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Multiple factors control the environmental effectiveness of agri-environment schemes: implications for design and evaluation

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Abstract
Achieving and evaluating the environmental effectiveness of agri-environment schemes (AESs) has proven difficult. The design and *ex ante* evaluation of AESs is a crucial phase for ensuring effectiveness, but seems to receive relatively little attention. We propose a programme theory (a structured description of the various cause-and-effect relationships that underpin and achieve a policy initiative) for AESs that considers multiple factors that drive environmental performance at farm-scale (appropriate farm-level objectives, farmer compliance, implementation by institutions, and cause-and-effect relationship between management prescriptions and environmental objectives), and factors that determine how farm-scale performance aggregates to produce scheme-scale performance (participation rate, targeting, and threshold effects). These factors can be used as assessment criteria with which to pinpoint specific causes of AES failure, and thereby offer a practical approach to complement the design and evaluation of the environmental effects of AESs.

Key Index Words: agri-environment schemes, REPS, policy evaluation, environmental effectiveness, rural environment.

Introduction

Agri-environment schemes (AESs) in the EU offer payments to farmers in return for undertaking management practices (measures) that maintain, enhance or restore the rural environment. Between 1992 and 2003, about 23 billion was spent on AE schemes in EU-15 countries (European Environment Agency, 2002). Given this level of expenditure, it is surprising that the environmental performance of many schemes is not clearly known, and the limited number of environmental studies of AESs have produced mixed results (for example, c.f. Aughney and Gormally, 2002; Feehan *et al.*, 2002; Carey *et al.,* 2003; Primdahl *et al.,* 2003; Kleijn *et al.,* 2006; Potts *et al.*, 2006). There is an official requirement for evaluation of AESs according to a range of criteria, but it is widely acknowledged that the environmental component can be significantly improved.

Evaluation has an associated academic discipline that can inform practical methods for policy planning and evaluation. The development of programme theories (a.k.a. impact models or logic models) is one such approach that identifies the various explanations and assumptions that underpin the expectation that a programme will achieve its objectives, and structures these as a sequence of causal relationships (see Weiss, 1972, 1997). In practice, a programme theory can be thought of as an heuristic device or working model that assists in enabling understanding of how multiple factors can interact and cause a programme to be a success or a failure. Here, we develop a simple programme theory for AESs, which explicitly identifies a number of factors (that reflect assumptions of scheme design and implementation) that strongly influence the delivery of environmental effects of AESs. Programme theories may generate understanding and insight into the various mechanisms that deliver environmentally effective schemes, but may also assist evaluation by directing evaluation effort toward the cause-and-effect relationships in the programme theory (i.e. theory-based evaluation; Weiss, 1972). This has a number of advantages, not least the ability to attribute programme failure to specific elements of a programme theory.

We begin by clarifying the understanding of environmental effectiveness. We then describe general features of the design and implementation of AESs, with reference to specific farm-level and scheme-level characteristics. Using this improved understanding about factors that underpin the environmental effectiveness of AESs, we discuss how to improve the design, implementation and evaluation of AE schemes.

Environmental effectiveness

The understanding of 'effectiveness' is not well defined in the context of AESs, and may confound attempts to evaluate the degree to which AE schemes are effective. The environmental *effectiveness* of a measure involves a judgement about whether or not the expected objectives and targets of the policy measure have been achieved (European Environment Agency, 2001; Finn, 2003; Lee and Bradshaw, 2004). Effectiveness is therefore determined by the comparison of clearly stated objectives and quantitative targets with the magnitude of the produced effects.

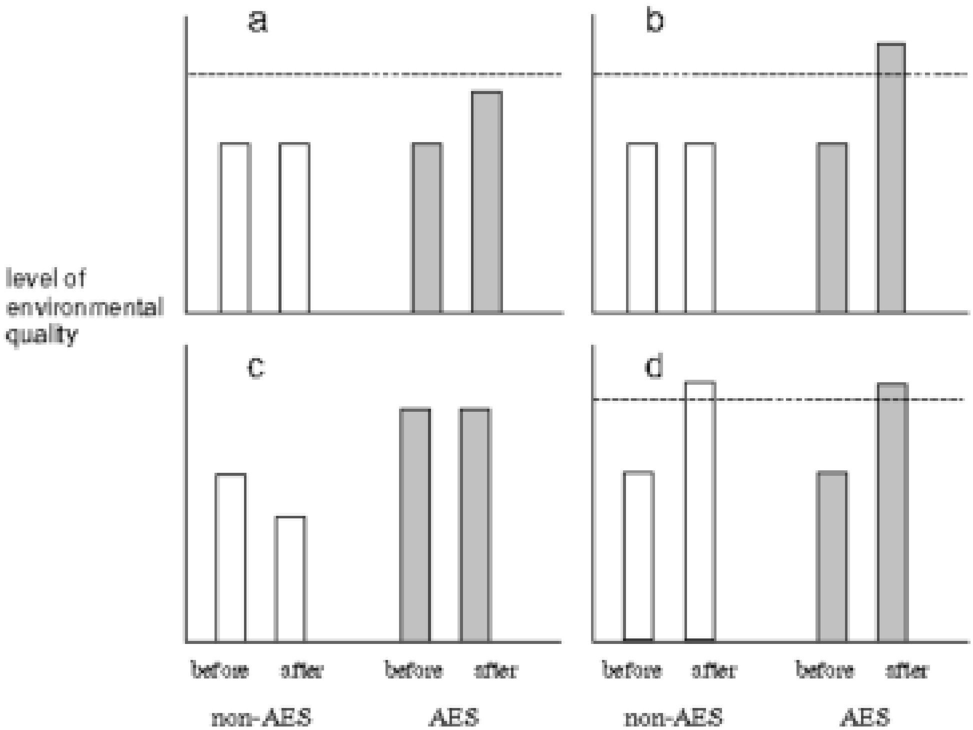
The above description of effectiveness is performance-related, and reflects the *a priori* setting of a performance level that can be measured to objectively determine whether it has been achieved. The difference between environmental effects and effectiveness is illustrated in Figures 1a and 1b. In both cases, the AE policy produces effects, but only in Fig. 1b are the effects of sufficient magnitude to achieve the quantitative objectives. This comparison highlights how the absence of a quantitative objective makes it impossible to differentiate between an effect, and effectiveness. An objective of AES policy may be to maintain existing high environmental quality, and Fig. 1c illustrates such a protection effect in which the AES farms maintain their high quality, despite general decreases in quality in non-AES farms (Finn, 2003; Primdahl *et al.,* 2003). In Fig. 1d, the AES policy appears to be effective, but the effects of policies in non-AES farms are of equal magnitude.

Multiple factors control environmental effectiveness: toward a programme theory

Here, we describe a number of primary factors that contribute to the achievement of environmental effectiveness in AESs. In the EU, agri-environment schemes must be offered by Member States, but participation is optional for any individual farmer. Note that the clear specification of scheme-level objectives and targets sets a fundamental context for AESs, and the relevance and appropriateness of the programme theory. Scheme-level objectives should reflect the environmental issues that are deemed most important in the rural environment, and should be clearly stated and measurable.

We distinguish between the level of environmental performance attained at the level of individual farms, and the level of environmental performance that is attained by the scheme. Obviously, these are strongly linked as it is the cumulative environmental effects produced across a number of individual farms that delivers the total environmental effect attributable to a scheme.

Figure 1: Idealised comparisons of level of environmental quality averaged across farms participating (AES) and not participating (non-AES) in an agri-environment scheme. Temporal changes within each group of farms are presented for environmental quality before and after the implementation of an agri-environment scheme. The dashed line indicates the target level of environmental quality to be achieved by the scheme.



Environmental effects at farm- and scheme-scales

The achievement of farm-scale environmental effects is determined by a number of factors that include the following:

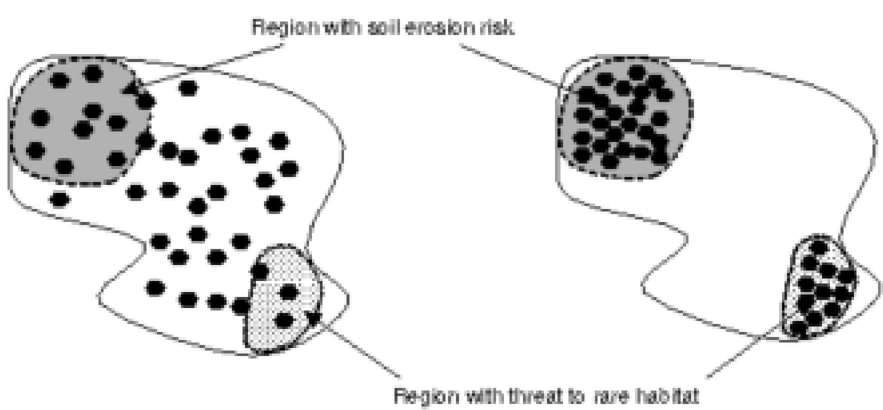
- *Appropriate objectives at farm-scale*. Scheme-level environmental objectives should be applied appropriately at farm-scale. Ideally, this should result in the main environmental issues that occur on a farm (or in the immediate region) being addressed, and also result in a farm not undertaking unnecessary measures. The degree of appropriateness will be determined by decisions about, for example, which areas of the farm to enrol in a scheme (where part-farm options are available). That the most environmentally appropriate objectives will be chosen cannot be assumed e.g. where a choice of options is possible, tensions may arise when choosing between options that best address an environmental issue, and those that are cheapest to implement.
- *Appropriate management prescriptions*. Achievement of the environmental objectives requires that the implemented management practices are appropriate to deliver the intended environmental effects. The validity of such cause-and-effect relationships is best established by experimentation.
- *Implementation*. Prescribed management practices (measures) are implemented by

farmers, and non-compliance arises when failure to correctly implement the measures is intentional. However, AESs are also implemented at an institutional level, which is responsible for providing correct advice, support and training to assist farmers. Any deficiencies in the quality of implementation by institutions can result in unintentional failure to correctly implement measures. Distinguishing between such alternatives is important for the identification of ameliorative actions for AESs that are performing below expectation. A standard economic solution to low compliance is to increase inspection rates and penalty levels; however, such a response would be inappropriate (and self-defeating if it caused participation rates to decline) in situations where institutional implementation may be at fault.

As mentioned above, scheme-scale environmental effects result from the cumulative environmental effects across individual participant farms. The level of scheme-scale effects can be determined by factors that transcend the level of individual farms. Thus, scheme-scale effectiveness may be seen as a product of:

- *Farm-scale environmental effects*. (As above.)
- *Participation rate*. The number of participants is obviously a very important determinant of the overall environmental effect delivered by a scheme. In many *ex post* evaluations of AESs, a dearth of environmental measurements has resulted in widespread reliance on participation rate as a surrogate measure of environmental delivery. (This reliance makes strong assumptions about other elements of the programme theory being satisfactory, which several studies indicate as being an unreasonable assumption e.g. the scientific validity of the cause-and-effect relationship may not be as high as expected (reviewed in Kleijn and Sutherland, 2003). There is significant scope at the stage of scheme design for clearer specification of the level of farmer participation that is required to achieve an intended level of environmental effect. Such issues have strong consequences for value-for-money: too little participation and objectives are not achieved whereas an excess of participation may represent unnecessary expenditure. The importance of participation rates raises very complex issues about how payment rates, information transfer, farmers' attitudes and behaviours towards AESs

Figure 2: Comparison of the same area (left) without targeting and; (right) with targeting that matches the spatial distribution of participation with environmental pressures.



all combine to influence farmers' decisions to participate, and how implementation agencies can increase participation rates (where necessary).

- *Targeting.* A specific feature of participation rate is the extent of geographical targeting, which aims to ensure that the spatial distribution of participation in an AES matches the spatial distribution of the local or regional agri-environmental issues that the overall scheme objectives aim to address (Fig. 2). The achievement of geographical targeting strongly depends on scheme design, and the degree to which knowledge of the spatial distribution of environmental pressures is available and utilised.
- *Threshold effects*. Threshold (or cumulative) effects (see below) may arise due to non-linear relationships between participation rates and the delivery of the environmental effects expected of an AES (Fig. 3). The level of participation required for scheme-scale effectiveness may be significantly affected by the occurrence and nature of threshold effects (Fig. 3) (Wu and Skelton-Groth, 2002).

For AESs that rely on relatively high levels of participation to achieve environmental objectives, threshold effects may be very important (see Fig. 3). The non-linear nature of curve 1 represents an environmental effect that is adequately delivered by a relatively low level of participation (V). In practice, for example, this may be achieved by very localized environmental objectives and spatial targeting of participation, or a combination of both. Line 2 represents a linear relationship between participation and delivery of the environmental service (at Y). Curve 3 of Fig. 3 represents an environmental service that requires a relatively high level of participation (Z) to attain the required delivery of environmental service. This situation may arise due to density-dependent relationships and scale effects. For example, high participation rates may be required for linear habitats (e.g. wildlife corridors, management of watercourses for water quality), and relatively low levels of non-participation may have disproportionately large consequences for the necessary degree of ecological connectedness for such habitats. Note also that bundles of measures may also give rise to threshold effects, whereby the implementation

Figure 3: Illustration of some different relationships between participation rate and the delivery of an environmental effect (lines 1-3). The expected level of environmental effect for which payment is made is indicated by the dashed line M.

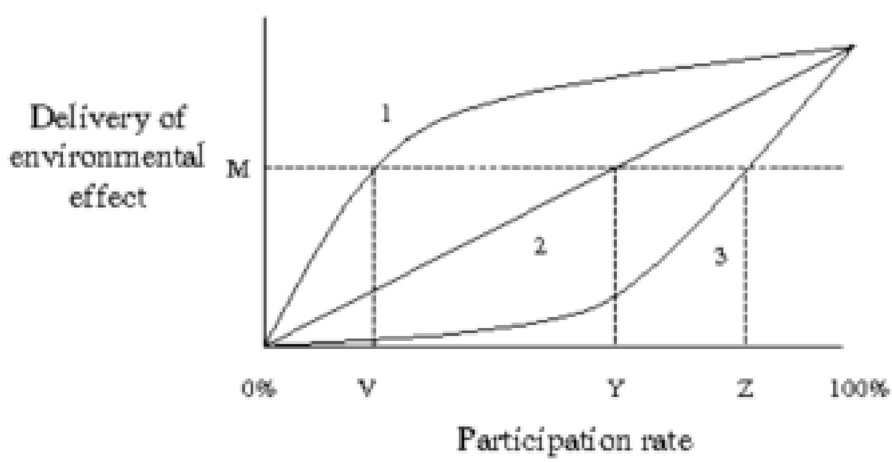
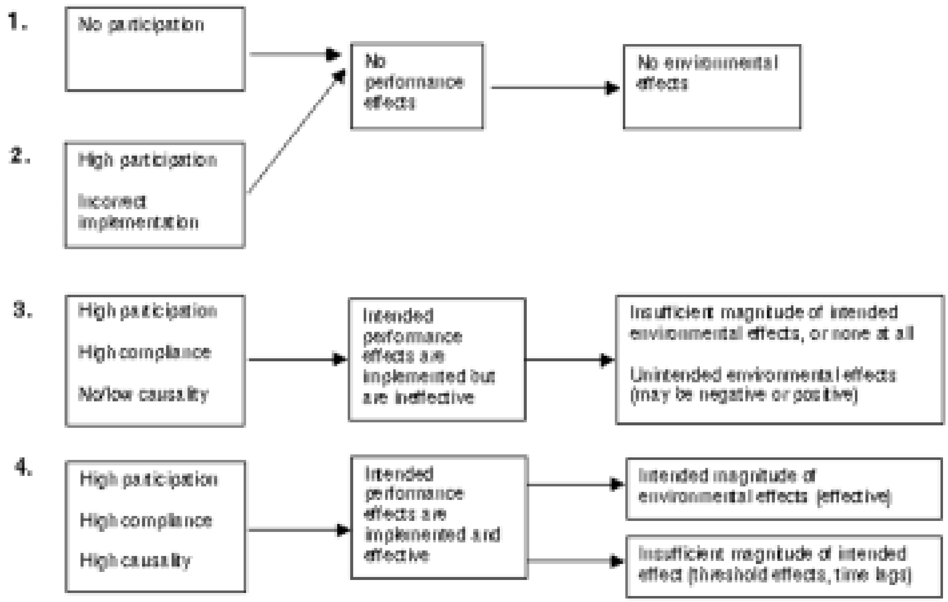


Figure 4: Conceptual outline of a programme theory for environmental effectiveness of AESs, illustrating different scenarios.



of several measures on an area may achieve more than the sum of the parts. It may be very difficult to quantitatively predict non-linear relationships between participation and a particular environmental benefit (Muradian, 2001); nevertheless, such effects can have profound impacts on environmental effectiveness and value-for-money (Wu and Boggess, 1999).

Based on the above programme theory, we present some scenarios that represent different serious effects on the environmental effectiveness of AESs (Fig. 4). To a certain extent, the idealised scenarios presented in Fig. 4 are caricatures of the real experience of AESs, nevertheless they highlight some of the different factors that contribute to scheme effectiveness:

- Scenario 1 indicates the trivial example where no participation results in no implementation and no environmental effects.
- Similarly, in scenario 2 high participation but incorrect implementation (either unintentional or due to non-compliance) results in an ineffective scheme.
- In scenario 3, high participation and high farmer compliance occurs, but there is a poor cause-and-effect relationship between the management prescriptions and the desired environmental effect. In essence, farmers comply with their agri-environment contract, but the requirement of the contract is inappropriate to achieve the intended environmental objectives. Note that the lack of effectiveness in this example can be attributed to deficiencies in scheme design.
- Scenario 4 represents the most desirable case, where there is relatively high (or sufficient) participation, high compliance and a valid causal relationship between the management prescriptions and environmental effects. Note that time lags may delay the achievement of the intended magnitude of effects.

These scenarios emphasise that AE schemes can only be sensibly improved after discerning which specific factors in a programme theory are limiting environmental effectiveness. Although environmental data are crucially important for identifying whether a scheme is ineffective, an understanding of *why* a scheme is ineffective will not be revealed from environmental data alone. For example, monitoring of species-rich vegetation permits a quantitative assessment about whether a target level of species richness has been reached. In situations where the environmental and ecological targets of AESs are not achieved, such data cannot discriminate whether failure is due to unrealistic target levels, inappropriate management prescriptions (poor cause-and-effect relationship), intentional non-compliance, improperly communicated management prescriptions, inadequate participation or some combination of these. Evaluations of agri-environmental policy explicitly intend to not just identify whether expected effects are achieved but, where they are not, to identify the reasons why, and to suggest modifications and improvements.

Looking at some studies of agri-environmental schemes may illustrate practical linkages with the features of our proposed framework (above). Perhaps most important is that both the European Commission and Member States have been criticised at the highest levels for inadequate clarification of the environmental objectives of their AE schemes, and the relative priority of these objectives (Court of Auditors, 2000). The influence of institutional implementation is illustrated in several studies that show that the provision of specific conservation advice increases farmers' appreciation of farmland wildlife (Aughney and Gormally, 2002) and their willingness to undertake conservation actions on their farm (Budillon, 1996; see also Winter *et al.*, 2000; Smallshire *et al.*, 2004; Gabbett and Finn, 2006). The validity of the cause-and-effect relationship is a crucial pre-requisite for effective schemes, and will be dependent on the available evidence base and its communication to, and incorporation by, scheme designers (Briggs, 2006). A recent conference on agri-environment schemes that address wildlife objectives concluded that there is significant potential for the current evidence base in conservation ecology to be better incorporated in AESs, 'In general, there is sufficient ecological insight and geographical information to identify the objectives, outcomes and targeting for potential AES prescriptions,' (Díaz *et al.*, 2006). Addressing another of the factors in our approach, participation rates (in AESs) of many Mediterranean countries (e.g. Greece, Spain and Italy) are very low, and unlikely to deliver sufficient environmental benefits on a widespread scale (EC, 2003). Finally, one of the most frequently cited examples of a successful AES is the recovery of the Cirl Bunting (*Emberiza cirlus*) population in the UK, which increased by 80% on agreement farms between 1982 and 1999 but by only 2% on non-participating farms (Peach *et al.*, 2001). Amongst other factors, this success is commonly attributed to the spatial targeting of the agreements to farms that occurred within the highly restricted range of this bird species. In general, however, AESs have been criticised for not being sufficiently targeted to "the zones with the greatest agri-environmental problems and/or potential" (Court of Auditors, 2000, p.2).

Improving the design and evaluation of agri-environment schemes

We suggest that there has been inadequate attention or appreciation of the multiple controls of environmental effectiveness in AESs (but see e.g. Carey *et al.,* 2003; Primdahl *et al.,* 2003), and the design of AESs could be improved by giving more explicit consideration to the multiple controls of environmental effectiveness.

How can programme theories about the environmental effectiveness of AESs be used as a practical tool by scheme designers or evaluators? Overall, the multiple factors identified in a programme theory can be used as criteria against which to assess the environmental effects of proposed (or implemented) AE measures. Thus, a measure that performs better across the criteria would be expected to deliver higher environmental performance. How can scheme designers or evaluators collect information with which to discriminate whether the design or implementation of specific criteria (factors) in the programme theory is adequate or deficient? To address this question, we use four different examples from scheme design, *ex ante* evaluation, *ex post* evaluation and rapid assessment.

Firstly, in the design stage, even a relatively informal effort by scheme designers to construct and consider a programme theory can improve the quality of decision-making about the design and implementation of measures to achieve stated agri-environmental objectives. In such a case, for example, the factors in the programme theory could be used as a checklist to ensure that important attributes of environmental performance are not omitted from consideration.

Secondly, *ex ante* evaluation would be expected to adopt a more formal approach (which is also suitable to the design phase), and could use the factors of the programme theory as assessment criteria to *predict* the likelihood of environmental effectiveness of measures in the proposed scheme design. In such a case, selected criteria can be scored along defined rating scales in which higher scores would indicate measures that are better designed, and would be expected to be more effective. One relatively quick way to assess such scores would be to use experts' judgement that is based on an integration of available knowledge where possible, and informed professional judgement where not (Phillips, 1999; Carey *et al.,* 2003; Marggraf, 2003; Tattari *et al.,* 2003; O'Hagan, 2005).

Thirdly, whereas *ex ante* evaluation would rely on experts' judgements to predict the likely effectiveness of a proposed AES, *ex post* evaluation would be expected to rely more on monitoring data to inform the assessment of performance along the criteria. In practice, however, the environmental evaluation of AESs is often hindered by the lack of dedicated monitoring programmes that use appropriate indicators. Even where monitoring programmes are implemented, however, a number of challenges can arise that include: incomplete monitoring whereby some environmental effects are monitored and others are not, and difficulties with the collation of multiple different monitoring studies. Thus, even where data exist on the status of the agri-environment, significant expertise may be required to attain a consistent and valid synthesis and interpretation. A consistent evaluation could use experts' judgement of available empirical data as a basis for scoring elements of a policy against the key criteria that underpin the delivery of environmental effectiveness.

Fourthly, we consider how schemes can be more responsive to identifying problems with scheme design. The ongoing success of an AES relies on effective monitoring of the environmental effects. When problems occur, however, scheme effectiveness can depend on the speed with which problems are identified i.e. measures do not achieve the intended effects or have negative unintended effects. Overall, the quicker a scheme identifies necessary changes for improvement, and the more responsive it is in implementing recommended changes, the more environmental effects it will achieve, and the more likely it is to be effective. Experts' judgements can be used as a rapid evaluation method to identify problems that may emerge after implementation. Experts' judgements may have to strongly rely on anecdotal evidence, but may at least identify likely problems that are a priority for further investigation. Such a rapid evaluation would address a genuine need to learn about the progress of a scheme, and would seem particularly appropriate soon (e.g. one year) after the implementation of new or substantially modified schemes.

Ex ante *evaluation*

To date, significant attention has focused on monitoring the environmental effects of schemes (Goldsmith, 1991; Hellawell, 1991; Lee and Bradshaw, 2004; Noss, 1999; Finn, 2003; Primdahl *et al.,* 2003; Bro *et al,.* 2004; Kleijn *et al.,* 2006; Potts *et al.,* 2006). Although activities of the design phase have received relatively less attention, we believe that the design phase has a disproportionate impact on scheme implementation, effectiveness and quality of *ex post* evaluation. *Ex ante* evaluation assesses the agri-environmental objectives and programme of measures prior to the implementation phase, and therefore represents a very significant opportunity to ensure the environmental effectiveness of AE schemes – before any significant expenditure occurs. *Ex ante* evaluation inspects the proposed design of a scheme, evaluates the likelihood of fulfilling the scheme objectives, and may recommend modifications to improve the proposed scheme design.

In practice, however, we suspect that the potential of *ex ante* evaluation is usually not sufficiently realised for assessing the environmental effectiveness of AE schemes. Here, we suggest a small number of practical approaches that may enhance the *ex ante* evaluation of the design of AE schemes.

- Clarify the relative priority of objectives. The formulation of agri-environmental objectives is an important step in the process of scheme design. The nature of the objectives determines the types of resources that are required, the way in which resources are utilised, the ability to judge the degree to which the objectives are achieved, and the ability to achieve the overall goals i.e. address the identified agri-environmental issues. One of the ultimate aims of an agri-environment scheme is to improve or maintain the environmental quality of farmed land. The objectives of a scheme should reflect the agri-environment priorities within a Member State, or within a sub-region. It is important, therefore, to ensure that priority agri-environment pressures are reflected as high priorities in AE schemes – and thereby avoid misguided and unnecessary scheme objectives. A clear statement of the relative priority of various scheme elements allows a clearer evaluation of the match between the priority associated with an environmental objective and the resources dedicated to it.
- Detail the cause-and-effect relationships between measures and objectives. For each measure, there should be a clear description of the cause-and-effect relationship between the measure and agri-environmental objective, and a description of the evidence base that justifies the choice of the measure. It should be clear when a measure contributes to more than one objective, and when an objective is to be achieved by more than one measure. In case of the latter, there should be a clear prioritisation of which measures are expected to contribute most to an objective. This would allow the detection of any mismatch between the high-level objectives of a scheme and the expected degree of achievement by the proposed measures. The evaluation of cause-and-effect relationships is particularly appropriate to *ex ante* evaluation, which can be assisted by the predictive ability of relevant models. Although such models can be very complex, many AE schemes would be improved significantly by the provision of relatively simple qualitative descriptions of the cause-and-effect relationships. In some cases, these may be no more complex than flow diagrams that relate the desired outcomes of an agri-environmental measure to the intended environmental impacts of these outcomes. Such an approach would improve clarity about the aims of a measure and would improve the provision of feedback from specialist scientists on assumptions about the key causal mechanisms.
- Consider other factors that determine effectiveness. Evaluations should also explicitly consider the impact of institu-

tional implementation, farmer compliance, the adequacy of participation rates and geographical targeting. Of course, factors other than these may be considered.

- Consider a variety of scheme options. The selection of a more effective measure to achieve an objective is likely to be improved when a variety of options are considered (Coiner *et al.*, 2001). Multi-criteria analysis is very appropriate for such exercises, and scheme designers can use some of the factors in the above programme theory as assessment criteria with which to conduct a consistent comparison across alternative scheme options. It would also be possible to include economic criteria.

In conclusion, the 5-year policy cycle of AESs is largely achieved via a combination of *ex ante* evaluation, mid-term review and *ex post* evaluation. Toward more effective design of AESs, we suggest that the process of *ex ante* evaluation be improved. The type of programme theory that we describe facilitates a more structured process of design and evaluation. By definition, a reliance on *ex post* evaluation to modify and improve AESs necessarily involves a period of at least 5 years. For an ineffective scheme, this represents a significant delay before applying an effective remedy. We are not implying that *ex post* evaluation is unimportant; rather, we stress the advantage of an increased emphasis on the role of *ex ante* evaluation to prevent problems from occurring in the first place. Indeed, *ex ante* evaluation can complement *ex post* evaluation; the expense of monitoring programmes is often a hindrance to their implementation, and further reduces the incentive to implement monitoring. Improved *ex ante* evaluation can provide a clearer focus on scheme objectives and relevant indicators (*via* the programme theory), and thereby support more effective and efficient expenditure on *ex post* evaluation. The experience and lessons from successful agri-environment measures and schemes are not adequately shared among ecologists and policymakers, and among different regions and Member States. Overall, there is a need for improved communication between the research community and policymakers (Pullin *et al.* 2004; Briggs, 2006; Sutherland *et al.* 2006) and for the process of scheme design to better ensure this.

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