow (vegetation cut and removed once a year and fertiliser use prohibited) (Knop et al., 2006). The authors evaluated the effectiveness for ECA on preservation of biodiversity and found more plant, grasshopper, and wild bee species in ECA than conventional meadows; for spiders there was no significant difference. There were some site-specific differences in the effect on biodiversity. Therefore, the authors suggest that there could be a case for some regional aspects in national AEP as results may be confounded by factors such as site condition, species pool and previous management strategy.

Dietschi et al., 2007

- Dietschi et al. (2007) evaluated the effectiveness of agri-environment incentive payments in mountain areas. In Switzerland extensive (€300 ha⁻¹ year⁻¹) and less intensive (€200 ha⁻¹ year⁻¹) management practices are supported by incentive payments based on management agreements.

Box 11. (Continued from previous page)

- Low input meadows (0-30 kg N ha⁻¹ year⁻¹) contribute to 86% (extensive meadows, 50% and low-intensive meadows 36%) of the total agri-environment compensation area of Switzerland. This study showed that in mountain areas plant species richness is increased in low input meadows and there was a significant negative relationship between plant species richness and management intensity. As a result the authors concluded that AEP were providing incentives that successfully promoted management strategies that benefited biodiversity in mountain areas. However, Dietschi et al. (2007) questioned the two levels of incentive payments as some sites showed little differences in species richness regardless of whether they were extensively or low-intensively managed.

Biodiversity delivery mechanisms via AEP

6.53 Traditionally, farming provides an important habitat for wildlife in Europe and many species are specifically adapted to the environment created by established farming practices, for example, hay meadows, or semi-natural grasslands often found in marginal areas and on poorer land. In spite of this, a number of these practices are threatened by land intensification and/or land abandonment both of which have negative effects on habitat and species status. Land that is traditionally managed under an extensive low input regime can be classified as High Nature Value (HNV)⁸ farmland and is particularly important for the conservation of biodiversity. According to estimates by the EEA, roughly 15–25% of the European countryside qualifies as HNV farmland, with the largest areas being found in eastern and southern Europe (European Environment Agency, 2004).

6.54 It has been reported that species adapted to the diversity of structure or resources on HNV cannot survive under increasingly intensive agriculture (Chamberlain et al., 2000; Firbank, 2005). Thus HNV farmland has an important role to play in the delivery of both the biodiversity service and the services that biodiversity supports. Despite the recognition of the value of HNV farmland for service provision many areas are under

threat due to partial or complete abandonment as a result of low farm incomes and lack of successors; or conversely via intensification of management practices. The percentage of abandoned land in most Eastern European countries (where HNV land tends to be concentrated) is high, ranging between 10 and 50% (Henle et al., 2008). Box 12 details a partial decoupling option introduced in Spain to prevent land abandonment.

Box 12. Land abandonment, an example from a Spanish AEP

The decoupling of agricultural production from support payments under CAP reform aimed to reduce the intensification of agricultural production. However, although this move is largely positive it can also lead to farm abandonment, particularly in areas where farm profit margins are small or even non-existent. This can also have negative impacts on biodiversity and environmental services, which may have become adapted to certain traditional management practices.

Oñate et al. (2007) report that in Spain a 'partial decoupling' option has been adopted to prevent land abandonment; 25% of payments are coupled to production. In Spain, the conservation of the cereal-steppe bird community, classified as of European importance relies on traditional cultivation and low intensity cereal systems (Oñate et al., 2007). To protect this area the Cereal Steppes AEP was set up during the 1993-1999 rural development programme period and by 2000 (the final year for enrolling in the scheme) 2,614 farmers were involved (Paniagua, 2001).

The scheme was not included in the 2000-2006 national programme as it did not fit with the horizontal approach of the new programme, and as it included measures that were classified as providing a production incentive. The authors suggest that this will lead to a reduction in farm gross margin levels that may lead to increased likelihood of abandonment.

6.55 Biodiversity is typically protected in AEP via components of the programme targeted at the preservation of species diversity, habitat status and genetic diversity. These usually

⁸ The concept of HNV farmland emerged in the 1990s with the growing recognition that many of the habitats and species upon which we place high nature conservation value, and which are declining, have been created, and need to be maintained by, farmers and their farming practices (Baldock et al., 1993)

include payment for the retention of hedgerows or trees, suitable management of field margins (e.g. planting with a range of wildflower species that provide wildlife with food and shelter), removal of intrusive or non-native species, support for extensive farming practices and appropriate management strategies (e.g. designing mowing regimes so that the impact on bird species is reduced). Measures to encourage genetic diversity are usually promoted through actions targeted at supporting rare plant or animal species. However, to date these have been limited in scope and have not been widely taken up in many countries.

- 6.56 Climate change will have a significant effect on biodiversity although this effect will be more pronounced in some areas of Europe and on some species. Consequently it is suggested that AEP strategies should be targeted towards those species that are increasingly vulnerable due to climate change induced alterations in species range, particularly where this coincides with areas of low habitat connectivity. It is suggested that habitat connectivity is likely to be a major focus of future AEP.

Biodiversity - payment for environmental services

- 6.57 In some cases it may be possible to establish a direct link between management practices and the increase in species diversity. In such cases it may be comparatively straightforward to establish a direct payment mechanism, i.e. one that rewards the land manager not for the change in management practices but for the change in species number. This could be an appropriate mechanism for rewarding land managers who successfully target particular bird or plant species. In addition, those land managers who increase genetic diversity through the use of rare animal and plant species should also be directly rewarded.
- 6.58 It may be considered more difficult to directly reward land managers for improvements in habitat condition unless it can also be established that this is benefiting biodiversity at the farm level. As a result payment should be based largely on changes to management practices. However, it is suggested that as the condition of habitat is of paramount importance, this should also be included in the payment mechanism. It may be possible to design a two-tier payment scheme, with the first tier simply rewarding for management that creates the targeted habitat and the second tier providing additional payments once a certain 'habitat condition' is obtained.

6.59 Despite the link between service provision and HNV farmland there is no apparent association between the overall agri-environment expenditure per hectare and the share of HNV farmland; for example, countries with large areas of HNV farmland, such as Spain, have small budgets per hectare for AEP (European Environment Agency, 2004). Moreover, as AEP payments are based on income foregone these are often low in marginal agricultural areas, typical of HNV farmland. This means that there is little incentive for participation in AEP, suggesting that the targeting of AEP at a European level seems far from optimal from a biodiversity conservation perspective. As a result, there may be a need for a new support system to ensure the continued delivery of environmental services from HNV farmland.

6.60 Support for HNV farmland should be targeted towards those farmers practicing traditional land management to ensure that biodiversity is retained in these areas. This means that AEP should include options that are specifically targeted at producers in HNV areas. However, as indicated previously, it would be insufficient to base these payments on income foregone and another method on which to base payments should be sought. The difficulties of linking AEP payments to outcome rather than management practice have already been discussed and need to be borne in mind when designing an appropriate incentive package for HNV farmland.

A note on Less Favoured Areas

6.61 Although outside the scope of this report Less Favoured Area (LFA) support can have important implications for service provision due to spatial overlap between HNV farmland and areas eligible for LFA support. However, LFA support is intended to compensate farm incomes in disadvantaged areas, through the payment of an annual compensatory allowance (for permanent natural handicaps) and is not linked to any requirements for environmentally beneficial management strategies. Farmers who have overcome their 'natural handicap' through environmentally harmful practices such as irrigation expansion are still entitled to the same payment as farmers who undertake management more favourable to environmental service provision.

6.62 In most cases, LFA payments have contributed to a baseline of protection, and not to environmental enhancement. Given that LFA often supports farmers in areas that inherently deliver a number of environmental services the LFA scheme has great potential to support the services these systems deliver. Nevertheless, significant changes would be required, both in terms of the designation criteria and conditions

attached to payments, which, together, could allow the reorientation of the scheme to the delivery of specific public benefits.

- 6.63 It is suggested that LFA should be more precisely targeted on farms where the threat of land abandonment is greatest, and on low intensity systems that deliver a number of environmental services, with irrigated land generally excluded. Strong cross compliance standards would contribute towards these aims and could perhaps be more specifically targeted at certain LFA areas.

Landscape preservation

- 6.64 There are many aspects of AEP that currently protect and enhance landscape features, although these are often by-products of actions aimed at the provision of other service types. For example, hedgerow planting has benefits for biodiversity and erosion control but also has many positive cultural associations in terms of landscape preservation. Measures that protect characteristic landscapes often have positive implications for biodiversity. This reflects the fact that much farmland biodiversity is dependent on factors that are essential to the traditions of farming in a particular area.

- 6.65 There is limited data on the status of landscape but it is likely that, for example, simplified crop rotations, increased mono-cropping, land abandonment, destruction of hedgerows and stone walls, ploughing of permanent pastures and increased urbanisation will have posed threats to landscape diversity.

Landscape preservation - delivery mechanism via AEP

- 6.66 The preservation of the overall landscape is not often a stated aim of AEP but more often a side effect of other measures designed to protect other environmental services. However, features such as hedgerows, dry-stone walls and so on are often explicitly protected in AEP. In line with current practices it is not suggested here that landscape services should become a focal point of AEP, rather that the impact on these should be minimised. It is likely that other policies will have a greater impact on this service, for example, LFA through minimisation of land abandonment.

Landscape preservation - payment for environmental services?

- 6.67 We suggest that payment for landscape services should continue to be on the basis of appropriate management strategies and the retention of traditional features. However, the range of features that can be protected could be expanded if necessary. In Austria, there is a well-established regional programme for rewarding farmers for landscape services, detailed below.
- 6.68 Farmers in some Austrian tourist communities receive voluntary local compensation payments for providing agricultural landscape services. The decision as to whether farmers receive a payment is based on a political bargaining process at municipal council level. Hackl et al. (2007) studied 266 communities in Austria and found that 15% reported voluntary payments for landscape enhancing agricultural activities in 1993, rising to 49% in 2000. However, the compensation received had decreased from approximately €56 per hectare in 1993 to €34 in 2000.
- 6.69 The programmes are open to all farmers who can opt into the programme or choose to stay out. Typical programme measures are €50 per hectare for cultivating an area, €100 per livestock unit kept on mountain pastures during summer, €79 mowing steep Alpine meadows and €40 per stallion – all amounts are annual payments. The study determined that the probability of agreeing a local payment scheme depends significantly on the benefits of agricultural amenities. In addition, when landscape diversity is perceived to be lower communities recognise the need to improve the landscape in order to increase tourist numbers. Hackl et al. (2007) also suggest that the Austrian AEP, OEPUL does not offer sufficient incentives for farmers to provide the recreational and conservation services desired by local communities. As a result there is a need for local compensatory schemes, which can deal with regionally specific issues and act as a complement to national AEP.

Box 13. Summary: Delivery of environmental services via AEP

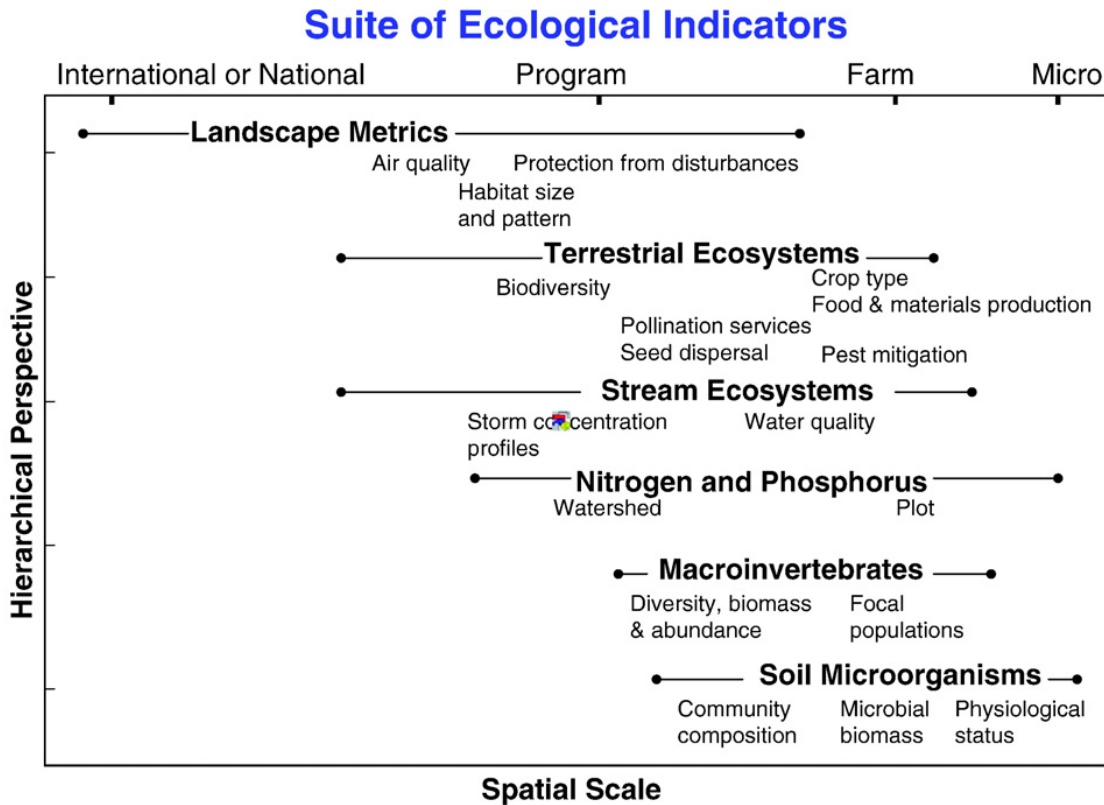
AEP have the potential to deliver a range of environmental services, given appropriate targeting. The most important considerations for scheme design follow:

- Biodiversity is both a cultural service and an important factor in the delivery of other environmental services; AEP should aim to protect and/or enhance biodiversity;
- HNV farmland has particularly high biodiversity and a high service output but is often located in areas under threat of abandonment; AEP should include specific mechanisms to target these areas so that service provision is maintained;
- AEP payments based on income foregone will not be sufficient in marginal areas and an alternative payment methodology should be further investigated;
- The establishment of direct payment mechanisms for AEP is complicated by the fact that it is often difficult to clarify the cause and effect relationship;
- However, where a direct link between management and outcome can be established and economically measured, such as the retention of a target plant species then payment, should, at least in part, be subject to delivery conditions;
- Proxy measures that can act as an indicator of the delivery of a specific environmental service would be useful tools to determine levels of service delivery when the service itself is difficult to measure;
- Co-operative action is needed to deliver some services at optimum level, these include pollination and hydrologic services, as a result there is need to consider how collective action can be best rewarded;
- Environmental services that can be delivered at the individual farm level will be simpler to achieve and reward, at least in the short-term;
- AEP are often delivered over a relatively short time scale and it is suggested that this should, in many cases, be increased for optimum service delivery; and
- It is proposed that cultural services should remain as an implicit part of AEP that are achieved in conjunction with management strategies that provide other environmental services.

Monitoring of AEP outcome

6.70 Currently, it is difficult to measure the flow of environmental services to and from agriculture due, in part, to limited monitoring. Moreover, it would be useful to have the capacity to measure the flow of services from agricultural systems at several scales of resolution. Indicators could then be selected from the appropriate scale to represent composition, structure, or function of ecological systems. Dale and Polasky (2007) suggest that “developing a suite of indicators that are both measurable and tied to the provision of ecosystem services is one way to make progress on tracking changes in ecological systems and how this might affect the flow of ecosystem services” (Dale and Polasky, 2007, p.287). They propose that a set of ecological indicators for services both to and from agriculture should be considered as they relate to all relevant spatial scales (Figure 3). Information at this spatial resolution would facilitate understanding of how service provision has been affected by alterations in the agricultural sector at various resolutions and could be an effective monitoring strategy for AEP.

Figure 3. Spatial scale of metrics that relate to environmental services from agriculture (from Dale and Polasky, 2007).



- 6.71 In general the monitoring of AEP has been insufficient and their impact has simply been inferred; most Member States have suggested what their AEP can achieve but have not verified these claims via monitoring. Figures for the uptake of AEP are relatively widely available but there is no clear link between this and environmental output in all cases (European Commission Directorate General for Agriculture and Rural Development, 2005).
- 6.72 Kleijn and Sutherland (2003) reported a lack of robust experiments to determine the effects of AEP on biodiversity coupled with a bias towards studies in intensively farmed landscapes. As a result they suggest that there is need for additional monitoring and that studies should include the collection of baseline data, should incorporate control sites that are similar to scheme sites in every respect but the change in management and finally that both control and scheme sites should be sufficiently replicated (Kleijn and Sutherland, 2003).
- 6.73 Box 14 gives a simple example of a potential indicator that could be used to measure a specific service; however, it is important that indicators are measured at the most appropriate spatial and temporal scale. Generally broad scale indicators can be useful to determine the overall effects on the system whereas more site-specific indicators can increase understanding of how management practices affect environmental services. As Dale and Polasky (2007) suggest, measurements are often needed at more than one scale but that the challenge then is to use these metrics together.

Box 14: An example, monitoring environmental services from soil

Soil is a fundamental agricultural resource that provides a number of valuable environmental services, which are affected both directly and indirectly by agricultural management practices; for example, an important and potentially growing service is that of carbon sequestration. As Heal and Small (2002) suggest to reward farmers for carbon sequestration requires the development of standardised measurement and verification protocols. If farmers are to have adequate incentives to make costly investments to improve the productivity of their natural capital as a provider of carbon sequestration they must be able to rely on accepted techniques to allow them to estimate their returns with a high degree of accuracy. However, as soil is inherently variable over both space and time it is difficult to accurately characterise soil-based services such as carbon sequestration. As a result, suitable proxy measurements are needed.

Perennial crops or forestry can increase the amount of carbon stored but it can be difficult to measure as soils are so variable. In this case measurements of above ground biomass could give a good indication of below ground carbon sequestration potential and could be used as a suitable proxy measure.

Conclusions

6.74 The requirement for adequate monitoring should be incorporated into any AEP that is designed to deliver environmental services. For most services it will not be possible to directly measure the quantity of service produced but instead it is likely that proxy measures will have to be determined. Further research will be needed to determine the precise indicators that should be used and to fully determine the relationship between the indicator and the environmental service.

6.75 To be effective in monitoring the success of AEP indicators should be closely linked to and predictive of changes in environmental services and must be at an appropriate resolution. Indicators may be selected at the appropriate scale to represent composition, structure or function of ecological systems; often structure and composition are easier to measure than function but can be used to reveal valuable information about the latter. We suggest that the challenge is to develop indicators that can be measured and monitored but that are also able to deal with the complexity of

the agro-ecosystem. Dale and Polasky (2007) propose the following criteria for ecological indicators of environmental services related to agriculture:

- Easily measured;
- Sensitive to changes in the systems;
- Respond to change in a predictable manner;
- Be anticipatory;
- Predict change that can be averted by management actions;
- Are integrative; the full suite of indicators should provide a measure of the coverage of key gradients across the ecological systems; and
- Have known variability in response.

The criteria outlined above would seem appropriate for the monitoring of the outcomes from AEP and further investigation of their applicability is suggested. Recommendations for the monitoring of AEP are summarised in the final chapter of this report.

Chapter 7: AEP - Spatial and temporal scale

Introduction

- 7.1 This chapter considers the temporal and spatial scale of AEP and details why these are important factors to consider in programme design. In moving from a field-based approach to programmes with a landscape level focus co-operative action between land managers will typically be required. Details of some of the mechanisms that might be used to promote and reward this type of approach are described.
- 7.2 Both the temporal and spatial scale of AEP is important. Typically, AEP involve relatively short-term agreements, often of about five-years and often at the field or farm scale. The length of agreement is governed by the Rural Development Regulations and has been reduced to five-years, previously agreements could run for up to ten-years. For example, in the UK the practice has been to have 10-year agreements with a five-year break clause. As each Rural Development programme only last seven-years it is difficult for Member States to commit funding for a longer period. This small scale, short-term targeting approach, however, may not achieve optimum outcomes in terms of the delivery of environmental services.

Spatial scale

- 7.3 Current AEP incentives to reward the provision of environmental services often use a field level or individual farm approach, and largely ignore landscape level interactions. However, landscape scale co-ordination is also important, as the spatial unit of management does not often correspond with the spatial unit of the service to be generated. Hence the challenge is to create AEP that span property boundaries. Towards that aim it is suggested that the supply and demand for environmental services could be analysed spatially across the landscape to determine the location of both providers and service consumers. Joint submission options could be introduced into AEP to address, for example, the issue of habitat fragmentation and species isolation. Examples from AEP in The Netherlands and Switzerland that are addressing the issues of fragmentation through a co-operative approach are detailed in Boxes 15 and 16.
- 7.4 Space plays an important role in that the ecological value of a habitat depends on its location; in particular, to what extent other habitats exist in its vicinity (Drechsler and

Watzold, 2007). Many key organisms that provide services and dis-services to agriculture do not inhabit the area under direct agricultural management but live in the surrounding landscape. The scale at which environmental services are delivered determines the relevant management units for influencing their flows from agriculture (Zhang et al., 2007).

- 7.5 Environmental services provided at the field or farm level mostly influence a single farm and so farmers have a direct private interest in managing, for example, soil fertility, soil erosion and pollination. Conversely those services provided at a wider scale cannot be managed at individual level and so are subject to typical externality and common resource problems. Thus for effective delivery of environmental services, AEP must be directed at the appropriate scale of intervention. Therefore, if services respond to fine-scale factors then single farm management could be rewarded. Otherwise, if the service is delivered over a larger area then an effective AEP will have to ensure that the actions of different land managers are co-ordinated in order to obtain the best results.
- 7.6 The 'demand' for environmental services is also important when considering the spatial scales over which they should be delivered. As the service cascade (Figure 2) suggests decisions about what constitutes a service are not solely determined by the way in which ecological structures are linked-up, but also by what features of the system people determine are important. In order to take a demand side focus we need to design AEP that consider the spatial distribution of consumer demand.
- 7.7 It has been reported that simple landscapes (characterised by low diversity and 1-20% of non-crop habitat) show contrasting responses to AEP when compared with complex landscapes (characterised by high diversity and >20% non-crop habitat) (Tschamntke et al., 2005). Biodiversity enhancement is greatest in simple landscapes and local habitat is an important driver of that change. On the other hand, as biodiversity is already high in complex landscapes, local management may not increase biodiversity and landscape level management will be more influential.

Temporal scale

- 7.8 As highlighted above, AEP are typically short-term in duration. As participation in AEP is voluntary this means that the continuation of good management practices or in the

supply of environmental services is largely dependent on farmer motivation to continue with the scheme. This can be addressed in a number of ways:

- Ensure that it is attractive to sign-up for an additional period under the AEP; perhaps this could involve reward mechanisms such as increased payments for those that re-apply for AEP or a one-off bonus payment to encourage continuation within the AEP programme;
- Ensure that the good management practice established under the AEP is more profitable than previous practices, so that this practice is likely to continue even in the absence of support; and
- Increase the length of time over which it is possible to register for participation in an AEP, although this is, to an extent, governed by Rural Development Regulation.

7.8 The long-term provision of environmental services can be difficult to deliver via AEP, which are typically short to medium term in duration. Currently AEP only commit farmers for up to five years and on intensively used farmland the re-instatement of more extensive management may take longer than this. This means that once payments have been ceased it is likely that production of the desired environmental service will also cease.

7.9 The Vittel case study detailed on page 48 is a good example of a scheme which delivered benefits via a long-term approach, offering contracts of between 18 and 30 years. In contrast, a number of studies such as those detailed earlier (pages 36-37) by Sierra and Rushman (2006) and Pagiola et al. (2007) report the problems caused by short-term payment strategies. The challenge is ensuring that the benefits obtained via short-term schemes are retained; the authors report both reversion to previous land use and return to more environmentally damaging land practices.

7.10 A number of strategies for co-operative delivery of environmental services, i.e. delivery at the landscape scale, are outlined below, as proposed by Goldman et al. (2007) and others. Following on from this a couple of case studies of co-operative AEP are described.

Co-operative reward

- 7.11 It has been suggested that local and regional services require cross-boundary landscape level management (Goldman et al., 2007). Co-operative action may well have a number of benefits for the delivery of environmental services and are worthy of consideration as part of any AEP. However, co-operative conservation can lead to problems, both from those who capitalise from the benefits of others and from those who refuse to participate; participation may have societal benefits that are greater than those at an individual level. This can lead to problems if the reward depends on joint participation as the level of reward (or eligibility for a reward) may depend on another land manager's behaviour. In addition, land managers may not all be able to provide the same level of environmental services despite the adoption of similar management practices. Inherent differences in service provision may exist; which can lead to problems with the structure of reward payments.
- 7.12 As with all reward mechanisms within AEP incentives must be large enough so that the difference between the incentive and the private cost allows the land manager to save more money than if had pursued an alternative strategy. Co-operative action also assumes an awareness of the area needed to provide the environmental service under consideration. However, this level of knowledge may well not exist, which will make it difficult to accurately target the AEP. In addition, to focus simply on agricultural land use may be ineffective; an incentive programme could need to include multiple land uses to be effective.

Co-operation bonus

- 7.13 Parkhurst, Shogren and others propose an agglomeration bonus mechanism that would pay an extra bonus for land, which a landowner retires, that borders on any other retired land area. They suggest that this mechanism would provide incentive for non-co-operative landowners to voluntarily create a contiguous reserve across their common border (Parkhurst et al., 2002). Goldman et al. (2007) suggest that a co-operation bonus does not require co-operative, cross boundary conservation to receive a reward but that the AEP should encourage this via the payment structure. They suggest that the agglomeration bonus mechanism could be used to build on opportunities offered by, for example, the US Conservation Reserve Programme. In that programme, for each area of land enrolled in the Conservation Reserve Programme the landowner must take this out of production and grow a resource

conserving cover crop in place of a commercial crop. Once the land is removed from production the landowner is paid a rental rate approximately equal to the opportunity cost of removing the land from production. The authors suggest that this scheme could be expanded so that for each area taken out of production adjacent to an area already in the scheme the landowner receives a bonus, payment for both the original and new area taken out of production. As Shogren et al. (2003) demonstrate, it is then in the landowners interest to retire land adjacent to their neighbours, although they do have to rely on their neighbour also retiring land in order to obtain any bonus payment This process would serve to encourage connectivity, as the best financial option is to remove from production land adjacent to that of another landowner. However, if one individual who chooses simply to retire border areas owns large areas of land, then a large amount of unconnected land may still result. In addition, Goldman et al. (2007, p.339) also highlight the administrative complexity that would be associated with such a scheme if it “were able to take into account all behaviours that we would want to encourage with the incentive and to establish suitable reward schemes”. This or similar mechanisms could be rewarded by European AEP if an appropriate reward structure could be put in place. Further research and investigation into this mechanism is suggested, to determine both its effectiveness and the level of interest in such schemes that may exist.

Entrepreneur

7.14 This incentive would reward creativity by offering landowners the chance to create their own landscape designs that promote environmental services at any scale. Goldman et al. (2007) suggest that the reward would be based on the number of services, their ranking and scientific value and the feasibility and cost of the project. The reward scheme would “pay for a total package that a cooperative of landowners would present” (Goldman et al., 2007, p.339). However, this method of reward would be difficult to target on any particular service due to the open remit – the scheme administrators would simply have to choose from those schemes offered. In addition, determining the level of reward for participants in this kind of AEP would be complex, particularly as it is currently difficult to accurately measure environmental services. Nevertheless, with appropriate research targeting these issues could be addressed in the future.

Environmental service districts

7.15 The environmental service district is proposed as a combination of regulation and incentive as well as voluntary and non-voluntary approaches. It is suggested that if the majority of owners in an area vote to form an environmental service district it will have legal authority and will receive the incentive as method of financing conservation options. Goldman et al. (2007), suggest that although formation would be voluntary once the majority had agreed participation would no longer be voluntary. Districts would have specific environmental services target and landowners could participate in more than one environmental services district if boundaries spanned their land. The approach would be likely to facilitate cooperation and reduce individual direct and transactions costs. On the other hand it may result in high logistical and administrative costs that would make it a difficult concept to introduce into AEP in the immediate future.

Conclusions

7.16 As noted above most AEP operate at the field or farm level and often fail to consider the mis-match between supply and demand of a number of environmental services. Similarly, little consideration has been given to the distribution of non-farmed land in the design, implementation and monitoring of AEP (Donald and Evans, 2006). Greater awareness and further research might lead to the development of an integrated strategy whereby the design and implementation of AEP consider not only the benefits to agriculture but also those to off-farm wildlife.

7.17 Donald and Evans (2006) report one example, of this, The Ecological Main Structure (Ecologische Hoofdstructuur) initiative in the Netherlands, which has already started to link isolated wildlife habitats together by reducing the intensity of the agricultural matrix that connects them (Box 15). Another example is detailed from Switzerland in Box 16. Additionally, in Australia the Living Landscapes project also aims to integrate conservation into the farming landscape. Funded and managed by Greening Australia and Alcoa World Alumina Australia it has been piloted in two catchments in the central wheat belt of Western Australia. The objective of the project was to assist the two groups of land managers to formulate conservation plans that were compatible within the “realities of farming” (Dilworth et al., 2000, p.165). This has been achieved by identifying the habitat requirement of the most ‘sensitive’ species and was based on ‘learning by doing’. The idea was to equip the land managers with the skills to identify

and respond to conservation needs without reliance on technical experts and to integrate conservation management into farm management practices.

Box 15. The case of the Netherlands AEP, Dutch Programma Beheer

In 2002 the Dutch AEP, Dutch Programma Beheer (Management Programme) integrated most existing Dutch AEP into three programmes (Franks and McGloin, 2007):

- 1 Subsidy Nature (SN), designed for designated nature reserves;
- 2 Subsidy Agricultural Nature (SAN), agri-environment management in designated areas including 26 nature schemes, 15 landscape schemes and, for example, payment for meadow bird grassland management (€600/ha), wetland ponds for meadow birds (€717/ha) and herb rich grassland (€1000/ha); and,
- 3 Subsidy Organisational Support (ROS), direct payments to support search and administration costs of work with AEP.

The introduction of these schemes was facilitated by an institutional innovation; environmental co-operatives were established in the Netherlands in 1992 as local organisations of farmers and non-farmers who collaborate with each other and with a variety of agencies to integrate nature management into farming practice (Franks and McGloin, 2007). It is estimated that there are about 125 environmental co-operatives with 10,000 members of which about 2,500 members are non-farmers.

There is a minimum farm size for application (100 ha) for many options to encourage farmers to co-operate to develop connected areas, which will reduce habitat fragmentation. Payment to neighbouring farmers who jointly submit land into an output related option vary with the species and level of output chosen but are based on payment by results and is applied to living species (e.g. number of grass species or pairs of breeding meadow birds). Rare species and higher output levels attract greater payments and, in addition, certain conditions must be complied with (e.g. nest protection, disturbance of grassland). There is also a penalty for underachieving and failing to deliver some contracted output ($\leq 30\%$ of payments).

Box 15. (Continued from previous page)

The positives of this scheme are suggested to be that farmers are involved as partners and are encouraged to use their local knowledge to derive innovative solutions; and that output measure enables the cost-effectiveness of the scheme to be measured. On the other hand, there are a number of external influences (such as the weather), which can affect scheme outcome, but which cannot be controlled. There are also potential time lags between farmer actions and ecosystem outcomes. In addition, the monitoring of outcomes does not always work well; for example, the presence of nests does not always indicate chick survival. In addition, the equitable allocation of payments between co-operating farmers can be difficult, particularly when the outcome is not equitably distributed between farms.

Box 16. An example of a co-operative AEP from Switzerland

In 1994 the canton of Aargau, in Switzerland established an AES, which was designed to address the issues of spatial disconnectivity (Roth et al., 2008). The scheme was based on special contracts with farmers and required high standards for quality, quantity and distribution of ecological compensated areas (ECA), which were evaluated and improved before a farmer could get a contract and additional payments. New ECA were placed so as to link with existing ECA or other designated land, if the farmer implemented a minimum proportion (12%) of his farmland he received a bonus. The farmer and adviser collaborated to devise and environmentally and biodiversity friendly management plan.

On each farm the focus was establishing ECA in the areas that would contribute most to improved biodiversity, i.e. the focus was moved away from financial gain. A contract secured the farmer extra payments to compensate the farmer for strict ecological measures for at least six years. Payments were made for the entire area of a farm plus additional payments for each ECA, depending on its category.

The effect of this scheme was monitored for ten years (sampled at five-yearly intervals) and showed that after the first sample period, three of four species groups had significantly higher species richness in plots with ECA. However, at the end of the study period vascular plant and snail species richness increased but there was no significant effect on bird or butterfly species richness. Therefore, it is suggested that AEP can improve biodiversity but that the effect may be dependent on the group of organisms under consideration.

Box 17. Summary: Chapter 7

The key findings from Chapter 7 are as follows:

- The temporal and spatial scale of AEP is important for service delivery;
- AEP should aim to ensure that the spatial unit of management matches that at which the service is generated;
- Additional research is needed to determine the location of the service providers and the service beneficiaries;
- AEP should incorporate reward mechanisms that are able to reward co-operative action that promotes environmental service supply;
- AEP are typically short-term in approach; this needs to be addressed to ensure continued service supply. This could include, for example, extending the length of AEP programmes or ensuring that it is simple to continue with the programme; and
- If short-term AEP are to be retained then the challenge is to maintain environmentally beneficial management is continued beyond the duration of the scheme.

Chapter 8: Summary – delivery of environmental services via AEP

Introduction

8.1 This Chapter summarises the provision of environmental services by land managers, highlights the current trends in service provision and suggest objectives for service delivery via AEP. Table 4 presents an overview of service provision and delivery mechanisms via AEP and sets out, in brief, the kind of land management prescriptions required for each service considered within this report. A reference is also given to earlier areas of this report where individual services have been discussed in detail. The table additionally indicates the spatial focus of service provision, for example, landscape or farm-scale and suggests which services would benefit from collective delivery. Recommendations for the basis of AEP payment are also given, for instance, whether this should be based on payments by results or changes to land management practices.

The provision of environmental services by land managers

8.2 A wide range of environmental service can, to varying degrees, be impacted beneficially by the actions of land managers; these are detailed in Table 4 above (see also Chapter 6). For example, land management can improve the potential of land to store carbon or water, to regulate erosion or to provide habitat for pollinators. Rarely, however, are such services exclusively controlled by the nature of agricultural or forestry practices alone, so that in general we need to consider the marginal effects that agri-environmental measures can bring. Moreover, it is often the case that land management activities determine intermediate processes that combine with other factors to determine the overall quality or level of service output. Thus it might be difficult to attribute improvements in service output directly to the individual actions of farmers.

Table 4. Mechanisms for the delivery of environmental services via AEP

Service	Delivery via AEP	Spatial focus of AEP	Collective action	Measurable	Basis of AEP Payments
Pollination (Sections 6.3-6.8)	Through effects on habitat/resource quality and distribution	Landscape level	Preferable	Difficult, some proxy measure would be required	Targeted changes to management practices
Water regulation (Sections 6.9-6.19)	Through establishment of buffer zones and appropriate cropping and management Wash-land areas for flood water storage	Catchment level and individual farm level	Buffer zones would ideally be established at the catchment level		Targeted changes to management practices Direct payment for wash-land areas
Water purification (Sections 6.9-6.19)	Buffer zones and appropriate cropping and management Reduced stocking density	Catchment level and individual farm level	As above	Improved water quality can be determined but difficult to attribute to individual action	Targeted changes to management practices
Carbon sequestration (Sections 6.19-6.33) Peatland (As above1)	Through less intensive land use; forestry or grassland, minimise cultivation and incorporate crop residues, utilise field margins Re-vegetation and re-wetting, removal of drainage gullies, extensive management	Global but action at individual farm level	No	Changes in soil carbon can be measured. But must establish baseline. Proxy, measures carbon in vegetation	Targeted changes to management practices or Payment linked to measured levels of soil Carbon Reward structure must be long-term

Table 4 (continued): Mechanisms for the delivery of environmental services via AEP

Service	Delivery via AEP	Spatial focus of AEP	Collective action	Measurable	Basis of AEP Payments
Erosion regulation (Sections 6.34-6.41)	Appropriate management, incorporation of crop residues, cover and/or inter cropping, retain hedgerows	Farm level	Not needed	Difficult to accurately measure erosion and hard to establish baseline levels	Targeted changes to management practices
Waste regulation (Sections 6.42-6.48)	Utilise biosolids and other similar organic material as fertiliser on appropriate crops	Farm level	Not needed		Reward per unit of biosolid or organic material used as percentage of fertiliser input
Biodiversity (Sections 6.49-6.63)	Preservation of habitat status, species and genetic diversity	Landscape and farm level	Preferable	Species number and diversity Habitat quantity and quality.	Targeted changes to management practices and/or Direct link between species number and payment Increased reward for improved habitat quality
Landscape preservation (Sections 6.64-6.69)	Preservation of hedgerow, dry-stone walls, architectural features etc As a side-effect of other service delivery	Landscape	No	Arbitrary and subjective	Targeted changes to management practices

- 8.3 The majority of AEP payments are not currently tied directly to measured environmental services but are based on proxies such as the area under a particular management regime. Some exceptions exist in the wider literature (e.g. Zabel and Holm-Müller, 2008, where payments are based on measuring carnivore offspring, page 35). In addition, some AEP do include some measures of outcome that must be achieved in order to receive payments (for instance, in the Netherlands some AEP payments are based on the measured number of plant or bird species, page 79). In principle, it would seem intuitive that payments should be based on service delivery. However, in reality this can be problematic particularly for those services where benefits and service provision are difficult to observe at the farm-scale. For example, changes in management practices that result in improved downstream water quality will be difficult to reward on the basis of outcome and input should remain the basis for reward. On the other hand services where the link between management and service output can be identified more clearly, such as carbon sequestration or target species number will make better candidates for output based reward mechanisms.
- 8.4 In general terms the services most easily delivered by agri-environmental schemes are those that do not depend on collective action across a landscape. Thus the maintenance of individual landscape features, such as walls or hedges for their biodiversity, heritage or cultural value, archaeological remains or access routes may be easier to achieve than say the reduction of overall pollution load to lakes and rivers, because the latter is largely determined by recruiting all or most of the land managers within a catchment rather than particular holdings (Table 4).

State and trends in environmental services affected by agricultural practices

- 8.5 An awareness of the current status and trends in environmental service provision within Europe is essential for the successful design of any AEP that seeks to promote service delivery. Currently, however, there is limited specific information available with regard to service provision, although one recent example is the assessment by Haines-Young and Potschin (2008). Using a service-based perspective to make an analysis of each service on the basis of the individual habitats that potentially contribute to service supply Haines-Young and Potschin (2008) assessed England's major terrestrial services. They found that of the eight services examined there was evidence of declining or impaired service output for five of them and inappropriate land management was identified as a major driver of these changes. The services that were

of most concern were those related to the regulation of water quality and quantity, pollination, the provision of genetic resources and climate regulation. In addition, the authors noted that the output of some services, particularly those associated with agricultural systems gave rise to both benefits and liabilities. A greater awareness of service provision at the EU scale will ensure that schemes, can, if necessary, be targeted at specific areas where service delivery is under threat, or where the maintenance of services is particularly critical. It may not always be sufficient to design a single scheme at the Member State level; instead some regional targeting may result in a greater level of service provision.

- 8.6 The output of environmental services associated with agriculture and forestry are vulnerable to changes in the economic and social conditions as well as to environmental conditions. The situation is particularly well illustrated by the potential impact of changes in farm economy. In some areas where agriculture is profitable the integrity of environmental systems may be threatened by intensification of activities. In more marginal areas, service output may be impacted by the withdrawal of management following extensification and land abandonment. As a result environmental services may show very different trends across Europe.
- 8.7 In areas subject to more intensive forms of agriculture, the key pressures are on the output of a clean and adequate water supply (both to ground and surface water bodies), flood protection and the control of surface runoff, soil quality, biodiversity and ecological processes such as pollination, landscape and recreational potential. The problem of devising effective agri-environmental measures in such areas is that, especially at times when farm prices are buoyant, the attractiveness of voluntary schemes is limited.
- 8.8 In marginal areas quite different problems arise. Here, the quality of service output is often due to the continued application of traditional farming practices, which may no longer be profitable. Thus in upland areas across many areas in Europe, land abandonment may threaten landscape character and the biodiversity and habitats associated with low input agriculture. The decline of management input (often coupled with inappropriate afforestation policies – e.g. Portugal, planting of eucalyptus) may also increase the risk of catastrophic fires. Appropriate interventions may also be difficult to implement because traditional knowledge and skills have been lost. The problems of devising agri-environmental schemes in such areas is that the changes are often brought about by drivers that go beyond the agricultural economy, such as demographic change (migration and ageing of the farm population) and so have to be

viewed as part of much wider policies for the support of rural communities. To successfully address these issues much better integration is needed between those aspects of CAP (Rural Development, third axis) that address social issues and those, such as AEP, with an environmental focus.

- 8.9 In general the geography of environmental services is poorly understood. Despite this a number of resources exist that could be used to target AEP. At the European scale, for example, maps of HNV farmland, soil carbon and soil erosion levels are available. This information could be used to identify areas where service provision is likely to be under most pressure and in need of targeted action to increase service supply, or conversely areas where high level of environmental services are likely to be found, which would require appropriate conservation action. As a result, AEP could be more specifically directed towards those areas where service output is particularly under threat or particularly 'valuable'.

Objectives for environmental services provided under AEP

- 8.10 An overriding objective of any AEP that is based on voluntary uptake must be to attract sufficient participants to allow the aims of the programme to be achieved. Thus it follows that for AEP to succeed in the generation of environmental services they must be well designed and attractive to those who are providing the services. It is obvious, but fundamental, that to be successful an AEP must have sufficient participants to achieve its goal. Participation in AEP is, so far, optional, which is considered to promote a positive attitude to environmental protection and constructive co-operation. However, due to the voluntary nature of participation in AEP the distribution of those enrolled may not be optimum for service delivery.
- 8.11 A crucial issue in determining the objectives for environmental services under AEP is an understanding of the level of required service output. However, our current understanding of environmental service limits (minimum service output) is inadequate meaning that appropriate service targets are difficult to specify and/or justify. In the UK, the study by Linstead et al. (2008) has looked at the extent to which targets can be defined for a range of environmental indicators. The authors concluded that, the current set of indicators gave a good overview of the natural environment but that there were gaps in their ability to deliver environmental services. However, as projects such

as SENSOR⁹ have shown it is presently difficult to map spatial variations in thresholds or limits of services and so frame assessments to take account of differences between geographical areas.

- 8.12 The specification of objectives is made difficult because it also depends both on an understanding of the biophysical factors that control service output, but also on the distribution and number of potential service beneficiaries and the values which they attach to the service. The notion of value is also, of itself complex, and difficult to determine. It may cover the monetary value that a beneficiary attaches to the service, determined by their 'willingness to pay' or 'willingness to travel'. It may also depend on the levels of risk that they are willing to accept in relation to being able to maintain service output, the costs involved in different levels of protection or their willingness to pay to restore the functioning of an environmental system. Such issues may make the design of AEP complex, in that different views about their viability may arise depending on what sets and types of value is considered.
- 8.13 The specification of objectives is also difficult because the distribution of those receiving agri-environmental support may be quite different from the distribution of those benefiting from the service. Indeed – in designing such schemes we have to be clear who the beneficiary is – in the case of schemes that also have the purpose of supporting the rural community the beneficiary is both the land manager and the wider public. Other measures, particularly those associated with the regulation services in more intensive agricultural landscapes are more clearly to do with public benefits rather than those of the individual land owner or manager – who is merely treated as a 'supplier'.
- 8.14 There is little understanding of how CAP (and AEP) objectives will change over time – especially under conditions of rapid social, economic and climatic transformations that are currently in progress. As people's values and needs change over time objectives will have to be reconsidered and updated. This implies and justifies an adaptive approach to management and policy, possibly set within the overall framework of an 'ecosystem approach'.

⁹ Sustainability Impact Assessment: Tools for Environmental, Social and Economic Effects of Multifunctional Land Use in European Regions <http://www.sensor-ip.org/>

Potschin, M. & R. Haines-Young (2008): Sustainability Impact Assessments: Limits, Thresholds and the Sustainability Choice Space. In: Helming, K., Tabbush, P. and M. Perez-Soba (Eds): Sustainability Impact Assessment of Land Use Policies. Springer, 425-450.

Table 5. Summary of AEP recommendations

Recommendation for AEP	Target service(s)	Proposed further investigation
<p>AEP should, in most cases, continue to reward changes to management practices</p>	<p>Most services</p>	<p>Determine more fully the links between changes in management practice and service provision</p> <p>Land management strategies that result in the provision of multiple services should be further investigated so that, where possible, AEP can be targeted towards those strategies.</p> <p>Investigate how payment mechanisms can account for potential trade-offs and synergies in the production of multiple environmental services</p>
<p>However, where a direct link between land management and service output can be measured, payment by results will be preferable</p>	<p>Biodiversity, e.g. direct link between management practice and bird or plant species</p>	<p>Further determine both the cost and the value of environmental services that could be delivered via AEP so that equitable payment is possible.</p> <p>Investigate the potential to operate combined systems of payments by results and payments for changes in management practice</p>
<p>AEP payments are based on cost incurred and income foregone, i.e. they take into account variable costs. However, in marginal areas there is a case that fixed costs should also be included.</p>	<p>All services</p>	<p>An alternative payment methodology should be further investigated for marginal areas where current emphasis on 'income foregone' provides insufficient reward.</p>

Table 5 (continued): Summary of AEP recommendations

Recommendation for AEP	Target service(s)	Proposed further investigation
AEP should carefully consider the relationship between mandatory cross compliance and voluntary participation in AEP. The gap between standard farming practice and AEP will change as the baseline standards of cross compliance are lowered or increased.	All services, but particularly those targeted by cross-compliance	The extent to which cross compliance and AEP are complementary is a critical determinant of the benefits that can be delivered by farmers. This requires further careful research in order to maximise the future delivery of environmental services.
Better targeting of AEP, e.g. towards intensive farming or more defined regional targeting. Two-tier systems have an important role to play in targeting 'higher level' stewardship	All services	Currently it is difficult to accurately value environmental services and additional investigation is needed to more fully establish valuation techniques
Co-operative action and connectivity should be rewarded	Pollination, some hydrologic and biodiversity services	Consider how collective action can be best rewarded, in particular how connectivity can be achieved in the absence of co-operative action.
Continuation of farmer participation in AEP is fundamental to their success and should be rewarded via appropriate incentive payments	All services	If short-term AEP are to be retained then the most appropriate mechanism for farmer retention should be investigated; stakeholders should be consulted to ascertain preferred reward mechanism

Table 5 (continued): Summary of AEP recommendations

Recommendation for AEP	Target service(s)	Proposed further investigation
AEP should be based on sound scientific evidence of cause and effect and avoid perverse incentives	All services	Further research on the valuation of environmental services and research on service quantity/quality and service demand is required.
Stakeholders should be involved in AEP design	All services	AEP should be developed in consultation with farmers to ensure that they are acceptable to those who will participate in them.
AEP should not simply be based on what land managers can supply, but must also consider the demands of the population that will benefit from the resulting service	All services	<p>Given the likely budget limitations for AEP more research is needed into which services to target. It is suggested that this could be based on societal demand for services or on some established need for a particular service.</p> <p>Additional research is needed to determine the location of the service providers and the service beneficiaries</p> <p>Investigate service weighting (according to the level of demand or need for this service)</p>

Table 5 (continued): Summary of AEP recommendations

Recommendation for AEP	Target service(s)	Proposed further investigation
<p>AEP should explicitly address climate change issues</p>	<p>Those services particularly influenced by climate change, e.g. biodiversity or influential for mitigation, e.g. carbon sequestration</p>	<p>There is an extensive evidence base with regard to climate change and agricultural management practices.</p> <p>Research effort should be concentrated on practical mechanisms for carbon sequestration, for example, the potential of field margins to sequester or retain carbon should be further investigated.</p>
<p>Efficient and economic monitoring of scheme performance is essential</p>	<p>All services</p>	<p>Investigate proxy measures that can act as an indicator of the delivery of a specific environmental service. These would be useful tools to determine levels of service delivery when the service itself is difficult to measure.</p> <p>Additional research into appropriate levels of monitoring is required.</p>

Chapter 9: Recommendations for service delivery via AEP

Introduction

9.1 The final Chapter sets out a number of recommendations for service delivery. These are first summarised in Table 5 (see previous pages) and then discussed in further detail in subsequent sections of the report. The summary table also highlights the existing evidence gaps and suggests further work that might be taken forward to increase knowledge in these areas. Bold text has been used to highlight important recommendations in the text in the following sections.

The Green Box and AEP payments

9.2 In the absence of additional incentives farmers are likely to continue to support those environmental goods and services, which have a clear market value, typically provisioning services such as food and fibre. **Those services that can be produced in conjunction with these provisioning services will also benefit, however, those services without defined market mechanisms need to be promoted through well-designed, well-funded AEP.**

9.3 AEP currently reward land managers for income foregone or for costs incurred, as a result of environmentally beneficial agricultural management. AEP are calculated on the basis of costs incurred and income foregone, with the option of adding up to 20% for transaction costs. This formula is necessitated to comply with Green Box regulations (Box 1) but fails to recognise the value of the environmental benefits delivered.

9.4 The ability of Green Box payments to effectively deliver environmental benefits is limited by WTO rules that place restrictions on how environmental payments can be calculated. This means that at present there is typically no link between the provision of environmental services and the subsequent level of payment. In addition, as Green Box payments are based on income foregone this makes it easier to compensate farmers for reverting from damaging practices than for maintaining positive management. Payments based on previous income rather than on public benefits may result in a concentration of payments in intensively farmed areas where income foregone is highest. This means that a system based on income foregone has limited suitability for economically marginal systems.

- 9.5 **A crucial issue that has to be addressed in the design of agri-environmental schemes is the division between what can be expected via cross compliance and what might be ‘purchased’ by society via targeted payments.** The general principle is that AEP provides payments for farmers in return for a service, while it is assumed that carrying out agri-environmental commitments go beyond the application of good farming practice. This is important as to respect the principle of ‘the polluter pays’ requires enhancement of the environment beyond that which is simply mandatory. AEP payments are normally based on cost incurred and income foregone, i.e. they normally take into account variable costs. **However, in areas under threat of abandonment there may be a case that fixed costs should also be included in AEP payment mechanisms. Future research should address the issue of AEP reward in marginal areas.** In addition, payment is often based on regional or national averages, which results in a simple administrative structure but is not always the most equitable system of reward/compensation (European Commission Directorate General for Agriculture and Rural Development, 2005).
- 9.6 Cross compliance presently assumes that farmers will act to become eligible to receive other agricultural payments. As payments move away from production to the delivery of other environmental services and rural support, the financial pressures to comply may lessen, especially if agriculture is profitable. **Thus those concerned with the design of future agri-environmental measures may have to rethink cross compliance and possibly treat it more as a ‘licence to farm’ rather than to receive support.** The imposition of minimum environmental standards by society may be one way of securing the long-term benefits arising from broad-scale changes in land management practices. The acceptability of such schemes may need to be encouraged by the provision of transitional payments and incentives as well and the design and monitoring of new regulations.
- 9.7 **It is suggested that if Green Box subsidies could include a requirement to deliver environmental and social benefit that are not delivered via market mechanisms then they may be more likely to deliver environmental services. To achieve this range of benefits, future AEP payments could be based on a combination of income foregone and the value of social and environmental benefits.**
- 9.8 Despite the limitation of Green Box payments it is suggested that good scheme design can help to ensure that AEP deliver within the scope of the current restrictions. In order to be effective AEP should always have a specific measurable outcome that should be measured through the use of appropriate indicators. **AEP should target those areas**

(for example, particular habitats or regions) where they will produce maximal benefit and delivery of environmental services, rather than aim to distribute support equally between all farmers.

AEP targeting

9.9 AEP are often not optimally distributed across the country and uptake is frequently higher in extensive areas than in intensive areas. This may be because extensive farmers often have to undertake little modification to existing practices to participate in scheme so there is little cost associated with this decision. **For more effective delivery of environmental services there is clearly a need to better target AEP towards intensive farmers.** This could be based on reward for efficiency, i.e. the ratio of inputs (e.g. fertiliser or pesticides) to outputs (e.g. in terms of crop yield or environmental services). **Overall it is suggested that AEP operated at regional scales, or at least with some regional targeting, may be more likely to yield benefits than those applied uniformly across a country.**

9.10 **Taking a two-tier approach to AEP design may result in more effective targeting for service provision.** This is because many single tier schemes take a 'broad brush/light green' approach, which makes relatively low demands coupled with similarly low payment levels. Although such scheme can encourage sustainable management practices, create habitat and reward practices such as buffer strips alongside water bodies there is little targeting of, for example, key species or habitats. As a result, **it is suggested that a two-tier approach should be adopted across the EU to encourage higher-level stewardship in targeted areas.** Such schemes would take a 'dark green' approach, making higher demands on land managers in return for higher payments. For example, in the case of habitat creation the first tier scheme would reward habitat creation, whereas the higher tier scheme would provide additional payments once a certain 'habitat condition' was obtained.

Basis for AEP payment

9.11 **In some cases it may be possible to establish a direct link between management practices and an increase in service provision.** In such cases it may be comparatively straightforward to establish a direct payment mechanism, i.e. one that rewards the land manager not for the change in management practices but for the

change in, for example, species number. **This could be an appropriate mechanism for rewarding land managers who successfully target particular bird or plant species. In addition, those land managers who maintain or increase genetic diversity through the use of rare breeds of animal or plant should also be directly rewarded.**

9.12 It is suggested that AEP that pay by results, i.e. on the basis of environmental outputs delivered rather than changes to management practices may have the following advantages:

- The creation of strong incentives to produce high quality environmental service, which could be coupled with the creation of incentives for co-operation where this could enhance efficiency
- A reduction in the need for compliance monitoring, although this could be counteracted by an increase in the level of overall monitoring required to verify improved outcomes.

9.13 Conversely, there are a number of problems associated with payment by results that would require careful consideration prior to scheme implementation.

- There is often a delay between the adoption of changes in land management practices and changes in outputs; farmers would require some initial financial incentive to undertake such changes, prior to increased outputs
- The relationship between input and output is not straightforward and often influenced by factors outside the direct control of a land manager such as climate and inherent soil type
- It is difficult to determine, measure and quantify the environmental services that would receive payments.
- At present there is little knowledge or consensus about the level of environmental service that should be delivered. This makes it difficult to determine an acceptable level of output of environmental services.

9.14 The issue of rewarding land managers for service provision is further complicated by the fact that it can be argued that schemes should also reward those managers who have successfully retained high levels of service provision through careful management. For example, if, as suggested, the levels of soil C can reach an equilibrium level (West and Post, 2002) then these land managers may be unable to sequester additional soil carbon if soil has reached or is approaching equilibrium. In

these situations, despite 'best' management practices a land manager could be unable to sequester any additional carbon. Consequently, **AEP should ensure that both those who have already retained service provision through 'good management practices', and those that are increasing their service level are rewarded.** Initial payments should be higher for those who have, for example, maintained their carbon resource than for those who are in the process of restoring that resource. Over a number of years as resource quality is improved payment levels should reach parity; long-term payments would be based on maintenance of the resource in a 'good condition'.

Co-operation and connectivity

- 9.15 The provision of public goods from AEP is often enhanced by co-ordination of actions across a landscape scale. Case studies have illustrated how the co-ordination and reward mechanisms have been implemented in several European countries. **It is suggested that the potential of co-operative schemes to deliver environmental services should be further investigated.**
- 9.16 Current AEP incentives to reward the provision of environmental services often use a field level or individual farm approach but largely ignore landscape level interactions. However, landscape scale co-ordination is also important, as the spatial unit of management does not often correspond with the spatial unit of the service to be generated. **Thus it may not always be sufficient simply to have high levels of participation if the spatial distribution of those participants has important implications for service provision.** In general, "the most important issue concerning participation is whether the right potential providers are participating" (Wunder et al., 2008, p.843).
- 9.17 Environmental services provided at the field or farm level mostly influence a single farm and so farmers have a direct private interest in managing, for example, soil fertility, soil erosion and pollination. Conversely those services provided at a larger scale cannot be managed at individual level and so are subject to typical externality and common resource problems. **Thus for effective delivery of environmental services, AEP must be directed at the appropriate scale of intervention.** Therefore, if services respond to small-scale factors then single farm management could be rewarded. Otherwise, if the service is delivered over a larger area then an effective AEP will have

to ensure that the actions of different land managers are co-ordinated in order to obtain the best results.

- 9.18 As participation in AEP is voluntary and the basic unit is often the field this may result in a patchy and erratic spatial distribution of AEP land. This mosaic of habitat of varying quality limits the effectiveness of AEP for the provision of, in particular, pollinator, hydrologic and biodiversity services. However, it is likely that efforts to implement the EU Water Framework Directive will be a key influence on how payments for environmental services might be taken forward in the area of water management. Co-operative action is likely to be required to significantly increase the supply of these services, without co-ordinated effort it can be argued that efforts to improve these services will be unsuccessful. **It is suggested that any payment for pollination services and many hydrologic and biodiversity services should be based on co-operative action.**
- 9.19 **Hence the challenge is to create AEP that span property boundaries.** Towards that aim it is suggested that the supply and demand for environmental services should be analysed spatially across the landscape to determine the location of both providers and service consumers. **Joint submission options could be introduced into AEP to address, for example, the issue of habitat fragmentation and species isolation.**
- 9.20 **Co-operative payments need further investigation to determine the best method to reward farmers that agree to, for example, buffer land adjacent to waterways in agreement with other landowners.** These agreements would reward for changes to land management rather than reward changes in outcome, as it would be difficult to determine precise relationships between cause and effect cases where co-operative action is rewarded. However, co-operative action has a number of associated problems that have been discussed in more detail on pages 76-78. For those reasons **mechanisms, which reward connectivity but do not rely directly on co-operative submission should also be investigated.**

Continuation of AEP agreements

- 9.21 **Long-term provision of environmental services can be difficult to deliver via AEP, which are typically short to medium term in duration.** Currently AEP typically only commit farmers for five years and on intensively used farmland the re-instatement of more extensive management may take longer than this. Evidence from PES

programmes suggests that the permanence of benefits once payments end is limited, meaning that once payments have been ceased it is likely that production of the desired environmental service will also cease.

9.22 Given that participation in AEP is voluntary the success of AEP depends to a large extent on the continued motivation of farmers to participate. This has important implications for the design of AEP as it has been reported that people are more likely to abide by regulation when they believe it is appropriate, fair, equitable, effective, proportionate, relevant and necessary (Winter and May, 2001). **It is suggested that farmers may be motivated to continue to participate in AEP in a number of ways:**

- Ensure that it is attractive to sign-up for an additional period under the AEP; perhaps this could involve reward mechanisms such as increased payments for those that re-apply for AEP or a one-off bonus payment to encourage continuation within the AEP programme;
- Ensure that the good management practice established under the AEP is more profitable than previous practices, so that this practice is likely to continue even in the absence of support; and
- Increase the length of time over which it is possible to register for participation in an AEP, although this is, to an extent, governed by Rural Development Regulation.

General recommendations for AEP

9.23 The participation of land managers in scheme design is recommended to ensure that service delivery mechanisms are acceptable to those who will implement them. The Vittel PES scheme (page 48) is a good example of where consultation with farmers led to an effective scheme design.

9.24 AEP must ensure that they do not create perverse incentives, the classic example being that offering payments for reforestation could result in deforestation prior to application for reforestation payments. It has been suggested that if payments are only offered only when severe threats of degradation exist then this may offer an incentive to land managers to create such a situation. However, careful design of AEP can ensure that conditions are created that avoids such perverse incentives.

- 9.25 **A well-designed AEP should also avoid ‘leakage’, where environmentally damaging activities are displaced rather than reduced.** This can be a problem both at the field and larger spatial scales, which can be both direct (substitution of one area of land for another) and indirect, (more land for forestry resulting in less land for crops and therefore higher food prices). Wunder et al (2008) suggest that leakage is only relevant when the spatial scope of intervention is lower than that of the desired service. Therefore, leakage will always be of most concern for global services such as carbon sequestration, which can only be counteracted by programmes that cover large spatial areas.
- 9.26 AEP design is usually the outcome of a process of balancing of a range of ecological, socio economic and political interests. As a result, the outcome is often not optimal either from a conservation point of view (Kleijn et al., 2006), or from the perspective of delivering an appropriate level of service output for society. **Thus in the development of future schemes, more appropriate balancing of rewards and benefits between land managers and the wider public might be needed. This will require that the design of schemes take account of minimum service levels (service limits/thresholds) as well as the economic costs of undertaking particular land management practices by individual farm managers.** In a competitive market, the provision of a service may need to be considered alongside the potential that land has to provide other income streams. More effective holistic valuations may be needed before appropriate reward structures can be designed.
- 9.27 **AEP should not simply be based on what land managers can supply, but must also consider the demands of the population that will benefit from the resulting service.** As the service cascade (Figure 2) suggests decisions about what constitutes a service are not solely determined by the way in which ecological structures are linked-up, but also by what features of the system people determine are important. In order to take a demand side focus we need to design AEP that consider the spatial distribution of consumer demand. **Towards that aim it is suggested that the supply and demand for environmental services should be analysed spatially across the landscape to determine the location of both providers and service consumers.**
- 9.28 **AEP should be based on sound scientific evidence of the link between management practice and service output;** without this knowledge service output can only be implied. **It is vital that AEP result in a change to land management that would not have occurred without the programme.** This is known as additionality and can be difficult to measure requiring the comparison with the observed behaviour

under the AEP with that which would have occurred in the absence of the AEP. Some studies of PES programmes in forest ecosystems in Costa Rica have assessed additionality with a range of results ranging from no impact on deforestation (Sanchez-Azofeifa et al., 2007) through to 10% increase in forest cover (Tattenbach et al., 2006. In: Wunder et al., 2008). Any new AEP should address this issue from initial implementation.

- 9.29 To date the potential of AEP to tackle problems such as climate change has not generally been considered in the design and deployment of AEP. However, sustainable management practices can contribute to a reduction in greenhouse gas emissions and preservation of the carbon sink in soil and help to adapt to the impacts of climate change. Current research confirms that whilst crops would respond positively to elevated CO₂ in the absence of climate change, the associated impacts of high temperature, alteration in rainfall patterns and increased frequency of extreme events are likely to decrease yield and increase production risks (Kimball et al., 2002). Global change will alter the both the supply of and demand for environmental services that are vital for human well-being (Schroter et al., 2005). Therefore, **it is essential to link adaptation and mitigation policies with AEP as climate change may exacerbate some of the problems already targeted within CAP.** In addition, there are potential synergies between some of the management practices required to reduce greenhouse gases and good management strategies.

Compliance monitoring of AEP

- 9.30 **If AEP are to reward land managers for the provision of environmental services then changes in land management must actually deliver the desired services.** Additionality alone is insufficient. Many AEP assume that the desired services will follow from changes in management practices or land use but make little attempt to determine whether this outcome actually follows. Wunder et al. (2008, p.846) suggest that, "it is quite likely that, in at least some areas, PES programmes are promoting the wrong land uses for the environmental services they desire". For example, through increasing forest cover in areas with water deficit. It is likely that this may also be true of AEP, however, the lack of monitoring makes this difficult to determine. Schemes with multiple or broad-brush aims are particularly complex to monitor. In contrast those with very specific aims, in terms of service provision, such as the 'Vittel water example' have been able to demonstrate a clear increase in the generation of the desired environmental service.

- 9.31 In order to deliver environmental services participants in AEP must carry out those actions that they have been contracted to perform. This in turns necessitates that **compliance should be monitored and that non-compliance should result in some form of negative consequence**. This is a significant weakness of many current AEP, which fail to monitor adequately either compliance with management recommendations and/or the outcomes of compliance.
- 9.32 Wunder et al. (2008) report that some AEP have very low annual inspection rates of about 5%; payments to most participants are therefore, in effect, not subject to compliance. The most usual penalty for non-compliance is the loss of future payments although given the typically low monitoring rates this may not provide much motivation for compliance. This is a significant weakness of many AEP and would need to be further addressed in the design of any mechanism to reward the delivery of environmental services. **Both the optimum level of monitoring and penalties for non-compliance should be further investigated.**

The future of AEP

- 9.33 As we look to the future design and operation of AEP, a key issue will be the extent to which public funding or the willingness of society to pay for services will be sufficient to meet needs. The assumption throughout this document has been that essentially payments for public goods will be delivered by state funded mechanisms.
- 9.34 The problem with such schemes is that they may be limited both in terms of the resource available and the terms of international agreements on fair trade. It is possible, however, to envisage more hybrid schemes that could mobilise private sources of funding. For example, 'habitat banking' or trade in environmental services could be devised, involving say developers 'buying' services (i.e. paying for the restoration or maintenance of services) in one area to compensate for impact or damage in another. Wetland banking is an established process, for example in the USA, and similar schemes covering other types of habitat or environmental service are being looked at elsewhere (e.g. Ecotrade¹⁰). These are designed to reward farmers for undertaking landscape and habitat management in much the same way as conventional AEP, which have succeeded in providing farmers with income above the minimum that state-funded AEP can provide. Private investment appeared to be

¹⁰ <http://www.ecotrade.ufz.de/>

attracted to such schemes in order to improve the environmental image or performance of an organisation.

9.35 Thus one could envisage future schemes that were part state and part private funded, with public organisations providing say, matched funds, or baseline payments to secure the minimum level of service output. The possibility of land managers undertaking management actions (afforestation, peat restoration) that allow them to sell carbon credits might be one area where such markets might be developed in the medium term. As we have seen from the Vittel example, particular local situations might attract considerable private interest. It could be argued that part of the funding currently used for agri-environmental schemes could be diverted towards setting up the market mechanisms needed to secure private engagement.

Conclusions

9.36 AEP have the potential to promote the delivery of environmental services. This Chapter has set out a number of recommendations for future scheme design and for areas in which further work will be needed, in order to design AEP that are able to effectively support service delivery. To summarise it is suggested that:

- AEP should continue to reward changes to management practice expect where a direct link between land management and service output can be measured;
- Co-operative action and connectivity should be emphasised in future AEP;
- Cross compliance has important implications for service delivery via AEP;
- Better targeting of AEP is essential and two-tier schemes should be used to target higher level stewardship;
- Continuing participation in AEP is essential and appropriate incentives should be investigated through stakeholder consultation;
- AEP should consider not only what services land managers can supply but what services Society demands;
- AEP should address climate change issues and, in general, be based on sound scientific evidence; and,
- Efficient monitoring of scheme performance is essential.

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Appendix 1 – terminology

- 10.1 There is, in fact, no universally acknowledged or agreed definition of either ecosystem or environmental services, and both are variously defined throughout the literature. In addition, the terms are sometimes used interchangeably and are similarly defined by different authors. However, others such as the FAO define environmental services as the sub-set of ecosystem services characterized by externalities (FAO, 2007). Whereas, Swallow et al. suggest that an environmental service is a positive benefit that people obtain from the environment (Swallow et al., 2007). They go on to say that “an environmental service is generated when an economic activity in one place, controlled by one economic agent, has positive spillover effects on other consumers or producers, often in other places” (Swallow et al., 2007, p.27). This definition would seem to imply some kind of unintentional positive benefit, which contrasts with the MA definition that focuses on the benefits people obtain from ecosystems, which seems to imply some implicit ‘demand’ for the service (MA, 2005). On the other hand, Smith (2006) defines an environmental service as “a measurable, end-use product of ecosystem processes, such as drinking water quality, bird population levels or acres of open space in a metropolitan area” (Smith, 2006, p.1167).
- 10.2 This debate is not simply a matter of terminology but has important implications for the delivery of ecosystem or environmental services via CAP. To take this principle forward a working definition should be agreed in future studies so that the associated issues of identifying, measuring and rewarding the supply of services can take place within an appropriate framework. However, it is important not to get too ‘hung-up’ on terminology and as, ‘environmental services’ is the term preferred by LUPG who perceive it as ‘related to, but wider than ‘ecosystem services’, encompassing the effects of human management of the natural world, this terminology will be taken forward in this report.