Land Use Policy Group

The UK statutory conservation, countryside and environment agencies

An analysis of the potential effectiveness of a Payment-by-Results approach to the delivery of environmental public goods and services supplied by Agri-Environment Schemes

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CONTENTS

EXECUTIVE SUMMARY

Agri-environment schemes (AES) have been an important policy tool within the EU for over 15 years and are viewed as a central element of the Rural Development Regulation (RDR) in seeking to secure certain environmental public goods. Currently, AES tend to be action-based rather than result-based. As a result they offer payments for adherence to management prescriptions that are assumed to deliver environmental benefits, rather than making payments conditional on realisation of the benefits themselves. This prescription-based approach is a pragmatic response to the measurement and monitoring problems associated with many environmental benefits which can be difficult to identify, value and ascribe to causal factors with total certainty.

However, payment-for-actions does lead to economic inefficiencies. If the costs of public good provision vary significantly across farms due to, for example, differences in resources, management skill and site history, then any uniform payment for voluntary participation will attract low cost farmers who are over-rewarded whilst failing to attract higher-cost farmers who might deliver additional benefits. By contrast, a more differentiated approach potentially allows for either expenditure savings and/or outcome gains. Part of the challenge in designing better policy instruments lies in identifying and targeting variation in costs of provision and environmental performance.

As a result the potential for payment-by-results (PBR) as an alternative approach is generating increased international interest under a variety of different names – although many cited examples are either at an early implementation stage and/or experimental in nature. Consequently, in an attempt to derive generic criteria for applying PBR to agri-environment schemes within the UK, this desk-based study explored a number of selected examples of publicly-funded agri-environment schemes loosely based on a PBR approach. The sixteen examples chosen cover ten countries and a variety of different specific objectives and operational issues. Both the advantages and difficulties identified for each scheme were reviewed (see section 3.3) and summarised in tabular form (see appendix 1) under the following headings: Administrative; Ecological; Economic; Social & cultural; and Monitoring. Analysis of the case-study examples was then combined with an exploration of the potential applications of the PBR approach at both habitat/species and landscape scales. Further discussion during a one-day stakeholder workshop, led to seven main conclusions:

PBR schemes can improve environmental targeting
PBR schemes can improve the environmental targeting of agri-environment measures in comparison to the payments based on management prescriptions. It also seems reasonable to assume that as a result of improved environmental targeting, PBR schemes will provide greater environmental benefits. However, the outcome of this review suggests that more empirical work on the ground is required to evaluate the environmental impact of PBR schemes over a longer period of time. Consequently, it would be advisable to continue testing the PBR approach through the implementation of prototypes at local level and the incorporation of specific outcome-based elements such as bonus payments in standard prescription-based schemes.

PBR need to be based on established baselines
Any workable PBR scheme has to be based on sound measurement of environmental baselines and the monitoring of changes in these baselines. In addition, the setting of targets and the understanding of how they might be achieved needs to be developed in partnership with land managers. At the present time the complexity of many agri-environmental systems typically requires significant resources to be devoted to administration and monitoring. Self-monitoring by scheme participants is an interesting idea that merits further exploration.

This suggests that it may be sensible to pilot PBR schemes by seeking to maintain rather than enhance existing environmental conditions where these are already favourable. In such cases both the baseline and the target are easily understood and land managers have a good idea of how to achieve the required outcome (no degradation of current condition). Such an approach offers practical advantages, but may be open to criticism on the grounds of limited additionality – of paying land managers in return for little extra effort.

PBR could provide both economic efficiencies and enthuse land managers

By offering incentives to achieve results, PBR can potentially deliver economic efficiency gains. It should also enthuse land managers by both releasing them from management prescriptions and offering a direct reward for outcomes in a manner (at least partially) analogous to other markets that they operate in. However, making rewards conditional on results when these are not entirely within the control of a manager (e.g. due to weather conditions, pests or the actions of neighbours) exposes them to a greater level of risk than more conventional prescription-based approaches. This suggests that payments may need to incorporate a risk premium or perhaps be split between a guaranteed payment for participation plus a bonus on delivering the desired outcome.

Current interpretations of policy could restrict use of PBR

The scope for varying payment calculations is constrained by strict interpretation of current WTO requirements for Green Box eligibility. Specifically, the requirement for AES payment calculations to be based on income forgone and additional costs does not sit easily with the logic of payments-by-results since it should be the value of the outcome not the cost of delivery that determines payment rates.

A less strict interpretation of WTO would focus on the over-riding principle of eligibility resting on an instrument being non-trade-distorting or at least less-trade-distorting than what it replaces (an approach adopted by other WTO panels). This means that a more flexible interpretation could ease the use of PBR. Yet this is dependent on high-level negotiations and a clear demonstration that a policy instrument does not affect commodity production and trade flows.

Auctions could offer a means to quantify payments in PBR schemes

Although subject to some concerns over their repeated use, auctions offer a possible means of not only improving efficiency relative to the current use of flat-rate payments but also relaxing the WTO constraint on the basis for payment calculations. If auctions are acceptable (and they are under the EC Rural Development Regulation) then bids can be interpreted as reflecting costs incurred and thus may permit a PBR approach. However, the setting of a public budget from which to fund a PBR and the identification of a maximum acceptable price to pay for a unit of a given public good requires a measure of demand to match the supply-side bid – and this implies recourse to some form of environmental valuation technique.

Pilot PBR schemes should be applied at different scales

Considering the application of prototypes at different scales, a pilot PBR scheme with its desired outcome set in terms of the desired characteristics of a particular habitat or plant species assemblage would be potentially easier to implement in practice. However, the desired biodiversity outcome not only needs to be set at the level of the individual site but also at the level of the area the scheme is designed to cover. Any PBR needs to set broader outcomes, for instance the amount of any particular habitat in that region which should be managed under that scheme.

PBR poses significant design challenges which are amplified at the landscape scale

Whilst PBR at the level of the individual site poses significant design challenges, these are amplified by potential landscape-scale applications where there may be a need to co-ordinate the activities of neighbouring land managers to achieve an aggregate outcome. In other words, if it matters "who does what" and "where it is done" in order to secure a particular pattern of landscape or habitat features, then targeting just individual land managers will be insufficient.

This poses additional challenges for scheme managers in terms of setting and monitoring targets, but also suggests that payment incentives alone may be insufficient to deliver desired environmental outcomes. Whilst payment design – perhaps in the form of "agglomeration bonuses" for joint working – may be worth considering, the development and support of local governance arrangements may be more important. For example, the inclusion of LEADER activities under Axis 4 of the RDR may offer opportunities for exploring the integration of local governance into agri-environment scheme design and delivery.

These general conclusions form a set of suggested criteria – some of which are not unique but apply to any AES - for developing a PBR approach, as summarised on the following page.

Set of criteria for developing a PBR approach

- Aims, outcomes and delivery mechanisms of a scheme need to be clearly defined prior to scheme implementation.
- Prototype payment-by-results schemes need to be simple, applicable at local level and easily understood by farmers, administrators and others involved.
- The feasibility of integrating outcome-based elements into existing prescriptions-based agri-environment measures should be explored.
- Close links between farmers actions and environmental outputs need to be established to ensure that the desired outcomes can be measured with relative reliability, confidence and at reasonable cost and payments can thus be justified.
- Payment design needs to address the risks faced by farmers and provide incentives for the delivery of higher level outcomes, for example by combining a fixed base payment with a performance or bonus component.
- The feasibility of quantifying payment levels based on ascertaining marginal costs to participants (e.g. through individually negotiated grants or auctions) should be explored on a case-by-case basis.
- Farmers and other land managers need to be involved in the process of establishing PBR schemes to ensure that local environmental knowledge is harnessed as part of seeking to produce environmental benefits.
- The promotion and co-ordination of collective actions to achieve the targeted environmental outcomes need to be considered as part of scheme design.
- Spatial equivalence between the application of the scheme and the scale of the targeted environmental outcome needs to be taken into account.
- The targeted environmental outcome needs to be consistent (and integrated) with the broader local environment and landscape character.
- The choice of outcome indicators needs to reflect a balance between the ecological complexity of the targeted outcome and the practical implementation and management of the scheme.
- For certain PBR schemes, such as those targeting particular species, it may be appropriate when setting targets to consider the overall level of species populations that is ecologically desirable.
- Adequate frequency and intensity of monitoring need to be set up and clear linkages between the monitoring of the outcome and a bonus or penalty system need to be established.

Practical implementation of PBR pilot scheme

A pilot PBR scheme focused on the maintenance of existing habitats (e.g. to maintain an acceptable status quo of the vegetation condition) would potentially be the easiest way of initially introducing the PBR approach. The relative simplicity of such pilot scheme would ensure an effective understanding by land managers of what is expected of them and encourage buy-in to the approach in the first place. This would foster general good-will within the wider farming community for any attempts in the future to establish more complex PBR schemes. However, a pilot PBR scheme which sought to enhance (rather than simply maintain) vegetation condition would potentially provide more of a test of the pros and cons and likely future acceptability of the PBR approach.

Generally, the suitability of implementing a PBR approach in agri-environment policies depends on the objectives of the AES, the scale at which the scheme will be applied and the outcomes it wants to achieve. An overview of the key strengths and key weaknesses of the PBR approach depending on outcome, scale and objectives is provided in Table E1.

Table E1 Suitability, key strengths and key weaknesses of implementing the PBR approach in AES

Dimension of the AES		Suitability for PBR	Key strengths	Key weaknesses
Outcome	Maintenance	Higher	Outcomes relatively easy to understand and monitor	Subject to criticism of low additionality
	Enhancement	Lower	Delivering improvements rather than the status quo	Outcomes harder to define, achieve and monitor
Scale	Site	Higher	Outcomes relatively easy to define and monitor	Some outcomes not achievable at individual site level
	Landscape	Lower	More typical scale at which ecosystem services are delivered	Challenges of co-ordination across different sites/land managers
Objectives	Single	Higher	Outcomes relatively easy to define and monitor	Relatively few outcomes are independent from others
	Multiple	Lower	More typical of current land use policy context and "bundled" nature of ecosystem services	Need to define and monitor multiple outcomes, and trade-offs/interactions between them

ABBREVIATIONS

AES	-	Agri-environment scheme
AoA	-	Agreement of Agriculture
CPP	-	Conservation Performance Payments
EC	-	Environmental Cooperatives
ES	-	Environmental Stewardship
ESI	-	Environmental Services Index
EU	-	European Union
GATT	-	General Agreement on Tariffs and Trade
HLS	-	Higher Level Stewardship
LEADER	-	Liaison Entre Actions de Développement de l'Economie Rurale
MEKA	-	Markt-, Entlastungs- und Kulturlandschaftsausgleich
PBR	-	Payment-by-result
RDR	-	Rural Development Regulation
RDS	-	Retained Duty System
SEK	-	Swedish krona
SSSI	-	Sites of Special Scientific Interest
UK	-	United Kingdom
US	-	United States (of America)
WTO	-	World Trade Organisation

1. INTRODUCTION

1.1 Background

Although Environmentally Sensitive Areas (ESAs) were introduced during the 1980s, it was the McSharry reforms of 1992 that led to the widespread implementation of agri-environment schemes under the Common Agricultural Policy. Since then, agri-environment schemes have become a key policy instrument in the EU as well as the UK. By 2002, they accounted for over 30 million hectares of land and over 2 bn Euros of expenditure within the EU15 (EEA, 2005) and the current Rural Development Regulation (RDR) has retained them as a compulsory element of the rural development plans prepared by individual member states.

Agri-environmental schemes provide payments to farmers for adopting environmentally beneficial farming practices. The benefits sought - such as attractive landscapes, enhanced biodiversity or soil and water quality - are typically characterised by economists as public goods, meaning that they are under-supplied by market mechanisms alone. Whilst direct provision by the state might be possible (as through the Forestry Commission) or voluntary organisations (such as the RSPB), the dominant approach for delivery of public goods is to rely on private land managers responding to either regulatory controls or payment incentives.

The current design of agri-environment schemes based on rewarding farming practices rather than the desired environmental outcome represents a pragmatic approach. That is, environmental outcomes are often dependent on a number of influences beyond the control of local land managers - such as prevailing climatic conditions or availability of neighbouring seed banks. Moreover, the final desired outcome - such as regeneration of vegetation - can take many years or even decades to appear. Consequently, monitoring and attributing outcomes to actions can be difficult and risk-averse farmers more familiar with annual payments for agricultural production can be wary of rewards that are conditional upon uncertain outcomes.

However, rewarding farming practices rather than outcomes potentially incurs various losses in economic efficiency. In particular, difficulties in observing actual land management practices before and after participation in a scheme means that scheme managers may know rather less than land managers about the changes actually achieved on the ground. This information asymmetry exposes scheme managers to both adverse selection and moral hazard problems[1], meaning that public funding may achieve relatively little because payment is not well targeted.

A further complication arises from the binding WTO Green Box criteria for agri-environment programmes - as defined in paragraph 12(b) of Annex 2, Payments under Environmental Programmes, of the GATT Agreement on Agriculture (GATT, 1994).

[1] In a situation where a principal (e.g. a Government agency or an insurance company) is offering contracts to agents (e.g. farmers or car drivers), the efficiency with which the principal's objective (e.g. securing public goods or making profits) is achieved can be reduced if the agents are able to hide information about themselves. Specifically, if the principal can not observe agents' circumstances and behaviour perfectly, then unsuitable individuals may be enrolled into schemes and/or cheating may occur. The former is referred to as adverse selection, the latter as moral hazard. Enrolling farmers with low costs of compliance is a problem if uniform payment rates lead to over compensation of such farmers when they could have been enrolled more cheaply. Undetected non-compliance is a problem since agents are paid despite failing to observe scheme prescriptions. Principal-agent problems are the subject of an extensive economic literature, some of it directed at agri-environmental issues, and offers some theoretical insights into different elements of contract design, including rewards, penalties and monitoring (Laffont & Tirole, 1993; Moxey et al., 1999; White, 2002; Fraser, 2002 & 2004).

Specifically, that:

> *'the amount of payment shall be limited to the extra costs or loss of income involved in complying with the government programme'*.

Constraining payments in this manner severely dilutes the incentive for adoption of voluntary schemes, thereby limiting policy effects {e.g. Diakosavvas, 2002). More problematically, when used in combination with standard payment rates set several years in advance, it exacerbates the adverse selection problem by effectively restricting enrolment to parcels of land with low compliance costs rather than necessarily high environmental values. This deadweight effect - gifting overpayments or "economic rent" to scheme members - has been noted in several cases (e.g. Matthews, 2006).

Unsurprisingly, the payment criteria have widely been criticised for being too narrow and inflexible, and insufficient to deal with the emerging challenges of combating climate change and preserving eco-system services. (Peterson, 2000; Latacz-Lohmann and Hodge, 2003; Glebe, 2007). Edwards and Fraser (2001) conclude that consigning the environment to the status of a subsidiary to agricultural output by restricting agri-environmental payments to agricultural opportunity costs is not warranted on economic efficiency grounds. Hence a number of studies emphasise the potential increase in environmental benefits of payment-by-results (PBR) schemes rather than providing compensation for income foregone (Schwarz et al., 2006; CRER and CJC Consulting, 2002; Blandford, 2001). Critically it is the potential achievement of stronger environmental benefits that makes the PBR approach more attractive.

Payment by results would bring agri-environmental measures closer to the notion of markets which reward producers for the quantity and quality of the final products rather than reimburse them for the costs of the inputs used in their production. An appropriate direct linkage of the payments to farmers and the desired environmental results could lead to a more efficient use of public funds compared to existing agri-environmental measures using the standard cost approach (Hespelt and Bertke, 2003; Moreddu, C., 2007). However, linking farm payments to the level of public goods supplied or environmental benefits is likely to be a difficult task and this approach has a number of drawbacks which need to be taken into account in the design and application of future agri-environmental payments.

It may be difficult and costly to measure environmental outputs to a standard that would satisfy the requirements of an enforceable contract. The required outcome may not be readily observable at all times, such as a number of birds feeding on a particular area of land, and may vary at different times of day or year. It may be difficult to replicate the factors determining outcome levels, which raises the likelihood of complaints and appeals by farmers who feel that they have been treated unfairly (Hodge and Reader, 2007). It is also important that the design of payments in outcome-based schemes take into account the higher exposure of farmers to risk and uncertainties.

Despite this, a number of studies conclude that PBR schemes can be a realistic alternative to the currently applied standard cost approach, if a close link between actions and outcomes can be established and the outcomes are measurable (CRER and CJC Consulting, 2002; Hanley et al., 2002; Claasen, 2003; Gerowitt, et al., 2003; Gagnon et al., 2005). However, Hodge and Reader (2007) stress that more work is required to develop appropriate indicators and institutional frameworks within which PBR could be applied. Intermediate options should be explored in which a proportion of the payment is linked to the required changes in management with a further element paid where the required environmental output has been delivered. In this context, it is a useful exercise to summarise the experience from a number of experimental schemes that have adopted this approach.

1.2 Objectives

The main aim of this study is to investigate the practical feasibility of a PBR approach in more detail and to derive generic criteria for applying the approach to agri-environment schemes within both the UK and EU. The study considers how best to develop agri-environment measures based entirely on PBR and on partial use of the concept. Specific attention is paid to the examination of the advantages and difficulties arising from the use of PBR schemes. In reviewing sixteen selected examples of PBR schemes, the study discusses the validity of a number of issues raised in a recent Land Use Policy Group report on maximising the provision of public goods from agri-environment schemes (Hodge and Reader, 2007).

In particular this study examines the validity of the following points:

- PBR would create strong incentives to produce high-quality environmental goods and to develop innovative approaches to environmental management.
- Farmers would be able to apply their superior knowledge in determining the methods used to supply the public goods on their particular holdings. There would be no need for separate payments for operational and capital items.
- Payment by results would create incentives for co-operation among farmers across several holdings where this could enhance efficiency.
- A result-based payment scheme may reduce the need for compliance monitoring. Rather than monitoring farmers' actions, the environmental agency would just need to check whether certain output had been produced.
- By allowing farmers more flexibility to achieve the desired goals PBR schemes would help offset criticism that the current agri-environment approach is too prescriptive, not adaptable to local conditions and is ineffective because of this.

This study also examines whether the following difficulties can realistically be overcome:

- There is often a substantial delay, potentially of several years, between the adoption of changes in land management and the production of the environmental outputs. Farmers would require some extra financial incentive to compensate for the period before the return is received.
- The relationship between changes in land management and the delivery of environmental outputs can be very uncertain, often depending on factors outside of the land managers' control.
- Farmers are generally risk-averse (though not always) and so for this reason would demand higher payment rates for the same level of uptake. The government, operating a large number of contracts, may effectively be indifferent to risk and so it could be less costly (and more efficient) for government rather than individual farmers to take on this risk.
- There is often no consensus over what counts as an acceptable environmental output or outcome. Even ecologists tend to disagree on this question in many cases, such as in the botanical composition of grassland.
- It may be difficult (and costly) to determine, measure and quantify environmental outputs to a standard that would satisfy the requirements of an enforceable, written contract. The output may not be readily observable at all times, such as a number of birds feeding on a particular area of land, and may anyway vary at different times

of day or year. It may thus be difficult to replicate the determination of output levels and so raises the likelihood of complaints and appeals by farmers who feel that they have been treated unfairly.

- Current WTO Green Box criteria limit payments to be based on additional costs and income foregone. Payments directly linked to environmental benefits would be most likely not condoned by existing WTO requirements. To increase the chance of the acceptability of such approach at international level, mechanisms have to be put in place to restrict potential production and trade effects to a minimum.

The report starts with a short description of the PBR approach defining the terminology and different types of PBR approaches in section 2. Section 3 presents the review of advantages and difficulties of existing examples of PBR agri-environment schemes. A set of generic principles for their implementation are suggested, and then discussed in more detail in relation to potential applications at habitat or wider landscape scale in section 4.

2. THE PAYMENT-BY-RESULTS APPROACH IN AGRI-ENVIRONMENT MEASURES: DEFINITION AND TERMINOLOGY

What is Payment by Results

Agri-environment programmes in the EU mainly consist of action- or prescription-based measures which provide financial compensation for required (prescribed) farm management changes to comply with the measure. In addition to the issues arising from prescription-based agri-environment measures outlined in the previous chapter, paying farmers on the basis of actions rather than results does not provide incentives for producers to seek out new methods of reducing costs, to introduce innovative approaches, or to take risks in seeking to provide such benefits. An alternative approach would be to pay farmers according to the environmental results achieved (CRER and CJC Consulting, 2002). The PBR approach provides a fundamentally different approach to the design of agri-environment support moving from an action-based to an outcome-based remuneration for the provision environmental services.

In the PBR approach, the payment is directly linked with the environmental outcome achieved by the farmer according to different levels of outcome. This suggests that, the payment is based on values obtained through monitoring. For example, in the case of species rich grassland the payment normally depends on the number of indicator species or in the case of nitrate contamination of groundwater the farmer is typically rewarded according to the amount of left-over mineralised nitrogen remaining in the soil (Brouwer et al., 2003). In contrast to the prescription-based approach of existing agri-environment measures, the farmer can choose which methods or farm management changes to implement in order to achieve the targeted outcome, taking into account the specific characteristics of the site.

Discussions at the stakeholder workshop showed that it is important to clarify the terminology and definition of PBR schemes. The term ‘payment-by-results’, as applied in this study, reflects a directly implemented environmental targeting of agri-environment payments through result or outcome-based indicators which need to be fulfilled by participants in order to receive the payment. In other words, payments are linked to the quantity or quality of environmental outcomes. However, this does not imply that payments are calculated or quantified based on the value of environmental benefits (e.g. by applying the willingness to pay approach). In fact, in all reviewed examples payments are still quantified based on income foregone and additional costs. Other terms used in the literature for PBR schemes are result-oriented schemes (e.g. Oppermann, 2003) and outcome-based schemes (e.g. Groth, 2005 and Latacz-Lohmann, 2000).

We define the key characteristics of a payment-by results scheme as follows:

- direct linkage of the payment provision to the environmental outcome
- differentiation of payment levels according to different environmental outcomes
- farmer choice over how best to achieve the desired outcome (in other words a lack of prescribed farm management changes).

Theoretical Approaches to calculations of payments

Payments within PBR agri-environment schemes could be based either on the opportunity costs of providing the desired environmental benefits or on the application of economic valuation methods applied to the same environmental benefits. The

literature discusses a range of different economic methods to value environmental benefits through the willingness to pay approach.

- The travel cost method is restricted to measuring the use value of an amenity by those who use it. Use value is implied by the costs incurred by people who travel to a particular site. This method has been used to measure the amenity value of forests, of angling and of national parks;
- The hedonic price method is also restricted to trying to estimate the use values placed upon environmental characteristics by those who trade in land or houses, as these are reflected in price premia paid for the view or other desirable locational characteristics;
- The contingent valuation method is used to value environmental benefits. In contrast to the previous two methods; and
- The contingent valuation method can also estimate non-use values. Basically, a sample of individuals, whether users or non-users, are asked for their willingness to pay to preserve or protection a particular environmental good (or alternatively, how much they would need to receive in order to compensate them for the loss of the asset) (Tietenberg and Lewis, 2008, Romstad, 2004).

However, while those methods are discussed in the academic literature, none of the reviewed prototypes or examples of PBR agri-environment measures applied the willingness to pay approach to quantify payments. Instead, agricultural opportunity costs expressed through income foregone are used to calculate payments.

The term PBR, as applied in this study, does not imply that payments are calculated based on the (assumed) value of environmental benefits.

Methods of Payments found in this study

Payments can be calculated based on average or marginal (opportunity) costs to achieve the targeted outcome. Whilst in some of the examples reviewed, flat-rate payments are provided to farmers, payments based on marginal costs better reflect the principle that the rewards available under PBR schemes should represent the different environmental results achieved by farmers. In an ideal situation, individually negotiated contracts would reflect the specific situation on a farm. It would provide the legal framework to design a payment according to the expected environmental outcome for that farm. However, such individual negotiations are associated with high transaction costs which would make a large scale application in agri-environment measures very costly.

Another option is the use competitive tendering through auctions. Farmers would be asked to tender for biodiversity projects as listed by Government. This would encourage a more targeted approach where farmers are viewed as potential providers of environmental services or outcomes which society wants to buy. The underlying logic is that society can achieve its environmental objectives at least cost because the most efficient providers of these services are awarded the contracts. The auction approach has been tested in a number of prototype PBR schemes and section 3 of this report considers this technique.

3. REVIEW OF PAYMENT-BY-RESULTS AGRI-ENVIRONMENT SCHEMES

3.1. Methodology

The purpose of the desk-based literature review was to derive key issues for the practical implementation of PBR agri-environment schemes from existing prototypes.

An in-depth review and analysis of existing PBR schemes formed the first part of this project. Relevant literature in journal articles, published and unpublished research reports and conference/workshop presentations was identified using online catalogue and search engines as well as library archives.

The short-term nature of this project limited the scope of this review to literature and desk-based studies. Interviews with researchers or administrators of PBR schemes were not conducted. However, two German PBR schemes were discussed with researchers and administrators at the project workshop held in May 2008. This provided the opportunity to explore some of the specific issues related to the development and use of a plant species indicator approach as well as the use of auctions in the administration and calculation of payments. Action-based agri-environment schemes have been included in the review to explore the potential of using other payment approaches such as auctions in PBR schemes and the promotion of collective actions through agri-environment support.

3.1.1 Design of review framework (or review indicators)

Although some of the literature suggests a large number of payment-by-result type schemes are already in existence, closer inspection reveals that relatively few are purely result oriented and many are experimental in nature and/or have been running for a comparatively short period of time (e.g. Landell-Mills, and Porras, 2002; Mayrand and Paquin, 2004). Moreover, the objectives and operational details of individual schemes vary. Consequently, the review framework was designed to use selected examples as a means of summarising key characteristics. Attention was focused primarily upon publicly-funded schemes with an explicitly agri-environmental objective rather than, for example, privately-funded schemes or forestry objectives.

The review and analysis of the 16 examples was organised within a matrix as shown in the appendix. This matrix summarises information contained within the literature on the background of each scheme, which includes:

- budget
- scheme initiation and administration
- scheme objectives
- targeted environmental outcome
- scale of scheme application
- approach to quantify environmental benefits
- approach to quantify and design of payments
- approach to scheme monitoring

In addition to this background information the matrix organises the potential advantages and disadvantages of each scheme in relation to the following five categories:

- administrative aspects
- ecological aspects
- economic aspects
- social and cultural aspects
- monitoring aspects

3.1.2 Selection of examples

In total, sixteen schemes from ten different countries (Scotland, England, Germany, Austria, Netherlands, Denmark, Sweden, USA, Australia and Nicaragua) were included in the review. Of these sixteen schemes, few can be considered to follow a strictly PBR model whereby payments are made according to the delivery of specific environmental outcomes. Similarly, there are very few examples of PBR agri-environment schemes targeting wider environmental issues such as diffuse pollution or carbon sequestration.

For these reasons, we expanded the review to include schemes that have the mechanisms which will be required if using a PBR approach is undertaken. These include:

- 'results-oriented' elements to achieve the environmental good e.g. the use of species/habitat indicators;
- collaborative action to ensure the delivery of objectives that are best achieved through the cooperative action of more than one holding, payments for ecosystem services; and
- the use of auctions to calculate more effectively the 'real cost' of the delivery of environmental goods and services.

It is, however, important to emphasise that some of the examples which use auctions or co-operative mechanisms are not PBR schemes, but illustrate the advantages and disadvantages of such mechanisms.

The following sections include descriptions of the schemes reviewed (section 3.2), followed by a summary of their main characteristics (section 3.3.1) and the main advantages and difficulties of a sub-sample of the schemes (section 3.3.2). More comprehensive details of the schemes and the analysis of the advantages and disadvantages of each (with respect to five main aspects: administrative, economic, social, ecological and monitoring) can be found in appendix 1.

3.2 Description of Schemes reviewed

3.2.1 European examples included in the review

1 East of Scotland Grassland Management Scheme, UK

This is one of several Scottish Natural Heritage Natural Care schemes and targets the maintenance or restoration of the 83 semi-natural lowland fen and grassland Sites of Special Scientific Interest (SSSI) located in the east of the country. Although the

scheme is specifically targeted at developing site specific management plans for designated SSSIs adjacent 'unprotected' land may also be eligible. The scheme uses a combination of management prescriptions and habitat indicators. Farmers monitor sward heights at three points during the year. Payments are made in arrears per hectare managed and can also be made for one-off capital payments.

2 Higher Level Stewardship (HLS) element of the Environmental Stewardship (ES) Agri-environment Scheme (AES), UK

This is normally combined with the Entry Level Stewardship element of ES which is a country wide AES in England. There are five primary objectives of HLS ranging from wildlife conservation to public access and understanding. Site specific management is detailed in a Farm Evaluation Plan and aims to maintain/improve the 'feature' or interest. The scheme combines the use of prescriptions and 'Indicators of Success' and Joint Character Areas guide the localised prioritisation of targets. Payments are made at a standard cost based flat rate and for the purchase of capital items.

3 Farm Conservation Scheme (1988-1996), Peak District National Park

This scheme, administered by the National Park Authority, aimed to capture and conserve the floristic diversity of hay meadows that were not entered into national AES (e.g. Environmentally Sensitive Area or Countryside Stewardship). Farmers received a basic payment for entering into the scheme and an enhancement payment for implementing ideal management. These payments were adjusted following periodic re-survey. 27 farmers entered into the scheme.

4 & 5 Brandenburg Germany

Two results-oriented agri-environment schemes have been developed for the region of Brandenburg. One, a prototype scheme, aims to conserve species rich grasslands on common agricultural land (equating to 30% of the total grassland area in the region). Eligible grasslands are recommended to contain a minimum threshold of four indicator species. The identification of species rich grassland occurs with the 'help of farmers'. The second scheme has the objective of improving water quality through a reduction in nitrate leaching from the root zone. The literature reviewed describes the process of modelling simulated environmental indicators from which basis a prototype scheme can be developed. Spatially explicit calculations (at the level of the smallest administrative unit) of nitrate leaching reduction are made for different land conversion scenarios.

6 Conservation of semi-natural grasslands in Lower Saxony

This is a 'results-oriented' AES targeting the conservation of semi-natural grasslands in Lower Saxony. The literature reviewed, describes and evaluates the ecological appropriateness of the selection of indicator plant species (which are used as the basis for making payments in a results-oriented scheme) for six study areas in this region (Wittig et al 2006) and evaluates the use of auctions to allocate agreements in Northeim in Lower Saxony (Klimek et al., in press; Groth, 2005). In this latter example, 38 farmers bid to enter the scheme and 28 were successful, equating to the entry of 289 ha. In addition in this scheme farmers are responsible for the identification of indicator species on the parcels of land entered into the scheme.

7 Conservation of semi-natural grasslands in Baden-Württemberg

Similar to example 6, the Baden-Württemberg scheme uses plant indicators to facilitate the management and monitoring of semi-natural grasslands. Farmers play an active role in the identification of the indicator species.

8 Oekopunkte in the Federal State of Lower Austria

In this AES farmers can accumulate scores for undertaking specific actions deemed to be ecological valuable. In converse, ecologically disadvantageous actions receive negative scores. Points can be 'banked' in an eco-account and converted into bonus

rates. However, the reviewed report highlights that the economic efficiency of the scheme is not known and over payments might be occurring. The high costs of administering the scheme prevent it from being rolled out nationally.

9 Environmental Cooperatives in the Netherlands

Franks and McGloin (2007) review the effectiveness of Environmental Cooperatives (EC) in delivering across-farm environmental and rural policy objectives. Although not a PBR scheme per se, the review of EC is included as an example of how collaborative action could be incorporated into PBR schemes. ECs were originally formed by groups of farmers as a reaction to top-down environmental programmes. There are now approximately 125 ECs, with a total of 10 000 members. Some are exclusively composed of farmers whilst others include a broader range of stakeholders. The cooperatives account for 10% of all Dutch farmers and 40% of the UAA. Schemes vary in their objectives but water management is of particular concern.

10 Meadow Birds Agreement, Netherlands

This scheme includes the implementation of an AES targeting the conservation of wader species is more effective at a cooperative level than at the level of the individual farmer. Collective packages require that 10-20% of entered land is subject to the delayed mowing scheme. The minimum eligible area for a collective package is 100 ha. A paper by Verhulst et al (2007) reviews the Dutch Meadow Birds Agreement which compliments Example 9. Although the paper does not detail how payment rates are calculated, in the payments-by-clutch scheme farmers are paid according to the number of clutches on their land, as monitored by the farmers themselves or by volunteers. The Meadow Birds Agreements is currently implemented on 150 000 ha of land and the Dutch government aim to secure the entry of a further 100 000 ha by 2010.

11 The Hedgerow Planting Scheme in Denmark

This scheme has a long history and originated in the west of the country in the late 1800s in an effort to prevent soil erosion. By the early 1900s, approximately 150 local planting associations had been formed. The scheme is now applicable to the whole country and has expanded its objectives to also increase biotopes and ecological corridors on agricultural land in addition to preventing erosion. The scheme is not exclusive to collectives only, individuals can apply but in 2005 78% of all funded projects were collective (in this year the scheme had a budget of 2.2 million €).

12 Conservation Performance Payments in Sweden

As the title of this scheme indicates, the payments of this scheme are conditional on the achievement of a specific conservation outcome, in this case, the number of carnivore reproductions certified on reindeer grazing land. The article reviewed (Zabel and Holm-Müller, 2008) focuses on the management of the distribution of payments by the Sami village administrations. In some cases, all village members collectively decide, in others an elected committee makes the decision. The paper evaluates whether common pool management provides sufficient an incentive to aloe carnivores to raise offspring on grazing land. Payments are calculated based on estimates of the likely monetary damage that the predators will cause during their life span. Payment levels in 2007 for certified wolverine and lynx reproductions entailed SEK200 000. In addition, payments can be made for the regular and occasional occurrence of lone wolverines (SEK 70 000) and lynx (SEK 35 000).

3.2.2 Non-European schemes included in the review

13 The US Conservation Reserve Program

Land retirement has been a policy tool in the US since the 1930s, stimulated by low farm incomes and environmental resource problems. The original purpose of the Conservation Reserve Program was to retire 45 million acres of highly erodible land. This example is not specifically related to a PBR approach but was included in the review for the purpose of illustrating the problems that can be associated with using an auction approach. The purpose of using auctions was to use market forces to reduce the cost of the programme; however, farmers bidding to enter land into retirement became aware of the maximum rental rates creating a 'de facto' offer system.

14 The Bush Tender pilot scheme in the state of Victoria, Australia

The Bush Tender Pilot Scheme also employs the use of auctions to select the land that will be entered into the scheme. The objective of this scheme is to conserve the biodiversity of native vegetation through means of stock exclusion, the retention of fallen trees and timber and through the control of weed and invasive species. Farmers submit sealed bids which are selected on a value for money basis and, if successful, are paid for their management actions. Assessment of single sites is made through the calculation of the Biodiversity Benefits Index (Biodiversity Significance Score x Habitat Services Score / Cost announced by the landholder) and the necessary ecological data is collected by scientists.

15 The Auction for Landscape Recovery pilot scheme in Western Australia

As the name implies, this scheme also uses auctions to determine which applicants receive payments, in this instance, for securing multiple goods (enhancement of biodiversity, control of salinity and ground water recharge abatement). In addition, landholders are encouraged to put in joint bids for conservation sites (where these sites cut across boundaries of tenure or where sites are geographically close and would benefit from joint management). Bids are evaluated using a regional metric of 'biodiversity complimentarily' which takes into account 'synergistic' effects caused by the number, size and distance of sites, in addition to the calculation of an environmental benefits index. An assessment of the feasibility of the bid is made by a group of independent experts.

16 The Regional Integrated Silvopastoral Ecosystem Management Project, Nicaragua

This project has been implemented in three countries, Nicaragua, Colombia and Costa Rica. In Nicaragua, the project is piloting the use of payments for ecosystems services based on the rationale that short-term payments could tip the balance, making silvopastoral land use practices more profitable than current land use practices (extensive pastures that deliver a basic level of services – biodiversity, carbon sequestration, hydrological). The budget was able to support the entry of 100 households and these were selected on a first come first served basis. An Environmental Services Index (ESI) is used to calculate net increases in ESI points and payment levels.

3.3 Results of the review

3.3.1 Main characteristics of the schemes

Budget and scale of scheme application
Budgetary information was not available (from the literature) for each of the schemes reviewed and is rarely comprehensive where it is included. This prevents a clear analysis of expenditure relative to, for example, number of agreements or area of land under agri-environment agreements. Similarly, the difference in the design of PBR or result oriented schemes compared to more 'conventional' payment-for actions based schemes limits an evaluation of the relative cost-effectiveness of the differing approaches.

Table 1 Budget and scheme application of reviewed examples

Scheme	Budget	Scale of scheme application
Conservation of grasslands pilot scheme in Northeim (Lower Saxony, Germany)	30 000 €	Regional (28 farmers, 159 plots, 289 ha)
Hedgerow Planting Scheme (Denmark)	2.2 million € in 2005	National
Conservation Reserve Program (US)	At least 35 billion US$ since 1985	National but specific to areas at risk
Bush Tender pilot scheme (Australia)	1.2 million A$ between 2001 and 2003	In localised areas within the state of Victoria
Auction for Landscape Recovery pilot scheme (Australia)	200 000 A$ (does not include the cost of monitoring)	Western Australia, 23 tenders accepted
The Regional Integrated Silvopastoral Ecosystem Management Project (Nicaragua)	4.5 million US$ divided amongst three project areas (Nicaragua, Costa Rica and Columbia)	Regional (Matiguás-Rio Blanco), budget allowed for the participation of 100 households

Scheme administration and implementation
The majority of schemes reviewed were initiated and administered 'top-down' by statutory authorities or agencies although the Nicaraguan Silvopastoral Project was implemented by the World Bank and locally by a non-governmental organisation The only example of a 'bottom-up' or endogenous initiative is that of the Environmental Cooperatives in the Netherlands which were originally formed by farmers as a reaction to top-down environmental programmes. In the case of Northeim in Germany (the use of auctions in outcome based grassland conservation agri-environment schemes) a Regional Advisory Board (which includes farmer and landowner representation) was established to represent the public demand for ecological goods and to allocate funds for the provision of these goods. However, in reality, budgetary constraints determine the amount of ecological goods that can be purchased.

Scheme objectives/targeted environmental outcome
Six of the schemes we reviewed targeted the conservation of semi-natural grasslands (examples 1-7). However, a number of examples also included non-biodiversity based

objectives. The Auction for Landscape Recovery in Australia attempts a more holistic approach combining the enhancement of biodiversity, salinity control and groundwater recharge. Similarly, the Nicaraguan example entails payments for increased biodiversity conservation and payments for carbon sequestration. At the other end of the spectrum two of the schemes reviewed focus on specific species, carnivores in Sweden and wading birds in the Netherlands.

Approach to quantifying environmental benefits
The schemes targeting the conservation of semi-natural grasslands rely on the use of plant indicator species. In some cases farmers are responsible for the identification of these indicator species (see examples 4, 6 and 7). Similarly, farmers and volunteers are responsible for recording the presence of wader clutches as part of the payment-per-clutch element of the Dutch Meadow Birds Agreement. Four of the schemes reviewed entail the calculation of an indices e.g:

- Environmental Benefit Index US Conservation Reserve Program and Auction for Landscape Recovery in Australia
- Biodiversity Benefits Index of the Bush Tender pilot scheme in Australia
- Environmental Services Index, Silvopastoral Project Nicaragua

Approach to quantify and design of payments
The Oekopunkte scheme in the Federal State of Lower Austria is unusual in that farmers can accumulate bonus points for actions deemed to be ecologically valuable. These points can then be converted into bonus rates that can be as high as 363€/ha. Net increases in the Environmental Services Indices of holdings are used as the basis of payments in the payments for ecosystems services approach of the Nicaraguan Silvopastoral Project. A number of examples reviewed use auctions as a means of determining who is successful in securing agri-environment payments. In these cases, payments may be received for management actions (Bush Tender pilot scheme) or, moving towards a result-oriented approach, for the achievement of a threshold number of indicator species (Brandenburg, Germany). In the case of the Higher Level Stewardship Scheme in England payments are mainly made on a standard cost based flat rate per hectare basis. Additional payments can be received in both this scheme and the East Scotland grassland Management Scheme for capital items.

Approach to scheme monitoring
The Higher Level Stewardship element of the English Environmental Stewardship Scheme incorporates bespoke monitoring to assess the maintenance/improvement in the condition of features. In addition, parameters of uptake have been developed. Farmers are involved in the monitoring of the biodiversity interest of their land in certain of the German results-oriented schemes and in the Dutch Meadows Birds Agreements. Payments are only made in the Silvopastoral Project in Nicaragua after monitoring of land use changes has occurred. Remote sensing is used to prepare detailed maps for each holding and non-participating control farms are also monitored. Bird indicator species are used in this instance to verify that conservation services are being provided.

3.3.2 Synthesis of the review

From the review of the advantages and disadvantages of PBR a number of key issues can be synthesized. According to the format of the review, the synthesis differentiates between the administrative, economic, social, ecological and monitoring aspects of implementing PBR agri-environment measures. Where appropriate, the synthesis specifically refers to the different components of PBR schemes.

General aspects

The objectives and environmental targeting of the examples we reviewed concentrate on biodiversity conservation with a particular focus on grassland habitats and plant species (examples 1-7) coupled with some examples focussing on specific animals and birds (e.g. example 10). Schemes addressing wider environmental issues such as diffuse pollution or carbon sequestration are referred to in the literature (e.g. Landell-Mills and Porras, 2002; Mayrand and Paquin. 2004), but relatively few are well-established or can truly be seen as PBR. In addition, the same few examples tend to be cited in the literature. Hence only the Regional Integrated Silvopastoral Ecosystem Management Project in Nicaragua (example 16), The Auction for Landscape Recovery pilot scheme in Western Australia (example 15) and one of the Brandenburg case studies (example 5) refer to landscape-scale objectives. The example from Brandenburg (5) represents only a modelling exercise simulating environmental indicators from which basis a prototype scheme can be developed. The lack of established examples for schemes targeting wider environmental issues such as diffuse pollution reflects the complex nature of implementing agri-environment measures at catchment or even larger scales.

Generally, the examples we have chosen are in different stages of the scheme development ranging from experimental modelling exercises to mainstream agri-environment measures implemented for a number of years (e.g. HLS in England (example 2)). Overall, many of the examples we have reviewed represent pilot schemes implemented at local or regional level.

Administrative aspects

Prototype agri-environment schemes are likely to entail higher administration and transaction costs as scheme implementation and operation cannot build on previous experience. This was particularly evident in the Regional Integrated Silvopastoral Ecosystem Management Project in Nicaragua (example 16). Because of its pilot nature, the Silvopastoral Project has relatively high costs for detailed monitoring and other activities that would not necessarily be needed in a scaled-up project (Pagiola et al., 2007).

Generally, there is a link between the complexity and degree of environmental targeting of the payment design. The more complex the environmental targeting and planning of PBR schemes, the higher that administration costs can be expected to be. Improved environmental planning through site specific plans as applied in the East of Scotland Grassland Management Scheme (example 1) increases administration costs. The Higher Level Stewardship Scheme in England (example 2) integrated outcome-based indicators to improve environmental targeting whilst at the same time trying to maintain the advantages of relative administrative simplicity arising from the use of standard agri-environment measures. Despite that, data from the Rural Development Service suggest that administration costs of the Higher Level Stewardship Scheme are around 40% of the total scheme spend per year (although this figure was associated with the launch stages of the scheme and initial peak activity), in comparison to less than 10% in the Entry Level Scheme offered to English land managers. Comparable figures for ESAs and Countryside Stewardship schemes range from 15-30%. This provides an indication for the high level of administration costs in pure PBR schemes.

Implementing a more complex scheme implies that administrative staff need to be sufficiently trained to evaluate the economic and environmental merits. It could also be reasoned that more complex schemes will require greater resources in the form of extension services. Similarly, potential reductions in administration costs through farmers' involvement in the monitoring of results, as applied in the Lower Saxony case study (example 4), need to be balanced against the necessity of providing sufficient

training to participants. While the discussion so far concentrates on the potential impacts of the design of PBR schemes on administration costs, it is also important to ensure that the scheme administration does not have adverse effects on the efficiency of the agri-environment measure. For instance, high uptake targets within the Conservation Reserve Programme in the US (example 13) reduced the effectiveness of the Programme and meant that virtually no bids would be refused.

Improving the environmental targeting of agri-environment measures can be seen as an investment in future environmental benefit. In other words higher administrative costs will be rewarded through increased environmental benefits in the future. However, there is a lack of experimental evidence to support this argument and it is often suggested in the literature that more work is needed in order to clarify both the extent and the type of future environmental benefits available through PBR agri-environment schemes.

Overall, the key challenge concerning the use of the PBR approach is to establish a balance between administrative costs and the desirability of payment design to achieve maximum environmental gain. The risk that the administrative costs of more complex agri-environment measures will rise to a politically unacceptable level raises questions in relation to the compromises that will be needed to ensure the application of the PBR approach in future. The outcome of the stakeholder workshop emphasised two possible approaches to this issue:

a) combining the use of targeted outcome-based elements with existing action-based agri-environment support (instead of seeking to implement comprehensive PBR approach immediately)

b) implementing small-scale PBR schemes at local level in addition to mainstream agri-environment schemes.

Economic aspects

Payments in the agri-environment schemes we reviewed are conditional on the fulfilment of outcome-based indicators. Examples of such an approach include the use of a threshold number of indicator species in the case studies in Lower Saxony and Baden Württemberg (examples 3 and 7), sward heights in the East of Scotland Grassland Management Scheme (example 1) and number of nests in the Dutch Meadow Birds Agreements (example 10). In addition, a number of the examples we reviewed differentiate between different environmental qualities which are then rewarded using different payment levels. This direct linkage between payment level and the environmental result achieved represents a very different approach to standard action-based agri-environment schemes and can be seen as a key feature of PBR schemes. The experience from the Lower Saxony case study (example 6) suggests that directly linking payments to the ecological results achieved leads to a more efficient use of public funds compared to existing agri- environmental measures. Similarly, different payment levels were also linked to different environmental outcomes within the Farm Conservation Scheme in the UK Peak District (example 3). The Oekopunkte scheme in the Federal State of Lower Austria (example 8) is unusual in comparison, because the farmers can accumulate bonus points for actions deemed to be ecologically valuable. These points can then be converted into bonus rates that can be as high as 363€/ha. However, it is not clear how the different payment levels have been calculated and thus how the link between economic and environmental value or outcome has been established.

Adverse selection problems also need to be addressed during scheme implementation. This term refers to situations where the “wrong” farmers with low potential for increasing environmental outputs enter conservation agreements. For example, in

action-based agri-environment measures, a farmer who is already using extensive farming methods is often described (e.g. Latacz-Lohmann and Schilizzi, 2005). In comparison with a farmer using high-input technology, an extensive farmer has greater incentive to sign up for an agri-environment agreement stipulating reduced usage of pesticides and fertiliser, because fewer changes need to be made to current farming practices. Selection of the more extensive farmer results in comparatively small additional environmental benefits and the overcompensation of compliance costs (representing windfall profits). However, the extent to which this is regarded as a problem depends on whether one believes that it is the amount of work involved rather than the outcome that should be remunerated through agri-environment measures. If the achievement of specific environmental targets and values represent the key objectives of agri-environment schemes, then the outcome is what matters. Consequently, if an outcome based approach is used to underpin scheme design, then it appears justifiable to pay for the maintenance of habitats (provided these are of the desired environmental value) and to be less concerned about the extent of changes in farm management practice.

This discussion emphasises the need for clear definitions of desired results including qualitative and quantitative thresholds and baselines. Moreover, the Regional Integrated Silvopastoral Ecosystem Management Project in Nicaragua (example 16) showed that economic incentives can have perverse, detrimental effects if sufficient care is not taken in clearly defining outcomes and baselines in advance. In this case the Scheme had to be modified to deal with the threat by some farmers that they would cut down existing trees in order to increase the level of subsequent environmental improvement (and hence their payments).

A range of cost-based approaches are used within the reviewed examples in order to quantify payments. Flat rate payments based on standard costs use average (or in some cases typical) cost figures, whilst schemes based on actual costs incurred and auctions consider the marginal costs applicable to each individual scheme participant or bidder.

Our review paid particular attention to the application of auctions as a tool for quantifying the payments applicable in agri-environment measures. In addition to the case study from Lower Saxony (example 6), the Conservation Reserve Programme (example 13), the Bush Tender pilot scheme (example 14) and the Landscape Recovery pilot scheme (example 15) were all added to the review in order to examine the auction approach. Auctions are discussed in the literature as a mechanism for improving the cost-efficiency of agri-environmental measures by addressing the adverse selection problems that arise within standard cost approaches. These are caused by the fact that Government Agencies tend to have less information about the real costs incurred in changing agricultural management practices than do scheme participants (Groth, 2005, Glebe, 2007). In the context of PBR schemes, auctions provide a tool for considering farmer's individual cost structures as part of producing the desired environmental outcome. However, the potential of auctions to improve the cost-efficiency and reduce the windfall profits accruing to some participants has been shown to be limited due to strategic behaviour of farmers and learning about bid caps. Basically, farmers will learn from their previous experience with auctions and adapt their behaviour in subsequent cases, thus reducing the cost-saving potential of this approach (Hailu and Schilizzi, 2004). Such problems were reported in both the Bush Tender pilot scheme (example 14) and the Conservation Reserve Program (example 13).

For a bidding system to be effective, land and farm management changes associated with a specific environmental outcome must be difficult to assess and farms must be heterogeneous in their costs to achieve the outcome. Moreover, there must be enough

farms involved in the bidding to ensure sufficient competition. In other words, if the costs of the management changes needed to achieve a given environmental outcome can be quantified relatively easily, the costs are similar across a wide range of farms and only a small number of farms are likely to take part in the bidding, there is no need for such system (Latacz-Lohmann and Schilizzi, 2005). In such situations, auctions are not the appropriate incentive mechanism and fixed-rate payments or individually negotiated grants should be considered instead.

The extent of windfall profits depends on payment design and is a particular issue for agri-environment measures such as the Higher Level Stewardship Scheme (example 2) which use a standard cost based approach to establish the level of payments. Variations in participation costs across a heterogeneous sample of farms are not taken into account by flat rate payments which are based on standard (i.e. average or typical) cost figures. However, more evaluation is needed to establish the extent to which current payment rates cover the costs incurred by participating farms and whether the use of differentiated payment rates would improve the effectiveness of the scheme. On the other hand, windfall profits are generally difficult to avoid and even the use of approaches such as actual costs incurred (in particular if applied on a cost-share basis) can result in windfall profits, albeit at a lower level (Schwarz et al., 2007). In the context of the PBR approach, the key issue is to be to decide on what level of windfall profits are acceptable to produce the desired environmental outcome and quality.

Case studies from Brandenburg and Lower Saxony (examples 3, 6) confirmed the PBR schemes do indeed promote entrepreneurship amongst farmers. As with auctions, farmers also benefited from greater flexibility in some PBR schemes as they could bid according to their specific cost structures and farm characteristics (example 6).

It is also important that payment design in PBR takes into account the higher exposure of farmers to risk and uncertainties. This could be overcome by paying part of the financial support as a lump sum at the beginning of the contract as a reward for introducing the required management changes, or by using flexible payment rates to address the impact of external factors such as extreme weather on outcome indicators. The agreed timetable for payments also needs to reflect the delay between farmers' input and the achievement of the environmental outcomes. The use of performance components (bonus payments) in addition to a fixed basic payment can help to integrate result-based elements into standard agri-environment measures and improve the environmental targeting, whilst at the same time addressing farmer concerns about risk and uncertainty. Such approaches have successfully been implemented in a number of schemes such as the MEKA-Programme in Baden Württemberg (example 7).

Social aspects

PBR schemes provide farmers with greater flexibility in responding to site specific conditions and this is likely to increase the acceptability of such schemes. Evidence that PBR schemes are more acceptable to farmers is available from the MEKA-Programme in Baden Württemberg (example 7) where the majority of farmers preferred a combination of outcome-based and action-based incentives instead of purely action-based schemes. Similarly, outcome-based indicators are used within both the HLS and East Scotland Grassland Management Schemes (examples 1, 2). On the other hand, if the fulfilment of outcome-based indicators requires significant changes to farm management, this might result in cultural resistance from farmers unwilling to move away from a focus on agricultural production (Burton et al., 2008).

An additional advantage of PBR is that farmers can employ their skills and knowledge to achieve the desired environmental outcome: the responsibility for achieving the result is to a certain extent transferred back to the farmer. This could help to increase

farmers' sense of scheme ownership with a greater sense of achievement when the desired result is achieved, particularly if successful management of land for conservation or environmental increases is recognised amongst the farming community. It is conceivable that this sense of achievement may be enhanced if the general public are made more aware of the active role that farmers can play in producing ecological and environmental goods and services.

It is also possible in certain situations that PBR schemes could tap in to local administrative structures, and by doing so, gain greater acceptance amongst participants. For instance, in the Conservation Performance Payments in Sweden (example 12) the decision as to how to make payments is devolved to the level of the village administration.

Existing standard agri-environment measures operate mainly at farm-scale, while environmental issues increasingly need to be addressed at landscape and catchment scales. This emphasises the possible role of PBR schemes in providing incentives for cooperative actions. Evidence from the Environmental Cooperatives in the Netherlands (example 9) confirms that working across whole landscapes rather than in a piecemeal manner has improved policy design and enhanced the delivery of environmental benefits (Franks and Gloin, 2007). Some of the other schemes we have reviewed have also tried to promote collective actions. The Auction for Landscape Recovery pilot scheme in Western Australia (example 15), encourages joint bids for conservation sites that cut across ownership boundaries or would benefit from coordinated management. However, cooperative action implies that land managers work together on a willing basis, and this often requires the development and maintenance of clear incentives to collaborate.

Providing payments for the achievement of collective environmental outcomes may create sufficient incentives for co-operation among farmers across several holdings. However, issues such as the "free-rider problem" and how best to reward individual contributions to a collective achievement need to be addressed in the payment design. In addition to the use of financial incentives to promote the collaboration of farmers within a single agri-environment agreement, social pressure may also help to achieve the required level of participation. Depending on the outcome required from a particular agri-environment agreement, simply ensuring cooperative action through the use of economic incentives may be enough to deliver the desired environmental benefits. Where the environmental outputs provided by each farmer are not simply additive, but are connected through complex and interdependent relationships requiring different inputs at different times, greater co-ordination of land management activity will be required.

In situations where cooperatives include non-farmer stakeholders (example 9), farmers may benefit from feeling that their conservation efforts are being valued and there is the potential to achieve a greater understanding amongst all participants. Moreover, co-operatives have an advisory and training role and can mediate between farmers and relevant agencies. However, the success of cooperative schemes in the Netherlands may not translate easily to other European countries. For example, the collective approach may not work in countries where enforced co-operation has left a legacy of distrust. In the UK context, Davies et al. (2004) reports on the challenges involved in promoting cooperative agri-environment action in Scotland and explain why cooperative agri-environment measures can be viewed with reticence by UK farmers. On the other hand, some successful examples of such co-operation do exist in the UK. For example, at the stakeholder workshop it was pointed out that co-operation has been successfully achieved, without the use of a bonus payment, in an HLS scheme (example 2) requiring the entry of three farms, each with complementary prescriptions to ensure the conservation of wading birds. Similar examples also exist on common

land in England and Wales (Mills et al., 2006).

Ecological aspects

Improved delivery and targeting are key advantages of the PBR approach. A PBR approach, in comparison with a prescription based approach, encourages greater focus on the results. This potentially allows the farmer more flexibility in the management of the land and could improve the environmental targeting. The diversity of the environmental outcomes targeted and the different scales of the schemes we have reviewed emphasises the need for clear definitions of both desired outcomes and underlying rationale. Consistency between the application of the scheme and the scale of the targeted environmental output is important. In addition, the implementation of PBR schemes (or even the incorporation of outcome-based incentive elements into action-based agri-environment measures) requires the definition of suitable ecological indicators. The choice of indicators has important effects on the environmental outcomes of agri-environment measure as well as the associated land management activities.

The use of broader indicators creates problems concerning the sensitivity of changes in these in relation to land management. For example, the use of plant genera, rather than of species, in the MEKA Programme in Baden Württemberg (example 7) means that indicators are identifiable by the farmers concerned, and therefore of practical use, but the impact of land management on changes in these indicators is less clear. Transparency is a key issue for successful implementation and operation of agri-environment measures. PBR schemes do not involve prescribing particular activities to farmers, but the transparency of outcome and its validation and measurement are important not only for farmers, but also in the context of international acceptability. The use of complex indicators such as the scoring index for multi-dimensional bids in the Auctions for Landscape Recovery pilot scheme in Western Australia (example 15) could lead to a reduced transparency and clarity of the scheme.

The use of a wide range of indicators for different habitats in the Higher Level Stewardship Scheme (example 2) may help to ensure that the management of a site is appropriately tailored to local conditions, an important condition for nationally implemented schemes. However, a balance needs to be struck between allowing sufficient flexibility in the range of indicators being used and ensuring that they are specific enough to be used in assessing that objectives are being achieved. The use of particular species to indicate that management actions are achieving the desired result needs to be robustly tested to ensure that the indicators are suitable for the range of habitats in which they are being deployed, in particular that they reflect the wider range of species associated with, for example, semi-natural grasslands.

The East of Scotland Grassland scheme (example 1) incorporates indicators based on a range of sward heights per site. The thinking is that variable sward heights should sustain a greater range of plant and invertebrate species than would otherwise be supported by more uniform vegetation. The scheme specifically targets statutorily protected sites but the inclusion of adjacent undesignated patches of habitat is also possible. This highlights the point that the ecological functioning of a site must be considered in the design of schemes that target the conservation of biodiversity and some of the complex issues which may need to be considered in the design of a scheme. Whilst it may be feasible to secure management practices that create suitable habitat conditions, this effort will have been in vain if the wider ecological circumstances are unsuitable. Will the target species be able to utilise the site for all of its life cycle requirements? If not, is there suitable habitat that could be utilised nearby or is it too far away? Will the area of managed habitat be sufficient in size to maintain metapopulations of species (populations of a species that exist at the same time but in different locations thus allowing the occurrence of natural patterns of extinction and

colonisation through the process of dispersal) or is it too small and too isolated? This discussion emphasises that desired species composition and plantings have to be consistent with the local landscape character and that the targeted outcome should be integrated in a landscape plan to fully utilise the ecological potential.

Monitoring aspects

The implementation of PBR schemes (or the incorporation of results-oriented elements into agri-environment schemes) increases the complexity of monitoring requirements. Visual monitoring can help to reduce the resources required and can be conducted by the farmers themselves. Experience from the Dutch Meadow Birds Agreement (example 10) shows that monitoring by farmers and volunteers seems to work well with easily identifiable indicators. In the MEKA Programme (example 7), visual monitoring has been facilitated by the use of readily identifiable plant indicators.

The monitoring of species richness is a common approach in many of the examples we reviewed. However there are other criteria, such as abundance that may be monitored. The level of monitoring required depends strongly on the defined outcomes. Similarly, the required frequency and intensity of the monitoring varies according to the defined outcome and indicators, but, the balance between monitoring costs and environmental outcome needs to be considered.

The responsibility for monitoring varies in the examples we reviewed. While in the Lower Saxony case study (example 6) farmers carry out the monitoring of indicator species, the paying agency conducts random checks of indicator species in the MEKA Programme in Baden Württemberg (example 7). Little if any information is given in the literature on how self-reporting by farmers on sward heights and other indicators is verified by the paying agencies. Also, if farmers have to conduct the monitoring in PBR, would they need to be paid for such work, as suggested by the Austrian case study (example 8)?

Discussions at the stakeholder workshop emphasised the importance of putting monitoring in place at the outset of any new scheme (including the monitoring of farmers' attitudes) so that there is a baseline with which to work in future. Monitoring clearly needs to underpin the use of bonus payments (as incentives for providing particular high environmental quality) and with penalties designed to minimise non-compliance and moral hazard problems. The principal-agent literature on compliance suggests that expected penalties for non-compliance influence compliance rates and that expected penalties are related to both headline penalty rates and the risk of detection. The latter is a function of monitoring effort, meaning that - at least to a certain degree - monitoring effort and headline penalties should be set jointly, with higher rates of one allowing for reductions in the other (Laffont & Tirole, 1993; Moxey et al., 1999; White, 2002; Fraser, 2002 & 2004).

However, care is needed to ensure that the features can be easily measured, especially when penalties are high or where rewards are contingent on compliance. From a Government perspective it is impractical to monitor every farm so it is preferable to monitor at just one point in the process and leave farmers to work out how to achieve the desired result themselves.

Payment calculations and WTO Green Box criteria

The preceding analysis has explored various aspects of scheme design without addressing the element of how payment rates should be calculated. Four main issues arise here:

- As part of most current agri-environment schemes developed under the RDR, payments are based on additional costs incurred and income foregone (plus a

modest allowance for transaction costs) in return for adhering to scheme prescriptions. This may be an appropriate basis for calculating payments when they are for actions rather than outcomes. That is, in action-based schemes it is the changes in input usage or management process that is being paid for and payments may be viewed as compensation for making such changes.

By contrast, a PBR approach shifts the focus to rewarding outcomes and – in a market situation – it can be argued is the value of these outcomes that should determine the payment rate, rather than the costs incurred in their generation. Designing a scheme to achieve specific outcomes but then setting payment rates with reference to the costs of actions that may be required rather than the value of the outcome is inconsistent. It may also be inefficient if there are a variety of different ways of achieving a given outcome.

- Whilst some situations may lend themselves to market–based approaches where outcomes are valued and paid for privately[2], the majority of agri-environmental benefits – whether targeted indirectly through action-based schemes or directly through outcome-based ones - are likely to remain as public goods. This means that most payments will continue to be made through Government Agencies with some means of identifying the level of demand being needed in order to set appropriate budgets and prices. This suggests using non-market valuation techniques, yet these remain contentious and often under-utilised in policy decisions (Randall, 2002; Adamowicz, 2004; Pearce, 2006).

- The RDR's restriction to using additional costs and income forgone as the basis for calculations merely reflects constraints imposed by strict interpretations of World Trade Organisation (WTO) rules on Green Box eligibility. That is, inclusion of any policy instrument in the Green Box is conditional on it having no, or at least, minimal distorting effect on trade patterns. This means that it should not influence the level of commodity production. In the case of environmental instruments, the Agreement on Agriculture (AoA)[3] goes further and specifies that payments can only be made on the basis of additional cost and income foregone.

  Consequently, the domestic scope for altering the basis of payment calculations is limited without a softening of the stance adopted by the relevant WTO panel. Yet although agri-environment schemes are viewed with suspicion by some trading partners, some commentators have suggested that even the existing AoA could allow other approaches to payment calculations if the panel were to adopt a more flexible stance (Anderson, 2001; Blandford and Boisvert, 2002; Smith, 2006). The preamble to the AoA implicitly acknowledges the legitimacy of domestic policies to address environmental market failures as non-trade concerns, and agri-environment schemes could thus be viewed as trade correcting or at least as less trade distorting than previous policies – a stance already adopted by other WTO panels when considering policy changes. This would however require high-level negotiations and an ability to demonstrate the limited impact of public good provision on commodity trade (Latacz-Lohmann and Hodge, 2001; Blandford and Josling, 2007; Blandford and Hill, 2008).

[2] For example, the use of cap & trade for carbon emissions or maintenance of water quality for a dominant user such as mineral water bottling plant.

[3] The Agreement on Agriculture (AoA), reached at the Uruguay round of the General Agreement on Tariffs and Trade (GATT), specifies a number of criteria under which the WTO scrutinises agricultural policy to determine its acceptability. (http://www.wto.org/english/tratop_e/agric_e/ag_intro00_contents_e.htm)

- The use of auctions as an alternative to setting a flat-rate payment is attracting increasing interest and is mentioned explicitly within the current RDR (Eggers et al., 2007). Although there are some concerns about their long-term effectiveness, the main attraction of auctions lies in their potential to address heterogeneity in the costs of environmental service provision – to reflect underlying variation in site conditions, practical managerial options and individual land managers' resources, skills and motivations. Relative to an average or flat-rate payment system, auctions can either achieve the same level of scheme enrolment at a lower total cost or expand enrolment within a given budget (Latacz-Lohmann and Schilizzi, 2007).

  Although auctions have been mainly considered in relation to action-based schemes, they are also applicable to outcome-based schemes since heterogeneity across land managers will still be relevant. In this case, bids would be invited for delivering outcomes rather than following management prescriptions, which would allow for greater variation and (local) innovation in management methods and resolve the tension arising in PBR schemes that seek particular outcomes but still reward actions. However, whilst the use of auctions in this manner might satisfy WTO rules, the requirement to demonstrate only limited trade effects would remain and is perhaps a more challenging task. Equally, whilst auctions may avoid the need for government agencies to collate average cost data, they also highlight once again the need for some demand-side measurement to establish the maximum unit price or aggregate quantity that public expenditure should be supporting.

Conclusion and generic principles

PBR schemes can improve the environmental targeting of agri-environment measures in comparison to the payments based on management prescriptions. PBR approaches are potentially more likely to deliver environmental benefits and more targeted, because their focus is directly on the objectives on the ground rather than indirectly on prescriptions to establish certain land management activities. Thus, PBR approaches allow more flexible land management to achieve the environmental objectives and provide more scope for innovation than standard prescriptions. However, at this stage there is limited evidence available from the examples we have reviewed to support this. More empirical work and research on the causal links between land-use, farming-system practices and their environmental outcomes is critical to identify the locations and activities that will generate the highest environmental service benefits and for designing effective PBR schemes (FAO, 2007).

When seeking to implement PBR schemes it is critical to define both the desired outcome and underpinning rationale of the measure. In some cases, the PBR approach might not be the best option. Moreover, care needs to be taken to establish the scale at which a PBR approach could be applied and defined. It is likely that it would be most appropriate at a local or regional level, as administration costs through greater requirements in terms of scheme implementation, monitoring and training of administration and farmers may not allow for large scale implementation at national level. The most significant role for PBR schemes may be as additional agri-environment support targeting local environmental issues in specific areas.

PBR schemes have the ability to address the need for landscape scale agri-environment measures and to provide specific economic incentives for collective actions of farmers to improve the ecological potential of land management. On the other hand, the need for co-operation and co-ordination of different activities between farmers implies higher demands on scheme management and administration (an issue not unique to PBR approaches). Such issues need to be addressed before a scheme is implemented.

PBR approaches may also expose farmers to greater risks of non-payment due to the uncertain nature of future environmental change. A range of external factors can affect the outcome of management activities. Such risks need to be taken into account in the design and timetable of payments under the scheme (Forest Trends, The Katoomba Group, and UNEP, 2008). Potential options may include incorporating a risk premium or perhaps splitting payments between a guaranteed element for participation plus a bonus upon delivery of the desired outcome.

On the other hand, a PBR approach may be a useful tool in stimulating the interest of farmers as it is in line with the current culture of producing for the market. Self-monitoring may also help to increase the environmental awareness of farmers and their acceptance of the objectives of agri-environment measures. Such an approach may also make farmers realise that their agri-environment efforts are valued by society, particularly if joint initiatives with other stakeholders are undertaken.

Care needs to be taken to justifying what is being paid for- the effort required or the desired outcome. If specific environmental targets and values are the key objectives of agri-environment payments, then the outcome is what matters. Consequently, if an outcome based approach is taken then it seems justifiable to also pay for the maintenance of habitats (with the desired environmental value). Maintenance payments for habitats of high environmental quality can be seen as one of the easier areas in which to deploy the PBR approach.

There is often an inconsistency in the sense that outcome targeted payments can still be based on agricultural income foregone. The risk of trade distortions and, generally, narrow interpretations of current WTO rules restrict methods for payment calculations of agri-environment measures and do not promote outcome-based approaches beyond agricultural income foregone and additional costs. However, at the moment it is difficult to see that what the alternative approach might be. More work is required to further evaluate alternative options.

In summary, the outcome of this review suggests that the PBR approach has the potential to improve the environmental targeting of agri-environment measures. We conclude that this approach should be further tested through the implementation of prototypes at local level and the incorporation of specific outcome-based elements such as bonus payments in standard prescription-based schemes.

Based on the outcome of this review, some general principles are derived for the practical implementations of PBR schemes (although some would also apply to any AES). These principles are listed below and form the basis of the discussion of scale-specific applications of PBR schemes in section 4.

General principles for payment-by-results schemes (or elements)

- Aims, outcomes and delivery mechanisms of a scheme need to be clearly defined prior to scheme implementation.
- Prototype payment-by-results schemes need to be simple, applicable at local level and easily understood by farmers, administrators and others involved.
- The feasibility of integrating outcome-based elements into existing prescriptions-based agri-environment measures should be explored.
- Close links between farmers actions and environmental outputs need to be established to ensure that the desired outcomes can be measured with relative reliability, confidence and at reasonable cost and payments can thus be justified.
- Payment design needs to address the risks faced by farmers and provide incentives for the delivery of higher level outcomes, for example by combining a fixed base payment with a performance or bonus component.
- The feasibility of quantifying payment levels based on ascertaining marginal costs to participants (e.g. through individually negotiated grants or auctions) should be explored on a case-by-case basis.
- Farmers and other land managers need to be involved in the process of establishing PBR schemes to ensure that local environmental knowledge is harnessed as part of seeking to produce environmental benefits.
- The promotion and co-ordination of collective actions to achieve the targeted environmental outcomes need to be considered as part of scheme design.
- Spatial equivalence between the application of the scheme and the scale of the targeted environmental outcome needs to be taken into account.
- The targeted environmental outcome needs to be consistent (and integrated) with the broader local environment and landscape character.
- The choice of outcome indicators needs to reflect a balance between the ecological complexity of the targeted outcome and the practical implementation and management of the scheme.
- For certain PBR schemes, such as those targeting particular species, it may be appropriate when setting targets to consider the overall level of species populations that is ecologically desirable.
- Adequate frequency and intensity of monitoring need to be set up and clear linkages between the monitoring of the outcome and a bonus or penalty system need to be established.

4. DEVELOPMENT OF TWO PROTOTYPE PAYMENT-BY-RESULTS SCHEMES

4.1 Habitat/species oriented prototype

This review suggests that the Payment by Results (PBR) approach has the potential to improve the environmental targeting of agri-environment measures. We conclude that this approach should be further tested through the implementation of prototypes at local level and the incorporation of specific outcome-based elements such as bonus payments in standard prescription-based schemes. Similar conclusions emerged during the London workshop, where the main debate centred around whether a PBR approach was of practical use in support schemes aimed at the management of habitats and species. The general conclusion was that PBR was best viewed as an approach that had the potential to be trialled and tested alongside the current use of more prescription-oriented schemes. However, further guidance was required on when, where and how PBR could best be applied.

The basic principle behind PBR is easy to grasp and relatively easy to visualise and describe, once a particular environmental outcome has been defined. However, it is the detailed delivery mechanism which are far more complex, especially in terms of managing the risk both farmers and funders, and designing cost-effective payment and monitoring schemes. The following highlights some of the key questions/issues which need to be taken into account when thinking of implementing a pilot PBR scheme with a focus on habitat/species concerns.

General principle
Ideally any scheme, whether PBR or not, needs to be transparent and its aims and delivery mechanisms easily understood by all concerned. The working of such a scheme needs to be relatively simple in order to encourage buy-in to the approach in the first place and ensure farmers understand what is expected of them, thereby fostering general good-will within the wider farming community which will be essential to underpin future attempts to establish more complex PBR schemes.

Biodiversity focus
While it is feasible to imagine the PBR approach being used to target a wide range of desired biodiversity outcomes (e.g. from individual plant species through habitats to populations or communities of more mobile organisms such as butterflies or birds), when considering a pilot approach it is more relevant to focus on a biodiversity target which is more closely influenced by the condition and management of an individual site (as opposed to targets which are more strongly influenced by factors potentially outwith the control of the target site manager). Such targets should help set the desired outcome in a relatively simple way and maximise the opportunity for these outcomes to be achieved. While both site and wider environmental factors impact on a wide range of species, it seems more practical to build a pilot PBR scheme around a focus on vegetation or plant species. However, management solely for an individual plant species can be just as complex and prone to outside influences as that for more mobile species. Hence setting the required outcome in terms of the desired characteristics of a particular habitat or plant species assemblage (and allowing for a range of variation within those characteristics) appears potentially easier to implement in practice.

Setting the desired outcome
The desired biodiversity outcome needs to be set not only at the level of the individual site (in order to help the manager visualise the management that is required at that site to achieve that outcome) but also at the level of the scheme itself. This will help set the wider context, help target the most relevant sites to incorporate into the scheme (in

terms of the amount of that habitat in the region that is desirable to target) and just as importantly help establish the budget required for the scheme. The amount of habitat does not necessarily have to be set at a level which implies any threshold above which the total biodiversity gains are more than the sum of the parts. While in an ideal situation this would be so, in practice such a level will generally simply reflect the scale of effort being asked of the pilot scheme as a whole. It is most appropriate to set the rationale behind a PBR scheme (and especially a PBR pilot) at a regional or local level, since not only is there greater understanding of the issues at such scales but also better understanding of the potential solutions. Hence appropriate guidance can be more readily supplied to managers.

However, at the individual site level, it is essential that the desired outcome should be set at a level which is easy to assess and monitor (both by the farmer as well as any regulatory body) and is ecologically meaningful and hence justifiable from a biodiversity perspective. A simple focus on the occurrence of a number of certain species may appear easier to assess, but in reality there will be a need to incorporate some indication of the desired overall cover of these species into the desired required outcome. It will also be necessary to incorporate some description of the vegetation structure which needs to be achieved in order to obtain the biodiversity benefits associated with that overall cover.

Careful consideration of the desired outcome will be critical to the overall success or failure of any PBR scheme, since all other aspects of the scheme (payment rates, timescale, attractiveness to farmers, transaction costs, etc) will relate directly to this desired outcome.

Maintain or enhance

During the London workshop, the point was made that it is probably easier to use PBR initially as a way of maintaining sites at a level where the desired biodiversity goals are already evident. This makes it easier to set the desired outcome (as it can be based on the existing condition and structure of the vegetation and hence is easier to describe) and in most instances the manager will already be aware of the management needed to achieve that condition and structure. In addition, if the desired biodiversity goal has already been achieved and the aim of the scheme goal is simply to maintain this over a certain period, then the level of risk faced by both farmer and funder is reduced (since there is a high chance that the desired outcome will continue to be achieved over the timescale set). This also makes it feasible to reduce monitoring costs, since the desired outcome may only need to be at the start and the end of the scheme period. Hence the easiest type of PBR pilot scheme to consider developing would be one in which a percentage of a particular existing habitat type is targeted within a region with the desired goal of maintaining it in its current condition or above a threshold which is considered to represent good condition.

A pilot scheme focused on maintaining condition of existing valuable habitats still leaves a number of issues to be considered (including the level of payment, how closely to monitor, etc) but it is likely that it would be more comfortable for farmers to switch to such an approach. However, from the pilot point of view, such an approach would not really be a thorough test of the PBR method.

By contrast, a pilot PBR scheme focused on the enhancement of vegetation condition (especially if this potentially required a marked change in management as well as farmer attitude) could potentially provide a more rigorous test of the pros and cons and likely acceptability of the PBR approach. However, the overall design of such a scheme would be much more complex. In particular, when looking at payments one would need to consider not just what the payment is for but also how much it should be and when should the level of the payment be released. All three of these elements may act as

incentives to farmers to join the scheme or discourage them. For example:

- When seeking to instigate some form of change in vegetation structure from a set starting point, a realistic timescale needs to be established along which land managers could be expected to reach the desired outcome. As existing prescription-based agri-environment schemes generally run on a 5 year agreement period (and as any pilot PBR scheme would be expected to be run alongside such existing schemes), then this would dictate that the change required within the PBR scheme would need to be achievable within a five year period.

- When looking to achieve a desired outcome at some point within a five year timescale it may be more relevant to split the payment available into an annual 'basic participation' payment plus an additional annual 'bonus payment' when the desired outcome is achieved. This would serve to reduce the risk to both farmers (who otherwise may not choose to enter the scheme) and funders. However, setting the ratio between basic and bonus payment levels could be a complex issue in its own right.

- For example, within the Higher Level Stewardship Scheme in England, an annual payment of £280 per ha is currently made in return for undertaking to try and create species-rich, semi-natural grassland. If this total of £1400 over five years is taken as an example of the overall value set on attempts to create such grasslands, then this overall figure can be used as the starting point for considering what payment levels could be within a pilot PBR scheme focused on the creation of the same type of grassland. Therefore one could envisage setting the basic participation payment at £100/ha/annum (i.e. the farmer was guaranteed to receive £500 over the five year period) with the added incentive of an additional payment of £300/ha/annum available once the desired outcome was achieved. From the starting point of an intensively grassland sward, then one would expect that the average farmer would not be able to achieve the desired outcome until at least year three of the scheme (and hence over the lifetime of the scheme these farmers would receive a total of £1400 consisting of the £500 basic payment plus £900 in additional payment). In setting these example payment levels, it is taken into account that even when starting from a broadly similar set of vegetation conditions (such as this intensively managed grassland sward example) different sites may take markedly different lengths of time to achieve the desired outcome (because of the influence of historical management and nutrient build up, soil type and other local environmental factors, climate). Hence, some participants may be able to achieve the desired outcome earlier in the scheme while others may not achieve this until year four or five (if at all). From the schemes budget perspective, the cost of paying the additional payment to the former participants earlier than 'anticipated' would be offset by the fact that the latter participants would not draw down the full amount of their potential additional payments.

- Careful consideration would therefore be needed of how best to spend (in this purely example instance) the average per participant of £1400/ha over five years that the funder would potentially be willing to pay for the creation of such grasslands. For example, in order to serve as appropriate incentives and rewards: what should the actual levels be?; should the basic payment reduce after a certain period?; how would those levels impact on the risk faced by the manager and funder?; etc. All these issues, cannot, however be divorced from the question of how often and how the sites should be monitored. Table 2 below highlights only a few of the pros and cons which would need to be taken into account when designing a payment and monitoring programme:

Table 2 Potential advantages and disadvantages of monitoring programmes

Type of monitoring	Potential advantages	Potential disadvantages
Annual by funder	Assesses site starting point is suitable for inclusion in the scheme Assesses whether site achieved outcome by end of scheme Allows payment of bonus payment to manager once desired outcome achieved	Substantial monitoring costs for funder Unlikely to be practical on any large scale
In years 1, 3 and 5 by funder	Assesses whether site starting point is suitable for inclusion in the scheme Assesses whether site achieved outcome by end of scheme Additional assessment at mid-point when many sites may be expected to have reached outcome	Still substantial monitoring costs, as all sites still need to be visited Potential disincentive to those who manage to achieve outcome by year 2 or 4, as would forego one year of bonus payment
Annual monitoring by manager and payment each year based on those results Proportion of sites visited each year by funder	Reduces monitoring costs for funder Gives manager more ownership of the scheme Gives funder some security in terms of random checks	Managers would need to be confident that they are assessing condition correctly Funder would need to be confident in managers ability to carry out monitoring in a reliable way

From a practical perspective it is difficult to envisage a PBR scheme where the farmers are not being asked to take some responsibility for the monitoring of the scheme (at least in part). This would, however, necessitate a change in mind-set and a realisation that by passing responsibility for achieving the desired outcome to the farmer, both farmers and funders will need to work in much closer partnership (with the need for mutual levels of trust and acceptance of potentially differing views) than is customary under more traditional pay-by-prescription schemes.

Conclusions

While the basic principle behind applying the PBR approach to habitat/species issues is relatively easy to grasp, the design and delivery of such an approach (even at a pilot scale) would in practice be quite complex. Building on the previous discussion, the following key points would need to be taken into account in the design of any pilot at habitat/species level:

- The working of any pilot scheme needs to be relatively simple in order to ensure effective understanding by managers of what is expected of them, encourage buy-in to the approach in the first place and thereby foster general good-will within the wider farming community for any attempts in the future to establish more complex PBR schemes.

- A pilot PBR scheme with its desired outcome set in terms of the desired characteristics of a particular habitat or plant species assemblage would be potentially easier to implement in practice.

- The desired biodiversity outcome not only needs to be set at the level of the individual site but also at the level of the scheme itself.

- A pilot PBR scheme focused on the maintenance of existing habitats would potentially be the easiest way of initially introducing the PBR approach. However, a pilot PBR scheme which sought to enhance (rather than simply maintain) vegetation condition would potentially provide more of a test of the pros and cons and likely future acceptability of the PBR approach.

- A pilot PBR scheme could be tested as part of existing prescription based schemes, e.g. by designing as PBR some elements of the required undertaking by the farmers. In the first instance it would be more relevant to attempt this approach in vegetation-oriented management prescriptions (such as grassland or woodland management) than attempting it with other prescriptions where the risk of achieving or even observing the outcome may be higher (such as with more mobile species like birds or butterflies which are also influenced by factors outwith the farmers control)

- The desired outcome and the payment levels available will have a major influence on the likely uptake by managers. It will be essential to be clear not only about what the different payment levels are for but also how much, when and on what basis each payment will be paid. All these factors have the potential to serve either as incentives or disincentives for managers when considering joining the scheme.

- If funders really want to test the potential of a pilot PBR scheme, then they will need to accept that there is some level of risk and some of the control associated with the scheme will need to pass from them to the managers on the ground.

4.2 Landscape scale oriented prototype

Introduction

Whilst a focus at the plot, field or farm level may be sufficient to target some environmental goods and services, others require a wider spatial perspective which takes account of patterns as well as extent. These include habitats that encompass a mosaic of different land uses and features across a relatively large area, or landscapes. However, even smaller areas of habitats and footpath networks often tend to straddle more than one farm, as do hydrological systems. Consequently, the delivery of many biodiversity, amenity and riparian benefits depends on a landscape or catchment scale approach.

This difference to plot, field or farm-level situations may also be described with reference to the distinction between independent, additive and joint, multiplicative effects (Rojahn, 2006; Meijerink, 2007). That is, for some environmental goods (e.g. carbon sequestration or local habitat provision) the aggregate effect of individual land managers' actions is largely independent of "who does what" and of "where they do it": individual contributions can simply be summed to give an overall benefit. This is to say that individual contributions are independent and additive and co-ordination between individual farmers is not required.

Yet many other environmental goods depend on the spatial arrangement of and connectivity between individual parcels of land. This means that it does matter "who does what" and "where they do it". That is, individual contributions interact, and overall aggregate effects are contingent upon the pattern of individual contributions. This can be illustrated by the maintenance of an attractive landscape or a mosaic of habitat types requiring a mix of different land uses and features across neighbouring farms.

In addition, whilst individual environmental services such as carbon sequestration, water management and biodiversity protection can all be identified and possibly delivered separately at the site-level, they are often "bundled" together at the landscape scale (Landell-Mills and Porras, 2002; Mayrand and Paquin, 2004). This is often reflected explicitly in multiple policy objectives, seeking the joint delivery of several outcomes rather than focusing on a single objective as tends to happen at the plot, field or farm level.

Relative to the habitat-scale, these multiplicative effects and the presence of multiple benefits/objectives pose some additional challenges with respect to designing policy mechanisms at the landscape scale. In particular, the separation of bundled outcomes can be difficult and measurement of outcomes attributable to individual scheme participants' efforts can be even more complicated than for habitat-scale schemes. Moreover, unless one land owner happens to control a sufficiently large area, mechanisms to encourage co-ordination of effort across individuals are required. These complications are encountered by current, payment for action instruments but are also problematic for PBR design.

Measurement & Monitoring

Measurement and monitoring at the individual habitat scale is hampered by both scientific uncertainty and the practical costs of inspecting multiple sites (White, 2005). These problems also apply to landscape scale outcomes, but are amplified by some additional complications.

Where effects are multiplicative (and in some cases where they are additive), it may not be possible to identify an individual's contribution to the overall outcome. Diffuse water pollution may technically be measurable at source, but it is usually monitored at selected points in-stream. This means that the observed outcome represents the combination of several individual land managers' efforts. This can make it difficult to calculate appropriate rewards (or penalties) for individuals. Indeed, if it is not possible to observe individual contributions, the problem of moral hazard avoided by PBR at the habitat scale re-emerges as a problem at the landscape scale with potential for "free-riding" within a group (Goldman et al., 2007).

In addition, where multiple benefits are involved, specifying the level of outcome required to trigger payment becomes more complicated since either separate payment elements are needed for separate outcome components or some system of weighting to combine different components into an overall outcome is needed. The latter approach is taken in the CRP (example 12), the bush tender (example 13) and the silvopastoral ecosystem management project (example 15). In the last case, an index - derived from available data and expert opinion - is used to estimate and aggregate different environmental benefits, with payments made conditional on improvements in the index score. Although not explicitly a landscape scale index, such an approach potentially allows identification and prioritisation of desirable interactions across the landscape (Crossman & Bryan, 2008).

Even if outcomes are observable or can be estimated through an index, apportioning relative values to the respective contributions made by different land managers may not be easy. For example, are all elements of a heterogeneous landscape mosaic or

sections of a network of footpaths or wildlife corridors of equal value or are some of greater (marginal) value? The latter raises the possibility of some land managers holding-out for higher payments than their already-committed neighbours, and/or threatening to withdraw (Goldman et al, 2007). Such strategic bargaining behaviour can undermine aggregate outcomes, but also raises issues of fairness in rewarding joint contributions where individual contributions are inseparable.

Need for co-ordination

In principle, provided that the value of measurable and monitored outcomes has been agreed, price signals alone could be sufficient to induce spontaneous joint working across individual land managers. This might simply be through the use of principal-agent theory to design contracts offering different incentives to different land managers, to avoid "cheating" by individuals and to deliver an aggregate outcome (Moxey et al., 1999; Ferraro, 2008). Equally, an "agglomeration bonus" could be used to encourage farmers to act together by progressively raising payment rates as more farmers and/or land joins a scheme (McFarlane, 1998; Parkhurst et al., 2002)

However, in practice, the effectiveness of such approaches has yet to be tested empirically beyond a few cases (Goldman et al., 2007). Moreover, the applicability to multiplicative, pattern outcomes or indeed multiple outcomes rather than simpler additive or single outcomes may also be questionable. For example, an agglomeration bonus will increase spatial coverage of a scheme but may not necessarily secure a mosaic of different land covers.

This suggests that achieving multiplicative, pattern-type outcomes across different land managers may require a greater degree of direction and co-ordination than can be achieved by the invisible hand of price signals alone. That is, if different contributions are required from different land managers and the choices available to any individual land manager are contingent upon choices made by neighbouring land managers, a degree of formal planning and negotiation is more likely to be required.

Possible ways forward

Taken together, these monitoring and co-ordination issues highlight the need to be clear about defining what the desired outcomes are and how they may be valorised, but also how rewards are directed fairly to those contributing to the outcomes. Consideration of how best to promote co-operative rather than individualistic behaviour reveals a need to address issues of governance and information provision as well as incentive design (Mayrand and Paquin, 2004; Goodman et al., 2007; Jackson et al., 2007; Pascual and Perrings, 2007).

Rather than entering into individual agreements with each land manager the Government could agree a collective contract with a group of land managers. This shifts the burden of individual monitoring and allocation of individual rewards from the Government onto the group itself. That is, provided that the aggregate outcome is achieved, a single payment is made to the group which then has to decide amongst itself as to how much each has contributed and how the aggregate payment should be divided. The Swedish conservation payments for carnivores (example 12) adopted this approach, with payments made to village leaders rather than individual villagers.

This approach has the attraction of internalising problems of individual monitoring and moral hazard, relying on peer-pressure and self-governance to achieve an effective and equitable outcome. However, its success depends partly upon the ability of a group of land managers to self-organise and self-regulate, and the capacity to do this may be weak in many cases. That is, individual land managers – and others in their community - may not necessarily naturally view themselves as a collective body, nor necessarily have the skills and experience to act as one (e.g. Davies et al., 2004).

This implies a potentially greater role for local community initiatives in delivering the necessary degree of cohesion and co-ordination for environmental outcomes. For example, Eggers et al (2007) point to the potential role of "Local Action Groups" funded through mechanisms such as LEADER under the EU Rural Development Regulation or other partnership arrangements. But they also acknowledge some of the practical capacity difficulties, a point echoed by more general literature on community initiatives and the need to develop human and social capital (Quirk, 2007; Slee et al., 2007).

This suggests that public assistance may be needed to support the formation of collectives, and indeed may be needed on an on-going basis (Franks & McGoin, 2007; Quirk, 2007). Such assistance may take the form of information and advice, possibly delivered through dedicated project officers. Equally it may take the form of financial support for administration and training. The use of financial incentives for co-operation, along the lines of agglomeration bonuses, may also be appropriate.

On-going research into community approaches to river catchment management may offer some insights into how incentives and governance might be designed to deliver collective outcomes in a UK context (Waterton, 2007; Anon, 2008; Smith, 2008), as may experience with Welsh common land (Mills et al., 2006). Parallels can also be drawn with the more general literature on management of open access and common resources and on sustainable development (e.g. Ostrom, 1990; Ostrom et al. 1993; Vatn, 2005, Meijerink, 2007). This again highlights the need to foster alternative institutional arrangements to improve social capital and (local) governance. The Dutch environmental co-ops and the Danish hedgerow groups (examples 9 and 11) also offer some insights, including the potential for group membership to be extended beyond land managers alone (see also OECD, 2008).

An aside: competition

In mimicking the operation of a market for environmental goods and services, PBR schemes seek to secure desirable environmental outcomes whilst possibly delivering new income streams to land managers and delivering improved value-for-money for public expenditure. Yet these last two objectives can be in conflict if competitive pressures are absent, leading to possible collusion amongst land managers to extract economic rent from the taxpayer.

The possibility of this problem stems essentially from perceived uniqueness of outcomes defined over a given area, or put another way, the lack of substitutability of outcomes between different sites. That is, a particular landscape or standard of water quality and quantity or habitat mosaic may be valued because of where it is as much as for what it is, and public acceptance of equivalent outcomes at other locations may be limited: outcomes are not fungible (Salzman & Ruhl, 2002; Kroeger & Casey, 2008).

If land managers in a given areas discern that they offer a unique and highly prized environmental service relatively insulted from external competitive pressures, they may seek to negotiate higher payment rates. To counter this, it may be necessary to impose some form of regulatory overview as with anti-competitive practices in other markets. Alternatively, it may be more realistic to simply signal that a degree of fungibility is acceptable and/or that payments can sometimes be replaced by alternative, less generous policy tools such as regulatory controls and direct state control. The need to design and target policies to deliver value-for-money as well as environmental outcomes is being increasingly recognised (Naidoo et al., 2006; Moreddu, 2007).

Conclusion

As noted by various authors, environmental services differ greatly in their characteristics and context, meaning that a one-size-fits-all approach is unlikely to be appropriate. This means that PBR may not always be the best policy tool and even when it is, the precise design may need to be tailored to the particular problem to be addressed (Landell-Mills and Porras, 2002; Schwarze et al., 2002; Pagiola et al., 2004; Wunder, 2005; Whitten and Shelton, 2005; Engel et al., 2008; Kroeger & Casey, 2008).

At the landscape scale, particular problems arise with respect to measurement and monitoring of multiple and multiplicative outcomes and to the need for differentiated yet co-ordinated contributions across individual land managers: "who does what and where" matters. These problems are not unique to a PBR but rather are characteristic of landscape scale outcomes and are shared by more traditional policy instruments. Nevertheless, as with the habitat-scale, it is apparent that a PBR approach merits some consideration. However, the policy focus probably needs to shift from contractual agreements with individuals to how best to award collective payments and support self-governance of groups of land managers.

5. CONCLUSIONS AND RECOMMENDATIONS

The main aim of the study is to investigate the practical feasibility of a PBR approach in more detail and to derive generic criteria for applying the PBR approach to agri-environment schemes within the UK. The main conclusions and recommendations presented here have therefore been set in the context of this overarching aim. The study also identified a number of more detailed objectives that it wished to consider. Aspects of these have been considered in different sections of this report and Table 3 provides an overview of the key findings arising from the study with regard to those detailed objectives.

Table 3 Key findings in relation to the specified objectives of the study

(a) One objective of the study was to examine the validity of the following previously stated potential advantages of the PBR approach:	**Brief summary of study conclusions with regard to each statement:**
○ It would create strong incentives to produce high-quality environmental goods and to develop innovative approaches to environmental management.	Statement appears valid. The strength of the incentive would, however, depend on the design of the scheme, especially with regard to the degree of risk carried by the farmers.
○ Farmers would be able to apply their superior knowledge in determining the methods used to supply the public goods on their particular holdings. There would be no need for separate payments for operational and capital items.	Statement appears largely valid. The farmers would need the required outcome to be clear, easily understood and readily identifiable. The potential need for capital items would also need to be taken into account in setting payment levels.
○ Payment by results would create incentives for co-operation among farmers across several holdings where this could enhance efficiency.	Statement only relevant if the biodiversity target and associated required outcome is one that needs to be addressed by farmers co-operating. It is feasible to envisage PBR approaches which are effective at the individual holding level. Moreover, different (local) governance arrangements may be needed as well as financial incentives to encourage co-operation.
○ A result-based payment scheme may reduce the need for compliance monitoring. Rather than monitoring farmers' actions, the environmental agency would just need to check whether certain output had been produced.	Statement appears overly optimistic. In many cases the monitoring of the required output will still require a substantial monitoring effort.
○ By allowing farmers more flexibility to achieve the desired goals PBR schemes would help offset criticism that the current agri-environment approach is too prescriptive, not adaptable to local conditions and thus ineffective.	Statement appears valid. In order to be effective, a PBR scheme will need to set targets and outcomes at a more local level. This in itself will help ensure that the goals are potentially more achievable.

(b) Another objective of the study was to examine whether the following difficulties with the PBR approach could realistically be overcome:	**Brief summary of study conclusions with regard to whether each potential difficulty could realistically be overcome:**
○ There is often a substantial delay, potentially of several years, between the adoption of changes in land management and the production of the environmental outputs. Farmers would require some extra financial incentive to compensate for the period before the return is received.	Difficulty potentially exists but could be overcome. Splitting the overall payment available between a guaranteed payment for participation plus a bonus on delivering the desired outcome would be one way of providing an effective incentive for farmers.
○ The relationship between changes in land management and the delivery of environmental outputs can be very uncertain, often depending on factors outside of the land managers' control.	Difficulty potentially exists, especially with regard biodiversity targets strongly influenced by factors in the wider landscape. This could be overcome by setting the target and desired outcome on a feature of the farm (e.g. habitat) where the development of the vegetation composition and structure is more clearly influenced by the land manager participating in the scheme. This may mean focusing on maintenance rather than enhancement.
○ Farmers are generally risk-averse (though not always) and so for this reason too would demand higher payment rates for the same level of uptake. We may note against this, that the government, operating a large number of contracts, may effectively be indifferent to risk and so it could be less costly (and more efficient) for government rather than individual farmers to take on this risk.	Difficulty potentially exists. However, the level of payment set in any PBR scheme needs to reflect the farmers achieving the underlying biodiversity objective. Hence obtaining any 'higher' payment rate needs to be conditional on achieving the biodiversity objective.
○ There is often no consensus over what counts as an acceptable environmental output or outcome. Even ecologists tend to disagree on this question in many cases, such as in the botanical composition of grassland.	Difficulty certainly exists but could be overcome. There needs to be an acceptance that the PBR approach will not be relevant in all current agri-environment concerns. However, through careful choice of the biodiversity feature to target (such as vegetation as opposed to mobile species) and setting the desired outcome based on local needs should help overcome this difficulty.

○ It may be difficult (and costly) to determine, measure and quantify environmental outputs to a standard that would satisfy the requirements of an enforceable, written contract. The output may not be readily observable at all times, such as a number of birds feeding on a particular area of land, and may anyway vary at different times of day or year. It may thus be difficult to replicate the determination of output levels and so raises the likelihood of complaints and appeals by farmers who feel that they have been treated unfairly.	Difficulty certainly exists but could be overcome through careful choice of both biodiversity feature of concern and the desired outcome to be achieved through the PBR approach. Involving farmers in some aspects of the monitoring process could increase their understanding of the issues and their feeling of being engaged directly in the delivery and assessment process.
○ Current WTO Green Box criteria limit payments to be based on additional costs and income foregone. Payments directly linked to environmental benefits would most likely not be condoned by existing WTO requirements. To increase the chance of the acceptability of such approach at international level, mechanisms have to be put in place to restrict potential production and trade effects to a minimum.	Difficulty certainly exists and is a large hurdle to overcome if true PBR schemes are to be introduced on a large scale. Any pilot PBR scheme will need to incorporate some assessment of its impact on commodity production and trade flows.

Sixteen selected examples of publicly-funded agri-environment schemes loosely based on a PBR approach have been reviewed. The sixteen examples covered ten countries and a variety of different specific objectives and operational issues. Identified advantages and difficulties of each scheme were reviewed (see section 3.3) and summarised in tabular form (see appendix 1) under the following headings: Administrative aspects; Ecological aspects; Economic aspects; Social and cultural aspects; and, Monitoring aspects. Analysis and synthesis of the case-study examples and the discussion of potential applications of the PBR approach at habitat/species and landscape scale, plus useful discussions during a one-day stakeholder workshop, led to seven main conclusions.

PBR schemes can improve environmental targeting

PBR schemes can improve the environmental targeting of agri-environment measures in comparison to the payments based on management prescriptions. It also seems reasonable to assume that as a result of improved environmental targeting, PBR schemes will provide greater environmental benefits. However, the outcome of this review suggests that more empirical work on the ground is required to evaluate the environmental impact of PBR schemes over a longer period of time. Consequently, it would be advisable to continue testing the PBR approach through the implementation of prototypes at local level and the incorporation of specific outcome-based elements such as bonus payments in standard prescription-based schemes.

PBR need to be based on established baselines

Any workable PBR scheme has to be based on sound measurement of environmental baselines and the monitoring of changes in these baselines. In addition, the setting of targets and the understanding of how they might be achieved needs to be developed in partnership with land managers. At the present time the complexity of many agri-environmental systems typically requires significant resources to be devoted to administration and monitoring. Self-monitoring by scheme participants is an interesting idea that merits further exploration.

This suggests that it may be sensible to pilot PBR schemes by seeking to maintain rather than enhance existing environmental conditions where these are already favourable. In such cases both the baseline and the target are easily understood and land managers have a good idea of how to achieve the required outcome (no degradation of current condition). Such an approach offers practical advantages, but may be open to criticism on the grounds of limited additionality – of paying land managers in return for little extra effort.

PBR could provide both economic efficiencies and enthuse land managers

By offering incentives to achieve results, PBR can potentially deliver economic efficiency gains. It should also enthuse land managers by both releasing them from management prescriptions and offering a direct reward for outcomes in a manner (at least partially) analogous to other markets that they operate in. However, making rewards conditional on results when these are not entirely within the control of a manager (e.g. due to weather conditions, pests or the actions of neighbours) exposes them to a greater level of risk than more conventional prescription-based approaches. This suggests that payments may need to incorporate a risk premium or perhaps be split between a guaranteed payment for participation plus a bonus on delivering the desired outcome.

Current interpretations of policy could restrict use of PBR

The scope for varying payment calculations is constrained by strict interpretation of current WTO requirements for Green Box eligibility. Specifically, the requirement for AES payment calculations to be based on income forgone and additional costs does not sit easily with the logic of payments-by-results since it should be the value of the outcome not the cost of delivery that determines payment rates.

A less strict interpretation of WTO would focus on the over-riding principle of eligibility resting on an instrument being non-trade-distorting or at least less-trade-distorting than what it replaces (an approach adopted by other WTO panels). This means that a more flexible interpretation could ease the use of PBR. Yet this is dependent on high-level negotiations and a clear demonstration that a policy instrument does not affect commodity production and trade flows.

Auctions could offer a means to quantify payments in PBR schemes

Although subject to some concerns over their repeated use, auctions offer a possible means of not only improving efficiency relative to the current use of flat-rate payments but also relaxing the WTO constraint on the basis for payment calculations. If auctions are acceptable (and they are under the EC Rural Development Regulation) then bids can be interpreted as reflecting costs incurred and thus may permit a PBR approach. However, the setting of a public budget from which to fund a PBR and the identification of a maximum acceptable price to pay for a unit of a given public good requires a measure of demand to match the supply-side bid – and this implies recourse to some form of environmental valuation technique.

Pilot PBR schemes should be applied at different scales

Considering the application of prototypes at different scales, a pilot PBR scheme with its desired outcome set in terms of the desired characteristics of a particular habitat or plant species assemblage would be potentially easier to implement in practice. However, the desired biodiversity outcome not only needs to be set at the level of the individual site but also at the level of the area the scheme is designed to cover. Any PBR needs to set broader outcomes, for instance the amount of any particular habitat in that region which should be managed under that scheme.

PBR poses significant design challenges which are amplified at the landscape scale

Whilst PBR at the level of the individual site poses significant design challenges, these are amplified by potential landscape-scale applications where there may be a need to co-ordinate the activities of neighbouring land managers to achieve an aggregate outcome. In other words, if it matters "who does what" and "where it is done" in order to secure a particular pattern of landscape or habitat features, then targeting just individual land managers will be insufficient.

This poses additional challenges for scheme managers in terms of setting and monitoring targets, but also suggests that payment incentives alone may be insufficient to deliver desired environmental outcomes. Whilst payment design – perhaps in the form of "agglomeration bonuses" for joint working – may be worth considering, the development and support of local governance arrangements may be more important. For example, the inclusion of LEADER activities under Axis 4 of the RDR may offer opportunities for exploring the integration of local governance into agri-environment scheme design and delivery.

Since one of the main difficulties with PBR is on specifying and monitoring outcomes (rather than actions), a PBR is better suited to situations where outcomes are more readily defined and observed. This suggests that implementation of a PBR will be harder for contexts in which multiple rather than single outcomes are sought and where improvement (enhancement) rather than avoidance of deterioration (maintenance) is sought. This is not to say that PBR could not be used, merely that implementation would be harder. For example, in a multiple objective context, the range of outcomes and possible substitution or complementarity between different outcomes would need to be defined, a landscape scale incurs additional complexities in co-ordinating across sites, and seeking enhancement rather than maintenance requires prior specification of the nature of and timeframe for improvements. Table 4 synthesises the suitability, key strengths and key weaknesses of implementing the PBR approach in AES.

Table 4 Suitability, key strengths and key weaknesses of implementing the PBR approach in AES

Dimension in AES		Suitability for PBR	Key strengths	Key weaknesses
Outcome	Maintenance	Higher	Outcomes relatively easy to understand and monitor	Subject to criticism of low additionality
	Enhancement	Lower	Delivering improvements rather than the status quo	Outcomes harder to define, achieve and monitor
Scale	Site	Higher	Outcomes relatively easy to define and monitor	Some outcomes not achievable at individual site level
	Landscape	Lower	More typical scale at which ecosystem services are delivered	Challenges of co-ordination across different sites/land managers
Objectives	Single	Higher	Outcomes relatively easy to define and monitor	Relatively few outcomes are separable from others
	Multiple	Lower	More typical of current land use policy context and “bundled” nature of ecosystem services	Need to define and monitor multiple outcomes, and trade-offs/interactions between them

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7. Appendix Review matrices of the payment-by-results examples

Table 1: UK examples

Scheme title	**Example 1** **East Scotland Grassland Management Scheme**	**Example 2** **Higher Level Stewardship (HLS) element of the Environmental Stewardship (ES) AES**	**Example 3** **Integrated Rural Development Project (1980-87) and Farm Conservation Scheme (1988-1996)** **Following concentrates on FCS as it differs from national AESs**
Source	http://www.snh.org.uk/pdfs/NatCare/GrasslandScheme.pdf	http://www.defra.gov.uk/erdp/schemes/hls/default.htm	http://resources.peakdistrict.gov.uk/pubs/hmp/hmp.pdf
Country/Region	East of Scotland	England	Peak District, England
Budget			
Scheme initiation and administration	SNH	DEFRA	Peak District National Park Authority
Scheme objective/s	Maintenance or restoration of 83 semi-natural lowland fen and grassland SSSIs	Five primary objectives: - wildlife conservation, - landscape quality and character, - natural resource protection, - protection of historic environment, - public access and understanding plus flood management and conservation of genetic resources	Conservation of hay meadow and pasture plants species
Targeted environmental outcome	Site specific management plan	Site specific management, detailed in each Farm Evaluation Plan, aims variously to maintain / 'improve' feature	Maximise conservation value of hay meadows.

Scale of scheme application (area or number of farms targeted)	SSSI status however, adjacent land may be considered 83 SSSIs in scheme catchment area plus adjacent land considered	Country-wide. Normally combined with Entry Level Stewardship (ELS)	Presence of flower rich meadows on farm FCS -throughout the Peak National targeting meadows unsuited to national schemes (e.g. ESA, Countryside Stewardship). 5-yr agreements. (27 entrants under FCS. Also 33 CS and 4 ESA applications considered to be influenced by FCS)
Approach to quantify environmental benefits	Habitat indicators (sward heights, < 25% cover litter cover, limited/ reduced scrub, bracken and weed cover) and prescriptions	'Indicators of Success' and prescriptions (use of the 150 Joint Character Areas to set localised priority targets)	NVC + indicator spp assessment of appropriate botanical composition in response to management prescriptions/advice. Recorded annually prior to cutting (late Apr-July)
Approach to quantification and design of payments	Payment in arrears per ha managed. One-off capital payments e.g. fencing, water troughs. No further information available on quantification of payment levels.	Standard cost based flat-rate payments mainly on a per hectare basis. Also provides financial support for capital items	Basic payment depending on quality of meadow plus enhancement payment for implementing 'ideal' management. Payments adjusted after periodic re-survey
Approach to scheme monitoring	None indicated apart from sward heights reported by farmer in Apr/Jul/Oct. May be spin-off results from ongoing SSSI management monitoring	Scheme monitored in relation to specific targets using parameters of uptake and bespoke monitoring studies to assess maintenance /improvement in condition of features (see http://www.defra.gov.uk/erdp/pdfs/es/ES-EvaluationPlan-jul06.pdf)	a. Visually distinct communities identified within each meadow. b. Each community surveyed separately; c. Sketch map (1:2,500) produced showing distribution of community. d. Species list compiled for each community; each species assigned DAFOR rating e. Each community given an approximate NVC type. f. Notes made on management, vegetation structure, other wildlife features, presence of characteristic or rare spp., productivity of sward. g. Subjective assessment of meadow 'quality'

Identified advantages in relation to:			
Administration and implementation	Access to in-house experience on important ecological aspects in relation to monitoring potentially facilitates administrative tasks Farmers involvement in the setting up and development of the scheme reduces administrative burden of payment agency	The ES/HLS is mainly a mainstream/standard agri-environment scheme. However, the HLS provides an example for the integration of environmental outcome based aspects such as the indicators of success into a standard agri-environment scheme while at the same time trying to maintain the relative administrative simplicity of standard cost based agri-environment payments.	The large flexibility in individual agreements may require more negotiation to reach an agreement but the time spent at the beginning can bring greater rewards and efficiencies with respect to the outcome of the scheme. The implementation of small scale or local payment-by-results agri-environment schemes may provide a useful addition to mainstream agri-environment schemes targeting specific regional or local environmental issues without the international and political constraints attached.
Ecological aspects	Management agreements drawn up by landowner in consultation with SNH to 'suit' each individual site needs (though final decision left with the landowner?). Aiming to achieve a range of sward heights per site, which should maximise the plant and invertebrate life which can utilise these Exact management decisions left in hands of landowner therefore more flexible to meet local site conditions and annual weather fluctuations	Focus of HLS on any farm is based on farm plan and discussions between farmers and adviser. So some scope to target what is done at key areas of the farm (though final decision rests with adviser with regard to what prescriptions to follow) The HLS options incorporate a range of indicators of success associated with each habitat type of interest and therefore has the apparent flexibility to adapt the required outcomes to specific local conditions (though see below)	All meadows of conservation interest eligible, not just those designated as SSSIs Management agreements drawn up by landowner in consultation with PDNP to 'suit' each individual site needs.

Economic aspects	Economic aspects strongly depend on the calculation and definition of payment levels. No information was available at this time. The scheme uses a combination of flat-rate payments and actual cost-based payments. Using payments based on actual costs increases the flexibility of payments to consider farm specific cost characteristics and would eliminate the data problem often associated with calculations of flat-rate payments. Also, using actual costs as a payment basis reduces the potential of windfall profits compared to flat-rate payments. Designing a specific management plan and agreement together with the farmer to achieve a specific outcome provides more scope to take into account specific farm characteristics and local knowledge of farmers than using predefined management prescriptions. Such approach could potentially also improve the cost-efficiency of payments.	Although the HLS predefines management requirements, there is scope to adjust the exact management requirements and prescriptions for each land management option to suit particular situations. From an economic point of view, this would provide the opportunity to adjust management activities taking into account farm-specific circumstances and keeping resulting costs close to the payment. On the other hand, to ensure adequate environmental outcome, management changes should rather be defined according to environmental requirements with payments being adjusted to cover the costs incurred.	Payments are directly targeted at environmental outcome and reflect the ecological quality of meadow. Such payments are closer to the notion of markets which reward producers for the final product, i.e. environmental outcome or ecological quality. Similar to the German example 6, different ecological qualities are defined with different payment levels attached. In other words, an attempt has been made to link economic aspects of the financial incentives directly with the ecological value of the meadow.

Social and cultural aspects	Approaches combining habitat indicators and prescriptions may be more attractive to farmers than purely prescriptive schemes. The combined approach may engender the feeling amongst scheme participants that they have more say in the management of their land and that they retain the ability to put their skills and knowledge into practice to meet the habitat indicator guidelines. This in turn might increase farmers' interest in achieving the desired outcome. The process of drawing up the management agreement in consultation with SNH may make farmers feel that they have more ownership of the scheme.	Monitoring of the HLS scheme could include an evaluation of whether the indicator approach is giving farmers sufficient flexibility to innovate in their land management practices. This innovation could be argued to be necessary to stimulate the utilisation of existing skills or development of the new skills and knowledge necessary for achieving the HLS objectives. The ability to innovate and develop the necessary conservation land management skills could result in the generation of cultural capital amongst farmers particularly if this skill is visibly apparent to others (e.g. other farmers and non-farmers recognise when a piece of land is being managed well for conservation gain)	The high involvement of farmers in the negotiation process to reach an agreement potentially builds stronger commitments of (and with) the farmer. This will be enhanced by the higher relevancy of the scheme to each farm. Hay meadows require active management giving farmers the opportunity to display their knowledge and skills. This may also result in satisfaction in a job well done in comparison to conservation management that is more 'hands-off' FCS may capture farmers' that are not eligible for national schemes or are unable to participate because of budgetary constraints and therefore goes some way to redressing issues of inequity. The shorter duration of the agreements compared to national scheme may be more attractive to farmers. The support of more labour intensive management practices may maintain social capital between farmers in cases where co-operation is required.

Indicators and monitoring	a. Simple self-reported records of sward heights.; hence low cost b. Presumably SNH's SSSI condition monitoring provides ancillary information at no direct cost to programme. c. Very discrete areas and veg. type to monitor	a. Clear targets against which to monitor each feature / management option b. Localised monitoring - each occurrence of a feature entered into HLS has own specific targets set out in Farm Evaluation Plan c. Some parameters (e.g. individual indicator spp. such as brown hares & some birds) easily monitored by non-specialists d. Well defined criteria for 'acceptable' land/features should enable more precise tailoring of monitoring methodology e. Includes structural as well as compositional parameters for some features (e.g. spp.-rich grassland)	a. Monitoring allows some comparisons with historical data b. Relatively rapid methods. c. Widespread, less intensive, sampling provides good broad overview with adequate sample sizes d. Monitored annually e. Concentrations of meadows selected for sampling, reducing travel time between sites f. Other aspects of ecological status noted g. High input of locally experienced staff
Identified difficulties in relation to:			
Administration and implementation	Setting up detailed management plans on a farm by farm basis increases the administrative burden	Detailed and farm-specific environmental farm plans increase administration requirements for the payment agency. More detailed and frequent as well as different monitoring requirements (see below) also increase the overall administrative burden.	Significant variations in payment rates and in management prescriptions (can) make the scheme complex and sometimes confusing. "Acting as a brokerage service" to explain the different schemes and to get the best option both for the farmer and the wildlife of the meadow increases the administrative burden and costs. For smaller or local schemes in general, competition with national schemes must be avoided when implementing local schemes.
Ecological aspects	Only targeted on land within the SSSIs themselves. Land outside can be entered provided it is 'next to the SSSI' and 'suitable', which one assumes means that it needs to be semi-natural in character. Focus is therefore on the 'islands'	Any prescription that demands 'enhancement' ignores fact that 'richest' grasslands may be at max. richness dictated by non-management factors. Attempts to 'enhance' these can be deleterious. The final decision on which prescriptions to	Priority is put on meadows of high conservation interest as opposed to 'all' meadows which may be eligible for the likes of Stewardship Although valuable in conservation terms, many entries into the scheme are small in both percentage of existing resource and overall ha

	of good habitat (as identified by the SSSI designation) and within SSSI the primary focus is on the areas of more interesting habitat within the SSSI – therefore focus is on maintenance (rather than on additionally expanding out areas of interest) and not targeting areas outwith the SSSI which may have adverse impacts upon them	apply and how success will be indicated rests with the adviser – this may divorce the farmer from any ownership of the management In many cases the indicators of success are quite broad (e.g. grass height should be between 2 and 15 cm in the spring) and while the underlying ecological rationale behind these is in many instances clear, it is less clear what impact on the ground such broad ranges would have	terms, e.g. only 151 meadows out of c. 400 meadows of identified conservation interest were protected by the PDNP (and only a small proportion of these were through the FCS) and those 151 meadows covered in total 185 ha.
Economic aspects	Although the scheme provides greater detail and flexibility than many mainstream agri-environment measures, the application of flat-rate payments is bound to lead to windfall profits and/or (in other cases) to situations where participation cost are not covered. However, small scale applications as well as the option for farmers to adjust their management changes limit the scale of this problem. The scheme description states that 'payment rates may be reviewed at any time to make sure that the payment rates reflect participation Cost', but no information are available if and how this was done.	The issue of windfall profits or deadweight losses applies as with all schemes using standard cost payments. More evaluation studies would be needed to assess, to what extent existing payment rates cover participation costs of farms and if and how more differentiated payments would improve the effectiveness of ES/HLS.	The issue of "economic justification" of varying payment rates arises. Care must be taken that the different payment rates can be easily justified in each case to minimise conflicts or bitterness between farmers over the different rates of payment available in different areas and cases. Linking payments to environmental good supply is a difficult task. It is not clear how the different payments have been defined or calculated and thus how the link between economic and environmental value or outcome has been established or quantified.
Social and cultural aspects	Geographical isolation of some of the eligible SSSIs might inhibit the development of cultural capital amongst participants for succeeding in achieving the desired objectives of the scheme. Non-participating neighbours may not appreciate or praise the management of land for		See the above row which raises the concern that varying payment rates might cause bad feelings between scheme participants

	conservation purposes. Pride in managing the land for conservation purposes could be developed (if this is not already occurring) by communicating scheme progress amongst participants and highlighting the farmers that have successfully used their farming skills and knowledge to progress towards meeting the objectives.		
Indicators and monitoring	1. Any independent corroboration of self-reported sward heights? 2. Is sward spp. composition monitored (e.g. during SSSI condition monitoring)? If not, sward ht. is a coarse measure of maintenance and poor measure of restoration 3.Very variable veg. types, therefore difficult to determine generalised targets. Targets almost have to be site-specific to take into account starting state of grasslands and past management history.	1. Holistic nature of scheme and very large number of options requires various (or very flexible) monitoring schemes. 2. Improvements/criteria for some features not readily assessed or require specialist skills (e.g. soil P index, pH, counts/identity of some uncommon spp.) 3. Frequent monitoring required - to pick up transient features (e.g. flocks of feeding passerine birds; butterflies) - where dates are important part of prescriptions (e.g. hedge cutting, hay cutting) - where contraventions may be difficult to detect e.g. fertilizer applications	1. DAFOR cover classes not sensitive enough to detect possibly indicative changes in more abundant spp. 2. Length of monitoring period and scheme (both 3 yrs)may be too short to detect improvements in less-rich meadows 3. Monitoring concentrations of meadows may give biased sample. 4. Some records subjective so may be difficult to analyse when assessing changes. 5. Apparently little monitoring of animal spp. associated with meadows

Table A2. Examples from Germany and Austria

	Example 4 **Results orientated AEM: conservation and enhancement of biodiversity**	**Example 5** **Results orientated AEM: enhancement of water quality**	**Example 6** **Results orientated AEM: biodiversity conservation**	**Example 7** **Results orientated AEM: biodiversity conservation**	**Example 8** **Oekopunkte Nieder-oesterreich**
Source	Matzdorf et al (2007) Leibniz-Centre for Agricultural Landscape Research Conference presentation. Conference on the Science and Education of Land Use, September 24-26, Washington DC. http://www.nercrd.psu.edu/TALUC/PowerPoints/Matzdorf.pdf		Klimek, S. et al., Rewarding farmers for delivering vascular plant diversity in managed grasslands: A transdisciplinary case-study approach, Biol. Conserv. (2008), doi:10.1016/j.biocon.2008.08.025 Wittig, B., Richter, A., Zacharias, D. (2006) An indicator species approach for result-orientated subsidies of ecological services in grasslands – A Study in Northwestern Germany. *Biological Conservation*, 133, 186-197* Groth, M. (2005) Auctions in an outcome-based payment scheme to reward ecological services in agriculture – Conception, implementation and results. Paper presented at the 45th Congress of the Regional Science Association in Amsterdam, 23-27th August 2005.†	Oppermann and Briemle (2002) Blumenwiesen in der landwirtschaftlichen foerderung. Naturschutz und Landschaftspalnung, 34, 203 – 209. Also: Oppermann (2003) and Wittig et al (2006)	Évaluation des Mesures Agro-Environnentales Final Report, November 2005 http://ec.europa.eu/agriculture/eval/reports/measures/annex7.pdf (brief explanation of Oekopunkte on page 6)

Country/ Region	Brandenburg, Germany		*Six study regions in Lower Saxony, Germany †Northeim, Lower Saxony, Germany	Baden-Württemberg, Germany	Federal State of Lower Austria
Budget	Budget for AEMs in Brandenburg approx 48 M €/year (no detail as to how this breaks down)		30k Euro, pilot scheme		
Scheme initiation and administ-ration	In 2008 Brandenburg is implementing a test-run of this prototype, but beside and in combination with standard agri-environment measures	Based on model simulations aim at the development of prototypes	Groth (2005) reports that the Regional Advisory Board represents public demand for ecological goods and decides allocation of funds for the defined good. Farmer's Union and landowner groups sit on the Regional Advisory Board	MEKA-Programme with seven agriculturally used meadows and grasslands	
Scheme objective/s	Biodiversity conservation Actual environmental state indicators used	Enhancement of water quality Simulated environmental indicators using HERMES model Simulation of N-leaching for; Conventional arable land Conventional grassland Organic arable land Organic grassland/extensive grassland Spatially explicit	Biodiversity conservation	Biodiversity conservation	

		calculations of N-leaching reduction for three scenarios (land conversion and change of use)			
Targeted environmental outcome	Conservation of species-rich grassland on 'common UAA'	Reduction of nitrate leaching from the root zone Reduction of N in kg Na ha-1	Conservation of semi-natural grasslands Achievement of certain number of plant indicator species	Conservation of semi-natural grasslands Selection of 28 plant indicator genera and species. Selection of genera to facilitate management and visual monitoring.	
Scale of scheme application	30% of total grassland area and 36% all grassland covered by extensive grassland AES would be eligible Distribution of eligible grasslands scattered throughout region. 'Outside of nature conservation areas payments made only for still species-rich grassland' with a recommended eligibility threshold of four indicator species	Aggregation of N-leaching reduction scenarios at smallest agricultural administrative levels (average size = 190ha)	In the Northeim case study (Groth, 2005) 140 farmers requested tender documents but only 38 put in offers accounting for 199 plots or 350 ha. Budget constraints only permitted 28 farmers to enter scheme (159 plots or 289 ha). Majority of grasslands in lower (less botanically diverse) tier		
Approach to quantify environmental benefits	Identification of species-rich common grassland 'by (with the help of) farmers'	Modelling to calculate N-leaching reduction	Farmers responsible for identification of indicator species.	Farmers responsible for identification of indicator genera and species.	

Approach to quantify and design of payments	Meeting threshold number of indicator species	Effectively a scheme based on highly targeted management prescriptions, rather than PBR *per se.* Very difficult to monitor outcomes so the 'result' that is paid for in this case is farmers undertaking prescribed reduction in N application, regardless of effects on water quality, biodiversity etc	The ecological good 'grassland' is defined through the number of species per plot and a catalogue of grassland species that are adapted to extensive grassland management and are characteristic for regional plant communities. Three different qualities of the ecological good are defined depending on the number of species, which attract different payments.	Seemingly no distinction of different ecological qualities, at least at the beginning. Flat-rate payment per hectare	Farmers can accumulate bonus payments by obtaining scores for specific actions. The actions are evaluated as; - Tolerable, scores 0 - ecological valuable, receives positive scores - ecologically disadvantageous, receives negative scores These scores are then 'banked' in an 'ecoaccount'. The balance is converted into bonus rates and may these reach as high as €363/ha.
Approach to scheme monitoring		None - unless there are checks on farmers' N applications	Monitoring of indictor species by farmers	Monitoring of indicator species by policy administration and payment agency through random checks. Payments reduced if scheme requirements not fulfilled	
Identified advantages in relation to					
Administration and implement-ation	Distinguishes different approaches for within and outwith spatial environmental designations		Regional Advisory Board allocated funds according to local priorities so this is an example of subsidiarity in action.		

Ecological aspects	Suite of indicator species used to identify potentially valuable sites to enter into scheme and progress of the management on the site – therefore more flexible than just targeting one or two species within the swards	None identified directly	Indicator species chosen were identifiable by the farmers concerned, and therefore of practical use In general the indicators chosen did reflect underlying grassland species richness conservation interest of the sites (but see below)	Indicator genera and species chosen were identifiable by the farmers concerned, and therefore of practical use	Professional advisers help provide farmers with a range the most appropriate measures to choose from (taking into account the farm concerned) The focus on reducing agricultural inputs would be expected to have some positive impact on water quality (through reducing diffuse pollution)
Economic aspects	Economic aspects of this example are similar to example 6 such as promotion of self-interest of farmers and stronger incentives, closer to the notion of markets etc.	No information available how payments differ in this example compared to standard or mainstream agri-environment schemes	The applied auction system allows to take into account farmer's individual cost structure and production conditions Payments, as defined in this example, bring agri-environmental measures closer to the notion of markets which reward producers for the quantity and quality of the final products rather than reimburse them for the costs of the inputs used in their production. Builds on the economic self-interest of farmers and create stronger incentives to produce high-quality environmental goods Example shows potential for cost reductions in comparison to mainstream agri-environment measures The direct linkage of the payments to farmers and the ecological results	Relatively simple economic targeting of environmental output	

			leads to a more efficient use of public funds compared to existing agri-environmental measures using the standard cost approach		
Social and cultural aspects	Interviews by the author indicate that 56% of farmers in Baden-Wuerttemberg (example 7) preferred a combination of payment-by-results schemes and action orientated incentives whilst 30% preferred an exclusive payments-by-results oriented scheme. It is assumed that similar acceptance would arise in Brandenburg. Higher levels of management flexibility may allow farmers to innovate to achieve the desired result. This may stimulate the production of 'cultural capital' or increased social standing for managing land for biodiversity conservation. This in turn might lead to an		Payment-by-results schemes as described in these German examples may be more justifiable cost wise to the general public. The high involvement of the farmers in monitoring and managing their land to achieve results may raise their social standing amongst non-farmers. The accumulation of knowledge regarding semi-natural plant communities may increase farmers' appreciation of biodiversity.	Applied method of selecting indicator genera and species found high acceptance in the farming community due to positive image of result oriented scheme design and disappointment of previous action-based agri-environment measures. High acceptance of at least combining payment-by-results schemes with action orientated incentives (see example 4)	

	increased acceptance amongst farmers of the objectives of agri-environment schemes.				
Indicators and monitoring	1. Simple indicators (nos. of spp) 2. Number of listed indicator spp apparently sufficient to overcome seasonal variation in presence (but may still require more than one monitoring p.a.) 3. Above is not problem if farmers make own continuous assessment 4. If based on simple presence/ absence of indicators, avoids difficulties of assessing plant cover	Very difficult to monitor outcomes economically hence apparently no indicators and no monitoring undertaken. Therefore very cheap in this respect. Effects depend on accuracy of model in determining appropriate N reduction. Even if model is not strictly accurate in all situations, it is still likely to produce a sensible weighting for N reduction	Advantages almost identical to Example 4	Selection of indicator genera simplifies monitoring tasks compared to selection of indicator species. Genera with high visual impact selected.	

Identified difficulties in relation to					
Administration and implementation	The onus is on farmers to check the eligibility of their grasslands – implications for the amount of resources necessary for training.	Theoretical modelling exercise rather than an actual, implemented scheme.	How does Regional Advisory Board estimate local demand? And how much extra cost does a Board incur? Farmers revealed some ignorance about own cost structures and therefore what to bid at in the auction.	Acknowledges difficulty of designing payment mechanisms, the trade-off between admin complexity and outcome achievement.	This measure competes with other AEMs which may be more environmentally suitable and efficient
Ecological aspects	Positive outcomes not 'guaranteed' as depend on historical land use on the site and in many cases takes long time to offset adverse impacts of that land use (e.g. nutrient built up in soils over time) No. of spp. criterion disregards cover of spp. (e.g. several spp in one segment of otherwise 'poor' grassland or meadow with low cover of indicators given same value as one with high cover) Also different indicators have different resilience to	No direct ecological benefit identified to-date though assumed that freshwater conditions should benefit. Focus is on amount of N reduced per ha – but ecological benefit of this likely not to be proportional to amount of reduction (will depend on initial starting level and on passing a threshold after which some positive	Indicator species approach did not always reflect underlying presence of rare species (with focus on red-listed species) Focussing simply on occurrence of grassland indicator species unlikely to be robust enough to be used to indicate good quality for other groups – additional measures of structures and condition and sward characteristics would be required for that. The following statement by Groth is highly debatable: "Therefore the number of species per plot and a catalogue of grassland species that are adapted to extensive grassland management and characteristic for regional plant communities are suitable for the definition of ecological goods grassland".	Evaluation provided evidence that payments were too low to expand areas of species rich grassland. Using genera rather than species makes problems of sensitivity relative to management Comments on use of indicator species and species *richness* as simplistic parameters of plant spp. *diversity* - see examples 4 & 6	Particularly targeted on landscape, soil and water – therefore focus rather broad and targeted at occurrence of elements in the landscape more than the quality of these elements. There is no need to follow any specific nature conservation plan in the scheme – so no emphasis or means of on targeting priority habitats or species Other available measures within the agri-environment programme may be more suitable to apply in specific instances and/or more efficient at achieving the environmental objectives

	change. Community composition may change from 'sensitive' spp. to 'resilient spp. - in functional and conservation value terms, they may be very different but have same 'indicators' score.	impact may be likely). Scale of ecological impact will depend on whole catchment approach, freshwater ecological condition always subject to adjacent and upstream processes			
Economic aspects	Economic aspects of this example are similar to example 6.	It remains unclear how the challenge of designing economic incentives for environmental outcome at larger scale would be addressed. Identified challenges focus on ecological and biophysical issues. However, in addition the assumed example would require	More research required on how the dynamic and long-run development of the farmers' bidding behaviour and bid-prices during further auctions affects efficiency of such schemes. How does the example address the issue of risk adverse behaviour of farmers in the context of uncertainty and risk concerning the fulfilment of the payment requirements in the future? How does the example address the time gap between farmers' actions and achievement of environmental outcome?	Evaluation provided evidence that payments were too low to expand areas of species rich grassland. From economic point of view, payments were only sufficient to manage already species rich grassland. Need to implement different payment levels according to ecological qualities or environmental benefits recognised and implemented in later examples such as in Lower Saxony.	The report identifies criticism of this approach: the efficiency of the measure is not known and it may be tending towards overpayment administrative costs are high (consultation, implementation and monitoring) these high costs prevent the national expansion of the measure. as farmers can already obtain payments for existing traditional landscape elements it is hard to justify to the wider public why they should be paid for maintaining or not degrading landscape structures

		significant adjustments in the land management (including switching production/land management systems) of participating farms with potentially larger economic consequences. This modelling simulation would provide an interesting case study to be followed in further discussions to obtain more information on potential economic implications.			there may be an issue of overcompensation if cross-compliance already demands certain actions
Social and cultural aspects	May be seen as an inequitable process by farmers.	It is difficult to assess the social consequences of this simulation exercise without further	The author of the Northeim case study questions the role of the Regional Advisory Board in representing public demand for ecological goods when in reality budgetary constraints determine the amount of ecological goods 'bought'. The scheme could potentially lose support amongst farmers and the		

		information. Other policy evaluation studies, e.g. the assessment of potential future options for LFA support in Scotland, suggests that such required farm management changes could impact on the social capital in the farming communities. However, this would need further exploration.	wider public if the administrative framework is difficult to justify. Unclear as to how the public goods produced may be 'accessed' by the public.		
Indicators and monitoring	1. Presence/ absence of indicators (just one aspect of biodiversity) ignores importance of spp. cover. (e.g. (a) several spp in one segment of otherwise 'poor' grassland or (b) meadow with low cover of indicators given same value as one with high cover - latter is clearly	No direct indicators monitored. The lowest level of reduction mentioned (5.8 kg ha^{-1}) is unlikely to have any detectable effect even with	Comments as for example 4. We draw attention again to the shortcomings of species *richness* as an indicator of species *diversity* (the latter including the important element of the cover of the different species). (see also 'ecological aspects' – above)	Comments as for examples 4 & 6	Difficulty in detecting infringements with regards to conserving landscape elements.

	'richer') 2. Potential problem of recognising if a few plants of a spp. has been sown tin to boost counts 3. Potential weather/ phenological effects on different indicators may necessitate several monitoring sessions (possibly most important in seasonally wet meadows). 4. Does design of monitoring take into account sensitivity of indicator spp. to management? (Meadow with robust indicator spp. may be declining but this is not reflected in results). 5. Possibility of long search time for one or two indicator spp. in marginally rich meadows may not be cost-effective	expensive monitoring.			

Table A3. Co-operative/collective schemes

	Example 9 **Environmental co-operatives (seven case study schemes)**	**Example 10** **Meadow Birds Agreements (focus on the postponed mowing and payment per clutch option)**	**Example 11** **The Hedgerow Planting Scheme**
Source	Franks, J. R. & McGloin, A. (2007) Environmental co-operatives as instruments for delivering across-farm environmental and rural policy objectives: Lessons for the UK. *Journal of Rural Studies,* 23, 472-489	Verhulst, J., Kleijn, D. and Berendse, F. (2007) Direct and indirect effects of the most widely implemented Dutch agri-environment schemes on breeding waders *Journal of Applied Ecology* 44, 70-80	Gravsholt Busck, A. Søderkvist, K. And Primdahl, J. The Hedgerow Planting Scheme in Denmark – a case study of objectives, context, effects and implications. In Hodge, I. and Reader, M. (2007) Maximising the Provision of public goods from future agri-environment schemes. Report to the LUPG. University of Cambridge.
Country/Region	Netherlands	Netherlands (this paper evaluates sites in the Western part of the country)	Denmark (started in the west of Denmark but now extended to the whole country)
Budget			In 2005 2.2 million Euros Decided annually. Now funded through article 33 of the Rural Development Programme. Initially funded by DLDS, later received assistance from the government which tailed off by mid 1970s until EU Structural Fund co-financing in 1974. Administration costs 8% in 2005
Scheme initiation and administration	'Endogenous development' (stimulated by farmers' reaction to top-down environment programmes) Some only open to farmers, at least half open to non-farmers	Since 1994 under agri-environment schemes, with an emphasis on collective action across a number of farms. Government funded.	Danish Land Development Service (DLDS) established in 1866 led to the more widespread planting of shelter belts. In 1902 formation of the Federation of Planting Associations, an umbrella organisation for local planting associations of which 150 were formed. Now called Danish Planting Association.

Scheme objective/s	Various. e.g. joint submission for 'collective bird and/or botanical package' of *Programma Beheer* AES.	Conservation of breeding waders in particular In this case study, the collective packages required 10-20% of land in the postponed mowing scheme the purpose of which is to reduce disturbance during the breeding season. Collective packages can be established for areas of at least 100ha	Shelter to agricultural land, increase small biotopes on agricultural land and to function as corridors in the landscape. Additional support available if 3 of the following are undertaken: No use of pesticides during establishment; establish of 1m+ uncultivated fringe alongside the hedgerow; establish beetle banks In connection to the planting and on the adjacent fields; establish footpath for public access. Only indigenous species allowed. Not exclusively collective, individuals can also apply but in 2005 78% of funded projects were collective. Most of the budget allocated to collective planting. Open to owners and tenants but tenants must have written permission from the owner.
Targeted environmental outcome	Various but water management is of key concern	To reverse decline in breeding wader populations by reducing disturbance during the breeding season and improving hatching and chick-rearing conditions	Reduced erosion, provision of shelter, encourage wildlife in beetle banks and hedge fringe, replace older hedges with mixed indigenous spp.
Scale of scheme application (area or number of farms targeted)	Approximately 125 Environmental Co-operatives, 10 000 members, 10% all farmers and 40% UAA. Quarter of members are non-farmers and half the schemes are open to non-farmers	Meadow Bird Agreements currently implemented on 150 000 ha with the Dutch government aiming to enter another 100 000 ha up to 2010	Now extended across the whole country but originated in 1800's on sandy soils in Western and Northern Jutland to prevent wind erosion and to create shelter belts. Collective planting associations (for planting across different holdings) further stimulated during the depression of the 1930's by the creation of planting 'flying squads', an initiative to lessen unemployment and financed by the Ministry of Social affairs
Approach to quantify environmental benefits		For the payments by clutch scheme, farmers or volunteers note the presence of all clutches and a members of the collective check these twice per season	

Approach to quantify and design of payments		Payments are based on the existence of clutches. However, no information was available how payments are quantified or calculated.	
Approach to scheme monitoring	No formal financial appraisals or environmental impact assessments of collective activities of ECs. Quote: ”Perhaps this simply reflects the overwhelming evidence in favour of EC: that their contribution to the policy debate and delivery suggests their non-pecuniary benefits have such clear and high value that a formal financial appraisal would be an unsatisfactory -environment schemes are subjected to formal environmental impact assessments” (Franks & McGloin, *ibid*). Any opportunities to monitor the relative effects of new EC-type arrangements should be taken up.	Monitoring of clutches by collective members	Directorate for Food, Fisheries and Agri-Business (DFFAB) is responsible for monitoring. 5% planted hedgerows monitored each year. Where good agricultural condition is breached, penalties are administered by the DFFAB. Other infringements handed by Danish Planting Association. No accessible references found about any need to monitor wildlife, for example, in association with plantings.
Identified advantages in relation to:			
Administration and implementation		Use of farmers and volunteers for monitoring of clutches presumably lowers monitoring costs.	
Ecological aspects	Agreements between groups of land managers and environment agencies can be contiguous with natural features thus overcoming ‘economics of configuration’ problem.	“Implementation of schemes by agri-environment collectives are more effective than postponed mowing implemented by individual farmers”	Institutional framework provides the basis to moving towards the incorporation of non-productivist objectives into landscape planning. Recent restrictions to planting of indigenous tree spp. only (incl. replacement hedges); introduction of options for restricted pesticides, extended hedge fringe, public access beetle banks.

Economic aspects	Co-operatives have an advisory and training role and mediate between farmers and relevant agencies. Opens up opportunities not accessible to individuals. Lower transaction costs and access to additional income streams.		Efficiency in the planting process and maintenance because purchase of plants and machinery is on a large scale Low transactions costs (8% of the total budget) as the scheme is run by the non-profit making Danish Planting Association
Social and cultural aspects	High involvement of farmers and, in some instances, farmers and other stakeholders work together giving rise to situations where reasons for conflict might be transformed into the development of shared understandings, values and visions for farmland.	Possible creation of new forms of social capital amongst farmers in areas where traditional land use practices that once entailed communal activity have become obsolete.	• Development of professional culture amongst farmers and other actors (but non-productivist objectives subsequently not well included) • Authors suggest that this can be a way of increasing cohesion in increasingly diverse rural communities by linking people with place
Indicators and monitoring	No formal indicators or monitoring (although, presumably, some impacts of AESs have to be monitored to justify EU funding). Future monitoring, e.g. of AES, could benefit from smaller sample sizes if robust results could be obtained with a collective as the basic sampling unit (c.f. ESAs) rather than individual farms (c.f. RSS)	Monitored by long-established methodology with known sampling characteristics	Apparently no formal monitoring apart from compliance with planting and maintenance requirements and associated options.
Identified difficulties in relation to:			
Administration and implementation			

Ecological aspects		Combination of these two scheme elements did not result in a significantly higher wader abundance Grass found to grow high and heavy and therefore unattractive to birds plus most Dutch grasslands agriculturally improved and therefore less suitable for both breeding and feeding	• Planting Associations comprise of farmers who chose to plant hedgerows in the same year. Preferences of individual farmers collected by an advisor who draws up a collective planting plan. Therefore risk that 'collective' plantings are little more than an aggregation of individual plans. • Full potential of the scheme in terms of ecological corridors etc not always realised. This is being redressed by development collective landscape plans which are also being used to reduce conflicts and increase 'ownership' of the scheme • Species composition and plantings rarely linked to local landscape character • Non-native species sometimes used • Lack of sensitivity to local landscape character
Economic aspects		Postponing mowing and other farm management activities potentially affects farm revenue. To what extent these economic changes are covered by AES payment is not clear. General economic problems in relation to payment-by-results schemes apply; for example, the challenge remains how linkage between clutch existence and payment justification is achieved.	

Social and cultural aspects	The collective approach may not work elsewhere in Europe particularly in countries such as Romania where enforced co-operation has left a legacy of distrust. However, this approach may also be viewed with reticence amongst UK farmers (see Davies et al, 2004 for a review of the challenges entailed in creating cooperative agri-environment action in Scotland)		
Indicators and monitoring	Potential difficulties in getting comparable collective and non-collective areas for assessing impacts, whether on biodiversity or socio-economic.	None. (However note that the authors conclusions about the relative effects of environmental variables are based on single fields and must therefore be treated with caution)	Apparent lack of formal monitoring to assess spin-off benefits for plants and wildlife.

Table A4. Auction/bid based schemes (see also Example 6 in Table 2 for a European case study)

	Example 12 **Conservation Reserve Program**	**Example 13** **Bush Tender (pilot scheme)**	**Example 14** **Auction for Landscape Recovery (pilot scheme)**
Source	Heimlich, R. E. The U.S. Conservation Reserve Program In Hodge, I. and Reader, M. (2007) Maximising the Provision of public goods from future agri-environment schemes. Report to the LUPG. University of Cambridge.	Lactacz-Lohmann, U. "Bush Tender" In Hodge, I. and Reader, M. (2007) Maximising the Provision of public goods from future agri-environment schemes. Report to the LUPG. University of Cambridge.	Lactacz-Lohmann, U. "Auction for Landscape Recovery" In Hodge, I. and Reader, M. (2007) Maximising the Provision of public goods from future agri-environment schemes. Report to the LUPG. University of Cambridge.
Country/Region	US	Australia, Victoria	Western Australia (north western wheat belt of south western Australia)
Budget	Since 1985, direct budgetary outlays for land retirement programmes amounted to approximately 35 billion USD. Since 1985, 1.9 billion dollars spent on technical assistance to evaluate farmers applications Mainstream agricultural support for land entered into CRP for the period1985-1995 would have cost approximately half of the CRP payments.	400 000 A$ in 2001 followed by 800 000 A$ in 2002-2003 however, pilot scheme only implemented in 'micro-regions' within the state. Transaction costs (for onsite research, ecological scoring and auction administration costs) = 50-60% of the amount used in the auction. However, as experience is gained, these costs should diminish Now also implemented in Southern Victoria and supplemented with a Carbon Tender which entails revegetation. Southern Victoria Scheme has a budget of $500 000	200 000 A$ Administration costs = 70% (all costs that are not payment transfers to farmers for on the ground works). Costs do not entail monitoring or compliance
Scheme initiation and administration	Administered by the U.S. Department of Agriculture's (USDA) Farm Service Agency (FSA). Technical support provided by USDAs Natural Resources Conservation Service		

Scheme objective/s	Conservation Reserve Program entails 10-15 year agreements with farmers for the purpose of conserving soil, water and wildlife resources by planting long-term cover e.g. permanent grasslands, shrubs, bushes, and trees Conservation Reserve Program includes Conservation Enhancement Reserve Program and the Farmable Wetlands Program Land retirement has been a policy tool since the 1930s. Originally driven by low farm incomes and environmental resource problems. Land entered into retirement based on bids by farmers. Purpose of bidding system was to use market based principles to reduce cost of the programme. Annual rental payments made.	Conservation of biodiversity through improved bush (native vegetation) management This entails stock exclusion, retaining trees and fallen timber, controlling weeds and non-native species	Aims at securing multiple benefits including biodiversity enhancement, salinity control and groundwater recharge abatement Also has a research purpose Landholders encouraged to put in joint bids for conservation sites. Could entail the management of sites that cut across boundaries or sites that are geographically close and which would benefit from joint management. Possibility to also submit multiple bids for a single site.
Targeted environmental outcome	Original goal of the CRP was to retire 45 million acres of highly erodible land. (The new Farm Act places emphasis on wetland restoration and there is also a more recent move towards targeting land that is worked e.g. the Environmental Quality Incentives Program (EQIP) which includes measures to improve tillage and nutrient management practices (see Claasen (2003)).		

Scale of scheme application (area or number of farms targeted)	In 1990, 36.4 million acres had been retired and this figure was used as a cap until 2002 when this figure rose to 39.2 million acres. Between 1986 to 1996, 37 million acres were entered into agreements but applications received for 57 million acres Since 1996, Conservation Reserve Enhancement Program which allows States to prioritise and designate areas. Land is these areas is eligible for higher payments and by 2005 851 00 acres had been enrolled in this initiative. Whole fields only eligible originally but since 1990, this may also entail partial fields. For the Conservation Reserve Program cropland is mainly eligible but must have resource 'problems or concerns' e.g. high erosion index or subject to scour erosion, be a cropped wetland, or have a function as e.g. a riparian buffer etc Marginal pasture land may also be eligible in certain cases. Additional eligibility criteria apply for entry of land into the Conservation Reserve Enhancement Program		In first round of applications 55 bids received from 38 land holders, 33 tenders from 21 landholders in the second round. A total of 23 tenders were accepted.

Approach to quantify environmental benefits	Soil adjusted rental rates (SRR) and a multicomponent environmental benefit index (EBI)	Biodiversity Benefits Index (benefit to cost ratio) used to assess single sites Biodiversity Significance Score X Habitat Services Score Divided by Cost announced by landholder Ecological data collected by scientists during bid preparation process Bids ranked highest value per dollar and selected until the budget depleted	Evaluation of bids using a regional metric of 'biodiversity complementarity'. In contrast to the Biodiversity Benefits Index used in the Bush Tender scheme, this accounts for 'synergistic' effects caused by the number, size and distance of sites. In addition, an environmental benefits index also calculated and compared with the biodiversity complementarity score
Approach to quantify and design of payments		Sealed bids selected on a value for money basis and payments received for management actions Bid entailed submission of an agreed management plan drawn up between land user and field officers.	Applications must be assessed for feasibility by an independent group of experts. This occurs before the bids are put forward.
Approach to scheme monitoring			
Identified advantages in relation to			
Administration and implementation	See 'difficulties' section for reasons why original bidding scheme collapsed These problems were addressed by - capping the acreage that could be enrolled - inclusion of a broader array of environmental objectives - use of soil adjusted rental rates and a multi-component environmental benefit index to rank bids thereby selecting the 'best' acres for the scheme		- Importance of extension support and communication evident

Ecological aspects	- large areas retired for long periods of time e.g. 30 or more years - many conservation gains		
Economic aspects		Budgetary cost-effectiveness: competition means that applicants are more likely to bid close to the true cost of providing the service Economic cost-effectiveness: ability to order bidders by provision of good for lowest cost Overcomes uncertainty of the value of the good because the land user sets a price that reflects the true cost of providing the good. Fairness: by moving away from pre-determined payments set by conservation agencies Initial calculations suggested that this scheme is 6.5 times less expensive than a fixed price non-auction scheme However, questions on the calculation method have arisen.	- More cost-effective than a fixed-price contract but difficult to quantify by how much
Social and cultural aspects		The authors suggest that auction based schemes can be can be popular with landowners as complex ideas (biodiversity) translated into practical actions. They also highlight that such an approach may be fairer as it removes the circumstance whereby conservation agencies determine payments rates.	
Indicators and monitoring			
Identified difficulties in relation to			
Administration and implementation	The erodibility standard was 'diluted' to increase eligible acreage but this meant that only 17% of the most erodible cropland was entered into the CRP.	Insufficient bidding is a risk	The term auction can be confusing

Ecological aspects	'Slippage' could be a problem, e.g. taking erodible land out of production may mean that equally erodible land may be bought into production. Unclear as to whether this has occurred in reality but needs to be anticipated in equivalent schemes.		- Developing a scoring index for ranking multidimensional bids is very difficult. Subjectivity unavoidable and makes transparency and defence of method difficult
Economic aspects	Excellent example to emphasise potential problems which can occur in relation to economic aspects of bidding systems: Maximum rental rates became known and were used by farmers as a de facto offer system Administrative staff not sufficiently technically equipped to evaluate the economic and environmental merits of bids submitted by landowners (information asymmetry) High target of retiring 45 million acres meant that virtually no offer would be refused (imbalance between supply and demand)	May entail higher transaction costs Theoretical pitfalls of an auction based scheme: Collusion and strategic behaviour amongst bidders (could be a problem in relation to EU agri-environment schemes where auctions would be repeated several times but measures could be taken to prevent this (e.g. announcing different reserve prices, changing the budget or target level) Risk of learning amongst bidders who then nudge bids upwards Bidding system requires larger number of heterogeneous bidders. In other words, if the costs of farm management changes can be relatively easily quantified, and the costs are similar across a wide range of farms and only a small number of farms would take part in the bidding, there is no need for such system. Balance between efficiency gains and higher administration costs need to be taken into account	Some farmers bid below their opportunity costs because they would have carried out conservation work even without payment, hence bidding price does not reflect true cost of achieving environmental outcome Evidence of some rent seeking by farmers, also due to the above reason Such schemes need to operate at a large scale so that high fixed costs can be distributed efficiently across a number of tenders
Social and cultural aspects	Farmers may feel uneasy being paid for not working the land.		Budgetary constraints may disenfranchise farmers who put together an unsuccessful bid.
Indicators and monitoring			

Table A5. Payments for ecosystems services pilot scheme in Nicaragua

	Example 15 **The Regional Integrated Silvopastoral Ecosystem Management Project**
Source	Pagiola, S., Ramírez, E., Gobbi, J., De Haan, C., Ibrahim, M., Murgueito, E. and Pablo Ruíz, J. (2007) Paying for the environmental services of silvopastoral practices in Nicaragua *Ecological Economics* 64, 374-385
Country/Region	Nicaragua, Matiguás-Río Blanco (The Silvopastoral Project includes this site in Nicaragua, a site in Costa Rica and a site in Columbia) First payment made in 2003
Budget	The Silvopastoral Project is funded by a 4.5 million US$ grant from the Global Environment Facility (GEF). The text is unclear but implies that this funding is for all three areas not just Nicaragua.
Scheme initiation and administration	The World Bank is the implementing agency but the project is implemented in the field by Nitaplan (an NGO affiliated with the Central American University).
Scheme objective/s	Piloting the use of payments for ecosystems services to encourage the increased adoption of silvopastoral practices. Current extensive pastures provide low levels of services (biodiversity, carbon sequestration, hydrological) but the adoption of silvopastoral practices could increase these. Rationale is that short-term payments could 'tip the balance' of profitability between current land use practices and silvopastoral land use practices.
Targeted environmental outcome	Payments are made for increases in biodiversity conservation and carbon sequestration services. Aim to incorporate payments for hydrological services in the future.
Scale of scheme application (area or number of farms targeted)	Budget limits participation to just over 100 households. First come first served basis until this limit was reached. Interest in the scheme was greater than could be provided for.
Approach to quantify environmental benefits	Development of an 'environmental services index' (ESI). This distinguishes 28 types of land use though not all are found at the Nicaraguan site.

Approach to quantify and design of payments	ESI used to pay participants for net increases in ESI points. Applies to the whole farm. Indices of biodiversity conservation and carbon sequestration developed. These were aggregated into the ESI which is similar to the Environmental Benefits Index described in Example 11, Table 4. Biodiversity conservation index is on a scale 0.0 (biodiversity poor land-uses) to 1.0 (biodiversity-rich land-uses). A panel of experts assigned points to each land use. 1 point in the carbon sequestration index equates to 10tC/ha/year (stable carbon in soil or hardwood). Payments made to landowners on an annual basis for four years based on the net increase in ESI points.
Approach to scheme monitoring	Payments are made after monitoring of land use changes has occurred. Remote sensing is used to prepare detailed land use maps for each participating farm on an annual basis. Also use of a control group of non-participating farms. However, selection of control groups was poor and analysis of these not included in the paper. Verification that the biodiversity conservation services are being achieved is verified with the monitoring of bird indicator species and complemented by research into butterflies, ants and molluscs.
Identified advantages in relation to	
Administration and implementation	Payment for improvements in index score rather than baseline position better targets actual gains, as advised by an expert panel.
Ecological aspects	Participants undertook significant changes in land uses in 24% of total project area in first two years of the project. Incremental payments could have a greater impact on changing land use compared to schemes that do not require incremental actions. Whole farm approach may prevent the displacement of undesired land uses. Initial results suggest that at both the plot and landscape level, biodiversity is being conserved.

Economic aspects	From the perspective of the household, it appears that the milk yields have increased and mortality of cattle decreased. Excess demand implies attractive payment rates
Social and cultural aspects	Initial results suggest that poorest households have not been excluded from participating in the scheme.
Indicators and monitoring	
Identified difficulties in relation to	
Administration and implementation	High administration costs due to the pilot nature of the scheme. Some confusion over payment calculations based on opportunity costs and payments for improved index scores. Payment on improved scores leads to perverse incentive to lower baseline, so additional payment also made for high baseline score. High transaction costs due to pilot status and intensive monitoring needs.
Ecological aspects	Extremely difficult to estimate the value of services Whilst solutions to financing long-term funding for carbon sequestration and water services may be found, this is more difficult for biodiversity conservation.
Economic aspects	How to secure long-term payments? E.g. 'Clean Development Mechanism' for carbon sequestration services. Short term payments are questionable because services will only be provided for as long as there are payments. Support for this argument is given by the example of participants with 2 year contracts who cut down their newly planted trees when payments ceased. Adequate mechanisms need to be in place to ensure ongoing commitments. This project 'aimed to 'tip the balance' to make silvopastoral practices more economically attractive. This will not work for every farmer. High transaction costs (largely due to monitoring and other activities) due to the pilot nature of the scheme. Extremely difficult to estimate the value of services An auction would have reduced the cots of the scheme by allowing the selection of the lowest cost providers but was thought to be too complex for the setting 'Leakage' may occur whereby farms not participating may benefit from better economic returns without delivering ecosystem services.

	Scheme had to be modified to include payments for ‘baseline services’ in reaction to the threat by farmers that they would cut down existing trees. ‘Frontloading’ payments were made at the Costa Rican project site.
Social and cultural aspects	Need for security of tenure, capital or access to credit may exclude poorer households. These households may also have less access to agricultural extension support. However, results indicate participation of poor households.
Indicators and monitoring	