ENVIEVAL

Development and application of new methodological frameworks for the evaluation of environmental impacts of rural development programmes in the EU

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Area 2.1.4: Socioeconomic research and support to policies

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Report D2.1

Summary report on the review of indicator sets and monitoring approaches

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Acronyms

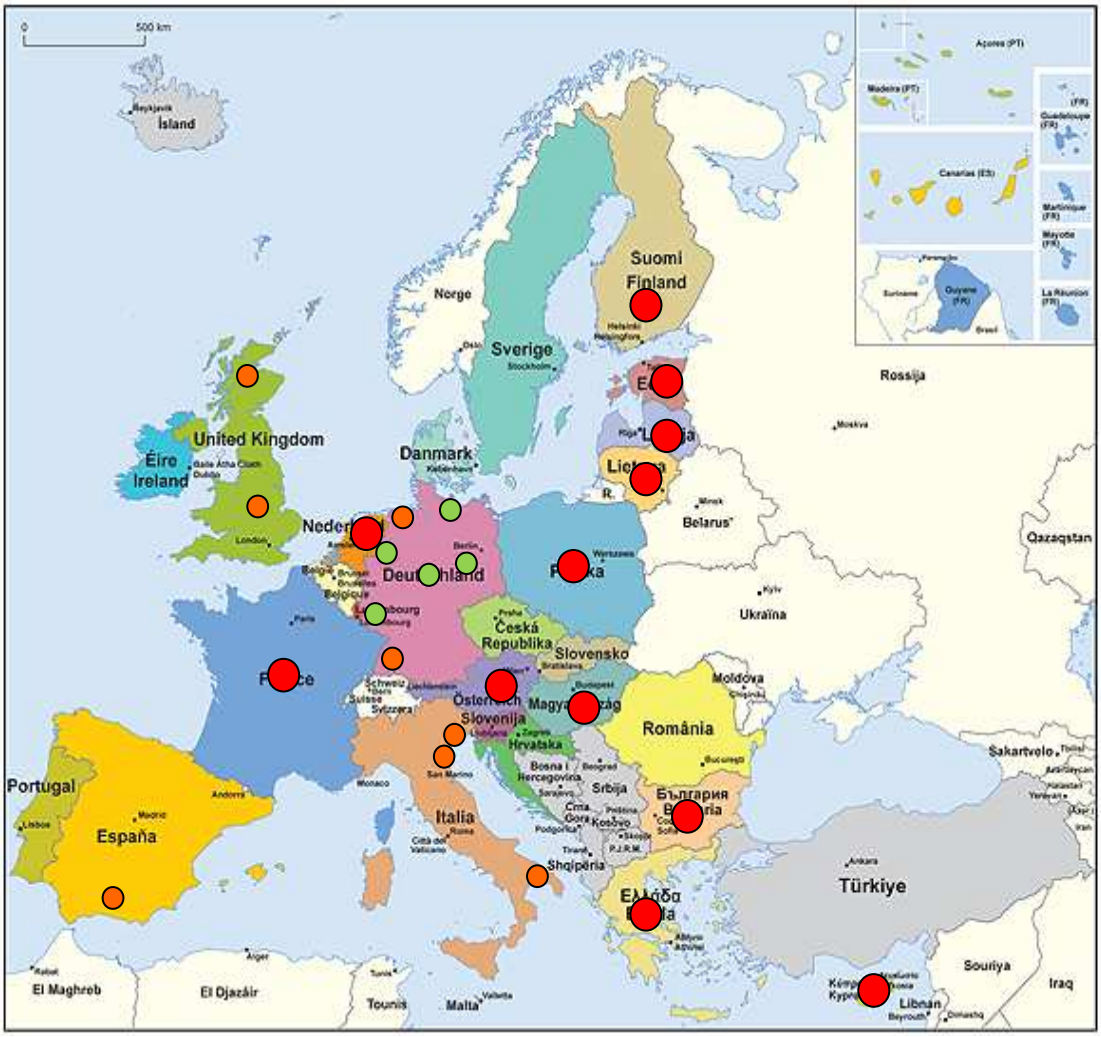
AEM	Agri-Environment Measure
CMEF	Common Monitoring and Evaluation Framework
FADN	Farm Accountancy Data Network
FBI	Farmland Bird Indicator
FOWL	Forest and Other Wooded Land
GAEC	Good Agricultural and Environmental Conditions
GHG	GreenHouse Gases
GIS	Geographic Information System
GNB	Gross Nutrient Balance
HACCP	Hazard Analysis and Critical Control Point
HNV	High Nature Value
IACS	Integrated Administration and Control System
IPCC	Intergovernmental Panel on Climate Change
KTBL	Association for Technology and Structures in Agriculture
LAG	Local Action Group
LFA	Less Favoured Area
LIM	Level of pollution Macrodescriptors
LPR	Landschaftspflegerichtlinie
LU	Livestock Unit
MEKA	Marktentlastungs- und Kulturlandschaftsausgleichs
MS	Member State
MTE	Mid-Term Evaluation
NDVI	Normalised Difference Vegetation Index
NGO	Non-Governmental Organisation
PDI	Patch Density Index
RD	Rural Development
RDP	Rural Development Programme
RICA	Le Réseau d'Information Comptable Agricole
SEA	Strategic Environmental Assessment
SMR	Statutory Management Requirement

TI	Transition Index
UAA	Utilised Agricultural Area
WTO	World Trade Organization

The information of this report was drawn from the respective evaluation documents of the following member states/regions.

Member State	Region	Code	Evaluation Document
Austria		AT	Mid term Evaluation 2007-2013 Ex post Evaluation 2000-2006
Bulgaria		BG	On going and Mid term Evaluation 2007-2013 Ex ante Evaluation 2007-2013
Cyprus		CY	Mid term Evaluation 2007-2013
Estonia		EE	Mid term Evaluation 2007-2013
Finland		FI	Mid term Evaluation 2007-2013 2007-2013 Assessment report 2011 2007-2013 Assessment report 2010
France		FR	Mid term Evaluation 2007-2013 (PDRH) On going Evaluation 2007-2013 (PDRH) Ex ante Evaluation 2007-2013 (PDRH) Ex post Evaluation 2000-2006 (PDRN) Mid term Evaluation 2000-2006 (PDRN) SEA (2007-2013)
Germany	Baden Württemberg	DE1	Mid term Evaluation 2007-2013 Ex post Evaluation 2000-2006
	Brandenburg	DE4	Thematic module report for the Ex post Evaluation 2007-2013
	Mecklenburg Western Pomerania	DE8	Mid term Evaluation 2007-2013
	Lower Saxony	DE9	Thematic module report for the Ex post Evaluation 2007-2013 Mid term Evaluation 2007-2013
	North Rhine-Westphalia	DEA	Mid term Evaluation 2007-2013
	Rhineland-Palatinate	DEB	Mid term Evaluation 2007-2013
	Thuringia	DEG	Mid term Evaluation 2007-2013
Greece		EL	Mid term Evaluation 2007-2013
Hungary		HU	Mid term Evaluation 2007-2013 Ex post Evaluation 2000-2006 SEA (2007-2013)
Italy	Emilia Romagna	ITH5	On going Mid term Evaluation 2007-2013
	Puglia	ITF4	Mid term Evaluation 2007-2013 Ex ante Evaluation 2007-2013 Ex post Evaluation 2000-2006 SEA (2007-2013)
	Veneto	ITH3	Mid term 'post' Evaluation 2007-2013 Ex ante Evaluation 2007-2013 Ex post Evaluation 2000-2006 SEA (2007-2013)
Latvia		LV	Mid term Evaluation 2007-2013
Lithuania		LT	Mid term Evaluation 2007-2013 Ex ante Evaluation 2007-2013 Ex post Evaluation 2004-2006
Netherlands		NL	Mid term Evaluation 2007-2013 SEA (2007-2013)

Member State	Region	Code	Evaluation Document
Poland		PL	Mid term Evaluation 2007-2013 Annual report from realisation RDP 2007-2013 Report product index, result index and impact for axis 2 RDP 2007-2013 (2010) Case-study from environment impact all activities co-financed by EU founds on rural areas on Pomorskie voivodship (2010) Ex post Evaluation 2004-2006 Annual report from realisation RDP 2004-2006
Spain	Andalucia	ES61	Mid term Evaluation 2007-2013
United Kingdom	England	UK-ENG	Mid term Evaluation 2007-2013
	Scotland	UKM	Mid term Evaluation 2007-2013



Executive Summary

Environmental concerns have been formally integrated in the Common Agricultural Policy and Rural Development measures since 1992. The need for common procedures for the evaluation of policies have arisen somewhat earlier i.e. with the introduction of integrated programming, and since then evaluation of policies on environmental grounds has been an issue and an ongoing debate in academia.

Policy measures with multiple objectives, different of policy measures implemented simultaneously at the same area, varying administrative structures and capacity and, last but not least, a wide variety of environmental conditions, roughly describe the challenges encountered.

Various indicator and monitoring frameworks have been proposed but also used for more than 20 years. In order to review these attempts, an inventory of indicators was created including the ones used in 16 member states' evaluation documents examined for the project by all partners and subcontractors, based on a common reporting template.

Within the scope of the reviews performed, and, hence of this report, seven public goods have been examined. Only two have been explicitly mentioned within the objectives in the totality of the MS/Regions that have been thoroughly examined. Those were climate change and biodiversity-wildlife. For four of them, i.e. water, soil quality, landscape and biodiversity High Nature Value Areas, at least one of the MS did not include it within the explicitly-stated objectives. In the case of animal welfare, there were four Member States where the design of Pillar 2 measures did not aim to improve living conditions for farm animals.

When looking for stated causal relationships between measures and public goods and then more expanded chains of reasoning between indicators – rural development policy interventions and public goods, there were 283 such causal chains identified. The overall number is relatively low, considering the total number of references to a RDP measure – public good relationship (914). A first conclusion is that, for less than one third of the stated relationships between public goods and RD intervention, there is a causal chain explicitly established within the evaluation documents.

Examining the number of indicators used in the various evaluation documents for the 20 RDPs studied, one can see that there are indicators available for all public goods examined. The distribution can also be considered satisfactory, with the sole exception of indicators to assess measures in terms of their impact on animal welfare. However, if one

breaks down the results by axis in order to assess the impact of the measures under the specific axis, one can see that there are cases of public goods where no indicator whatsoever is available. An example of this is animal welfare in the case of axis 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity' and both facets of biodiversity and soil quality in the case of 'Leader approach' (Axis 4). Hence, focus on these gaps was considered essential and a list of indicators was provided in order to fill these gaps.

Moreover, in order to exploit the potential offered by other frameworks, suggested in studies or research projects as well as the latest version of context and impact indicators provided by the Commission services, an effort was made to examine them and construct a list of alternative suitable indicators per public good.

However, the final selection of the appropriate indicators will depend on which evaluation method will be used, data availability and environmentally circumstances in each case study area.

1 Introduction - Scope of the Report

1.1 Environmental Evaluation of Rural Development Policies

The first attempts to introduce incentives for environmentally-friendly farming in European Union (EU) Member States (MS) coincided with the first concise version of Rural Development Policy measures under Reg. EEC/797/85. Since then, a number of milestones in the evolution of environmentally-friendly policy schemes in the EU can be identified. The establishment of an obligation for MS to implement Agri-Environmental Measures (AEMs) as accompanying measures in the 1992 Common Agricultural Policy (CAP) reform, drawing the relevant resources from the core of the CAP financing instrument, was one of these milestones (Baldock and Lowe, 1996; Buller, 1999; EEA, 2006) since by the end of the first implementation period 18% of the EU-15 agricultural area was under an Agri-Environment (AE) agreement (EC, 1998). The incorporation of AEMs as an integral part of the second pillar of the CAP, as Rural Development Policy came to be known after the 1999 reform, marked the start of the second period of implementation of AEMs (2000-2006). By the end of this period, 54% of the Utilised Agricultural Area (UAA) of EU 25 was covered by an AE agreement (EC, 2009). The third implementation period for AEMs, currently underway as part of the 2007-2013 Rural Development framework, will complete two decades of formal implementation of Agri-Environment Schemes (AESs) in the EU.

During these two decades, many attempts to evaluate the environmental performance of Rural Development Policy measures have been made. As part of the RDP, these policies are required to comply with a medium-term programming procedure as well as undergo a formal evaluation process. MS must perform evaluations ex ante (currently in the form of Strategic Environmental Assessment, SEA), at mid-term, and ex post at the end of the implementation period. Within these evaluations, environmental assessment has been an increasingly important issue. EU-level evaluation exercises within the EU policy evaluation procedures have also been undertaken, based mainly on formal national programmes evaluations. A goal of these EU-level assessments was to compile national reports into a single document (EC, 1998; 1999; 2006; Oréade Brèche, 2005). This task proved to be quite difficult to achieve, not least because the reporting frameworks used by MS were not always harmonised. Recognising these difficulties and the resulting lack of clarity, a great effort has been made over a number of years to formulate a common evaluation framework for all national Rural Development Programmes (RDPs) (EC,

2000a; 2000b; 2006). These successive frameworks have become increasingly elaborate and detailed (Primdahl et al., 2010). Environmental evaluation of all RDP measures as an omnipresent criterion, but also the need for a more efficient evaluation specifically of AEMs, has led several EU services to focus their interest on agri-environmental indicator systems in order to facilitate the process. Hence, based on work done at Organisation for Economic Co-operation and Development (see OECD, 1997; 1998; 1999; 2000; 2003; Peschard et al., 2004) and since 2000 in European institutions (see EC, 2000c; 2001; EEA, 1999; 2005a; 2005b; 2006), much effort has been dedicated to these issues.

Evaluation of RDPs in environmental terms has also been a high priority in the academic research agenda for these two decades (see for example Damianos and Giannakopoulos, 1999; Peco et al., 2000; Louloudis et al., 2000; Kleijn and Sutherland, 2003; Primdahl et al., 2003; Kleijn et al., 2006; Finn et al., 2007; 2008; 2009).

1.2 Challenges in Environmental Evaluation

The problems identified during the above-mentioned exercises can be classified into three main categories. The first has to do with problems inherent in environmental evaluation per se, the second category is comprised of the problems created by the approach selected for the implementation of EU policy and the third relates to the specific situation at the MS level.

One of the major difficulties is due to the complexity of the interface between agricultural activities and the environment. Land use and management practices are diffuse and variable, both in spatial terms and time scale. In a relatively small area, a number of farmers and farm operators, i.e. farm-level decision makers, can interact with the environment through individual decisions such as fertiliser application or biocide use. These decisions are normally taken independently of each other, and yet they all contribute to the combined environmental impact of farming in that area. Moreover, farming interactions with the environment vary in intensity as well as in the very nature of the impacts which can have a seasonal[1] or sequential dimension. For example, tree farmers in Mediterranean regions apply fertilisers during late winter-early spring and the possible impact of erroneous use is mainly nutrient loss and water pollution. The same farmers use insecticides during late spring, over the summer and sometimes well into autumn. In that case, the focus of an impact assessment should be on biodiversity effects

[1] This is also frequent in other sectors. For example, pollution caused by transport is more intense at peak periods.

and product safety rather than on water quality. At the same time, the timing of insecticide application is crucial, since spraying at the correct time can minimise adverse biodiversity effects while earlier or later application may result in both a damaged crop and a degraded environment.

Another important challenge facing an environmental evaluation is the variety and heterogeneity of causal mechanisms involved in environmental issues, particularly with respect to their local or regional relevance and type of impact (Stoate et al., 2009; Primdahl et al., 2010; Cooper et al., 2010). For example, a specific farming practice, grazing, and the main pressure associated with this practice, namely an excessive number of animals grazing an area (*overgrazing*), expressed as livestock units per hectare, can have entirely different impacts depending on the agro-ecosystem concerned. In northern or north-western Europe, overgrazing of bovine animals typically affects water quality, whereas in the case of most Mediterranean pastures, overgrazing of sheep and goats is a principal cause of soil erosion.

The second group of issues identified in assessments is due to complexities raised by the implementation approach adopted at EU level.

The rationale for rural development policy measures has been their potential for promoting simultaneously, or at least not acting against, a multiplicity of objectives, such as the rural development objectives, which can be summarised under the three pillars of sustainability, namely economic, social and environmental (Buller, 1999; Lowe et al., 1997; Park et al., 2004). Furthermore, within the environmental domain, the choice made by most of the implementing authorities to apply broad and shallow types of schemes instead of an approach of targeting towards one specific environmental objective (Andersen et al., 1999; European Parliament, 1998; European Commission, 1998). This choice, of striving to achieve multiple objectives with one measure, added considerable complexity to the assessment exercises.

The Rural Development (RD) regulations place an obligation on both the national authorities and the European Commission to evaluate RD measures. Nevertheless, despite the two decades of RD implementation in the EU, the problem of time frame for the evaluations remains, rendering all official evaluations of limited scope within the implementation period examined. Given that there is always a delay in setting up the measures, since all RDPs have to be negotiated and approved by the Commission services, there is only limited data available for mid-term evaluations – indeed, in most

cases, only monitoring data are available. Going back to previous implementation periods of the same measure is not within the terms of reference of the mid-term evaluation; hence a discontinuity is created in assessments. Furthermore, *ex post* evaluations are usually made available only long after the policy following the one evaluated has been formulated. As a consequence, the design and implementation of RDP in general are based on a very poor evaluation input, even as regards each MS's own implementation experience, let alone the experience of other MS, since the EU-wide compilations of the national evaluation reports are issued even later. In that sense, it is no surprise that policy formulation does not benefit from a learning process (Finn et al., 2009; Primdahl et al., 2010).

A further complexity has been caused by the approach adopted for calculating AE payments. The World Trade Organization (WTO) Agreement on Agriculture allows AESs to be classified as 'green box' payments as long as the farmer's compensation does not exceed income forgone and the implementation costs incurred (WTO, 1994). The amount of AE payments is, thus, based on the performance effects of AES and evaluations focus strongly on these effects. As a consequence, there is little incentive for evaluators to focus on impacts, nor for policy makers to facilitate the provision of information on impacts, since these are not decisive for calculating the budget cost of the measure.

By contrast, the performance effects of the measure would give a better idea of the value society gets. Following this line of reasoning, performance effect indicators *could* provide satisfactory estimates for the actual impacts, if a very well established, quantitative impact model were available. However, this is not the case for the majority of the AESs implemented across the EU. In a study of 60 AESs, only 15% of the 93 management packages comprising these measures were found to be based on quantitative impact models while more than half of them seem to have been based on intuitive models (Primdahl et al., 2010).

Finally, we can describe some of the problems arising from the specific MS implementation approaches and procedures in the local context. The most immediate problem is the lack of sufficient appropriate data, i.e. data measured at the required spatial levels, with appropriate frequency, and at the necessary points in time. In some respects, these deficiencies may be somewhat alleviated when the evaluation is performed within a research context, but here there is always the problem of limited resources.

When resources are limited, sample sizes and numbers of case studies are small, and the specificities already described render generalisations based on relatively few observed cases potentially spurious. The result is that the formulation of general, scientifically-based conclusions and proposals for policy improvement are not feasible (Carey et al., 2003; Finn et al., 2008; 2009).

One should also observe that, from the definition of RD Policy objectives negotiated with the commission by regional or MS authorities down to policy-induced changes in farming practices, there are many factors and actors that influence farmers' performance and hence the outcome of the measures. In fact, one could argue that the greater the distance between the design and the implementation levels, the more likely one is to find differentiations and distortions due to different policy agendas at different levels of the policy complex (Paniagua A., 2001; Juntti & Potter, 2002; Juntti & Wilson, 2004). Differing degrees of administrative efficiency, deficient knowledge of local conditions as well as the existence of individual farm and farming household perceptions, needs and strategies are some of these factors (Damianos & Giannakopoulos, 2002).

Workpackage two of the project had two main objectives: firstly to review the strengths, gaps and challenges of existing indicator and monitoring frameworks; and, consequently, to recommend evaluation indicators to be incorporated into the methodological frameworks of the evaluation tools and tested in the public good case studies.

For that purpose an inventory of indicators used in the 16 member states' evaluation documents was put together and examined for the project by all partners and subcontractors, based on a common reporting template.

The aim of the present report is to summarise the findings of this detailed examination and synthesise the strengths, gaps and challenges of existing indicator sets and their monitoring requirements paying particular attention to key evaluation challenges such as the linkages between micro- and macro level results, and between basis, output, result and impact indicators and also provide recommendations for the design of suitable indicator sets and their monitoring needs for the development of the methodological evaluation frameworks in WP3, WP4, WP5 and the cost-effectiveness assessment in WP7.

2 Rural Development Measures Relevant to Public Goods

2.1 Climate Change Mitigation

Climate change mitigation is reported in all 20 member states/regions examined, as primary or secondary objective of the relevant RD measures. It should be noted that out of the 35 RD measures examined, 30 have been identified as having a direct or indirect focus on climate change mitigation.

The figure below shows the range of the RD measures reported as influencing climate-change mitigation as well as the frequency of each RD measure as recorded in all RDPs (Figure 1).

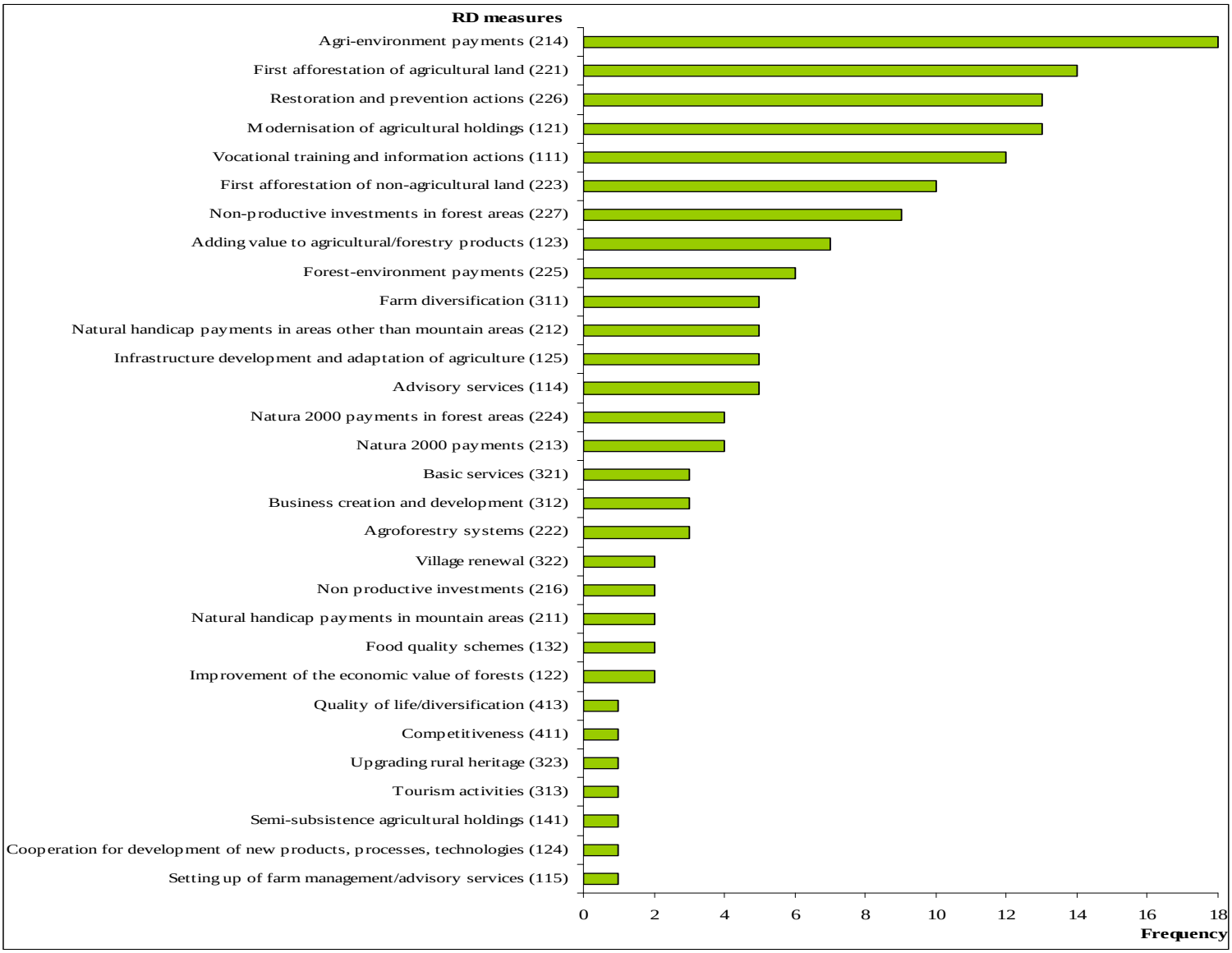


Figure 1 RD measures relevant to climate change mitigation

It can be seen that the main Axes affecting the climate change mitigation are Axes 1 'Improving the Competitiveness of the Agricultural and Forestry Sector' and 2 'Improving the Environment and the Countryside through Land Management'. They account for 31% and 58% respectively of all references to RD measures, while the lowest proportions of 10% and 1% are allocated to Axes 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity' and 4 'Leader approach' respectively. These findings seem reasonable, as measures under Axis 1 support investments introducing new technology and innovations, which are designed to be more environmentally friendly and measures under Axis 2 promote sustainable agricultural management practices that contribute to mitigating climate change. Additionally, measures under Axis 3 are considered significant, mainly because of providing incentives for renewable energy production. On the other hand, there are only few references to the environmental role of Axis 4 in the evaluation documents.

The most important measures, those that recorded more than 10 times in the various evaluation documents, are training activities (111) and farm modernisation (121) under Axis 1, as well as AEMs (214), afforestation measures (221 and 223) and investments for forest fire prevention/restoration after natural disasters (226) under Axis 2.

In general, mentioned as having a potential contribution to combating climate change are:

- rational fertiliser and manure application,
- extensive farming systems that maintain the carbon storage capacity of agricultural soils,
- environmentally friendly investments in agricultural and forestry sector using renewable energy,
- innovations targeted at less emission production,
- the capacity of forest trees to absorb the greenhouse gases' (GHG) emissions.

For instance, in Austria, during the 2007-2013 RDP, (a) investments in biogas and biomass plants (b) certain agricultural management measures and (c) environmentally-friendly farm buildings, are promoted, contributing to reducing GHG and NH_3 emissions.

Also, the French RDP (PDRH 2007-2013) strongly intervenes in a multitude of issues with respect to climate change, including: the modernisation of livestock buildings (effluent management), renewable energy and energy savings in farms (energy efficiency in buildings), the land, grass-crops and agricultural practices (conversion of arable land to grassland, promoting more or less intensive use of meadows, the intensity and efficiency of input use in the broad sense, the development of organic agriculture, etc.) and finally development of the forest and its exploitation (afforestation).

2.2 Biodiversity Wildlife

All member states/regions have applied RD measures which have an impact on the provision of biodiversity-wildlife. Out of a total of 35 RD measures examined 30 have been reported as relevant to this public good. The range of RD measures that influence biodiversity-wildlife and the frequency each RD measure is recorded for all RDPs are presented in the following figure (Figure 2).

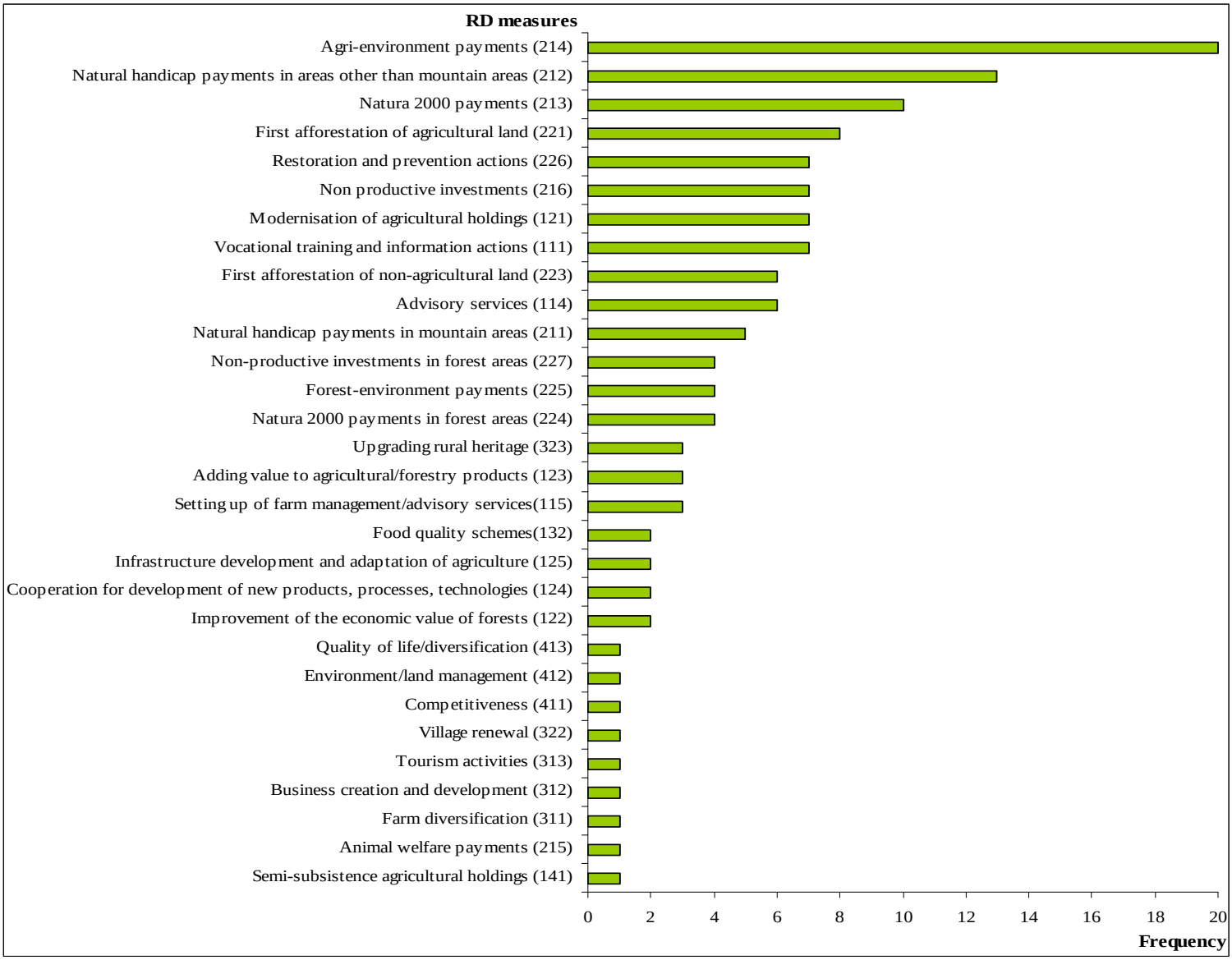


Figure 2 RD measures relevant to biodiversity-wildlife

It can be seen that the main Axes affecting biodiversity-wildlife are Axes 1 'Improving the Competitiveness of the Agricultural and Forestry Sector' and 2 'Improving the Environment and the Countryside through Land Management'. They account for 26% and 67% respectively of all references to RD measures, while the lowest proportions of 5% and 2% are allocated on Axes 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity' and 4 'Leader approach' respectively.

Based on the evidence, the AEMs are by far the most frequently reported measures for providing biodiversity-wildlife. Other RD measures considered as the most influential are those that grant compensatory payments to farmers in LFAs and Natura 2000 areas, measures 212 and 213 respectively, as well as measure 121 'Modernisation in agricultural holdings' under Axis 1.

The AEMs, through biodiversity targeted actions, Natura 2000 payments, by focusing on compensating income forgone by delivering biodiversity-wildlife and LFA payments mainly through continued agricultural use of land in biodiversity rich and otherwise important areas, contribute to the maintenance of wildlife.

However the interpretation of the frequent reporting of the farm modernisation measure (7 times) seems to be that this measure supports investments, which can indirectly improve the environment and biodiversity in general.

2.3 Biodiversity-HNV

All member states/regions have applied measures which have an impact on the provision of biodiversity-HNV, except for Hungary. According to the Hungarian evaluation reports (ex post 2000-2006, mid term 2007-2013, SEA for 2007-2013) none of the RD measures had the potential to deliver this specific public good. Out of all of 35 RD measures examined 25 have been reported as relevant to biodiversity-HNV.

The range of the RD measures that influence biodiversity-HNV and the frequency each RD measure is recorded in all RDPs are presented in Figure 3.

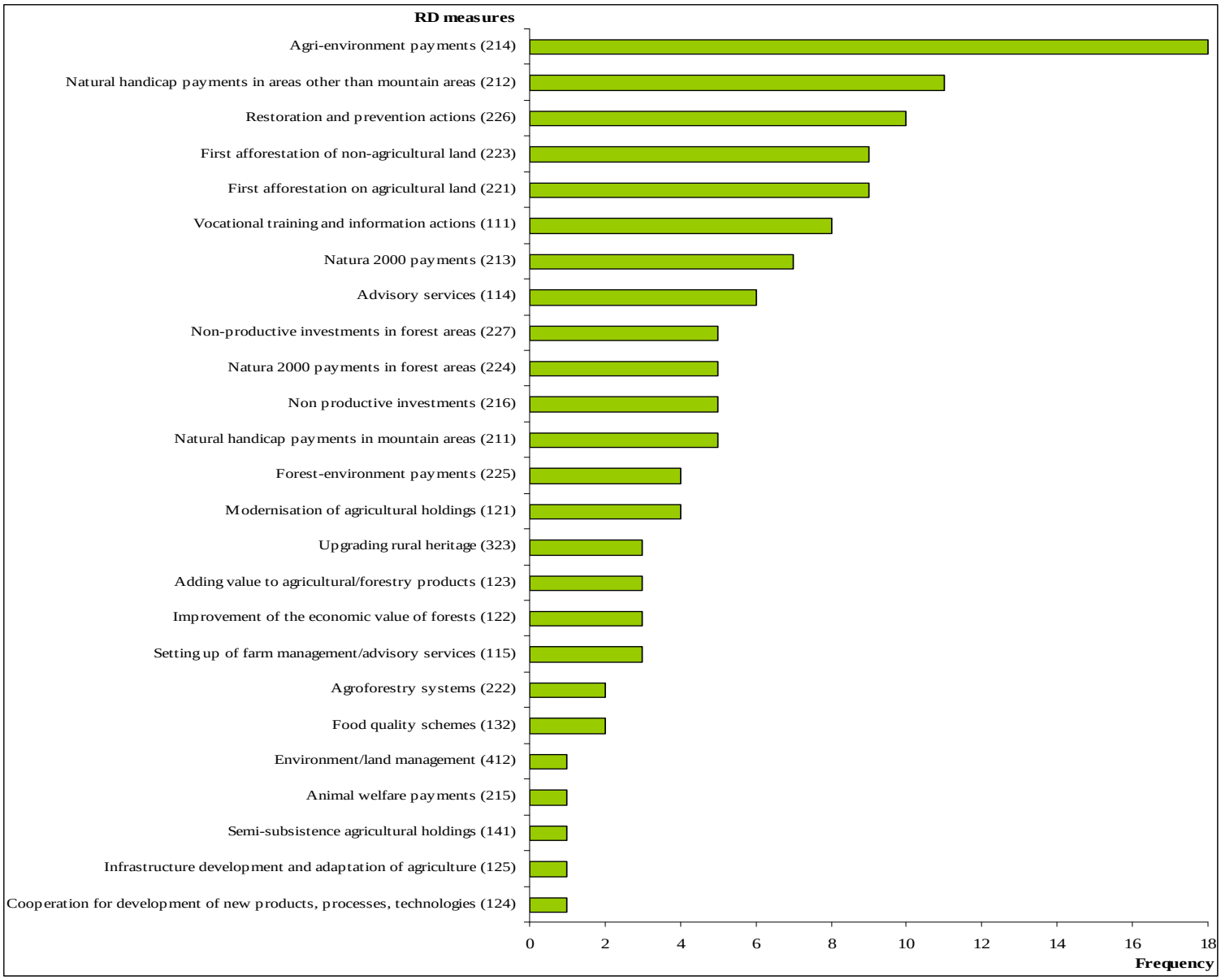


Figure 3 RD measures relevant to biodiversity-HNV

The highest proportions of all references to RD measures are allocated on Axes 1 'Improving the Competitiveness of the Agricultural and Forestry Sector' and 2 'Improving the Environment and the Countryside through Land Management' (25% and 72% respectively), while the role of measures under Axes 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity' and 4 'Leader approach' in delivering biodiversity-HNV could be considered negligible (2% and 1% respectively).

AEMs have been identified as the most frequently mentioned measures alongside the measure concerning LFAs payments (212). The difference between the two LFA measures (211 and 212) is that the measure 211 'Natural Handicap on mountain areas' is not implemented by all member states (Latvia, Netherlands, Scotland, England, Estonia).

Other considerable measures are prevention and restoration investments (226) and afforestation (221 and 223). In fact, all measures under Axis 2 have the potential to contribute to improving biodiversity-HNV.

Under Axis 1, the most frequently reported measure to have an impact on biodiversity HNV is the training measure (111). This measure, through its important role for enhancing the educational level of farmers especially as far as the sustainable management of natural resources is concerned, is thought as having an indirect impact on biodiversity-HNV.

Only one measure from each of the Axes 3 and 4 is found to be relevant to biodiversity-HNV (323 'Upgrading rural heritage' and 412 'Environment/land management'). These two measures support actions that focus on farmland biodiversity.

2.4 Water Quality

The delivery of water quality is identified as a possible impact of the RDP in all member states/regions, except from Hungary. According to the Hungarian evaluation reports (ex post 2000-2006, mid term 2007-2013, SEA 2007-2013), none of the RD measures has the potential to deliver the specific public good. Out of all of 35 RD measures examined 29 have been reported as relevant to water quality.

The following figure shows the range of the RD measures reported as influencing the water quality and the frequency each RD measure is recorded in all RDPs (Figure 4).

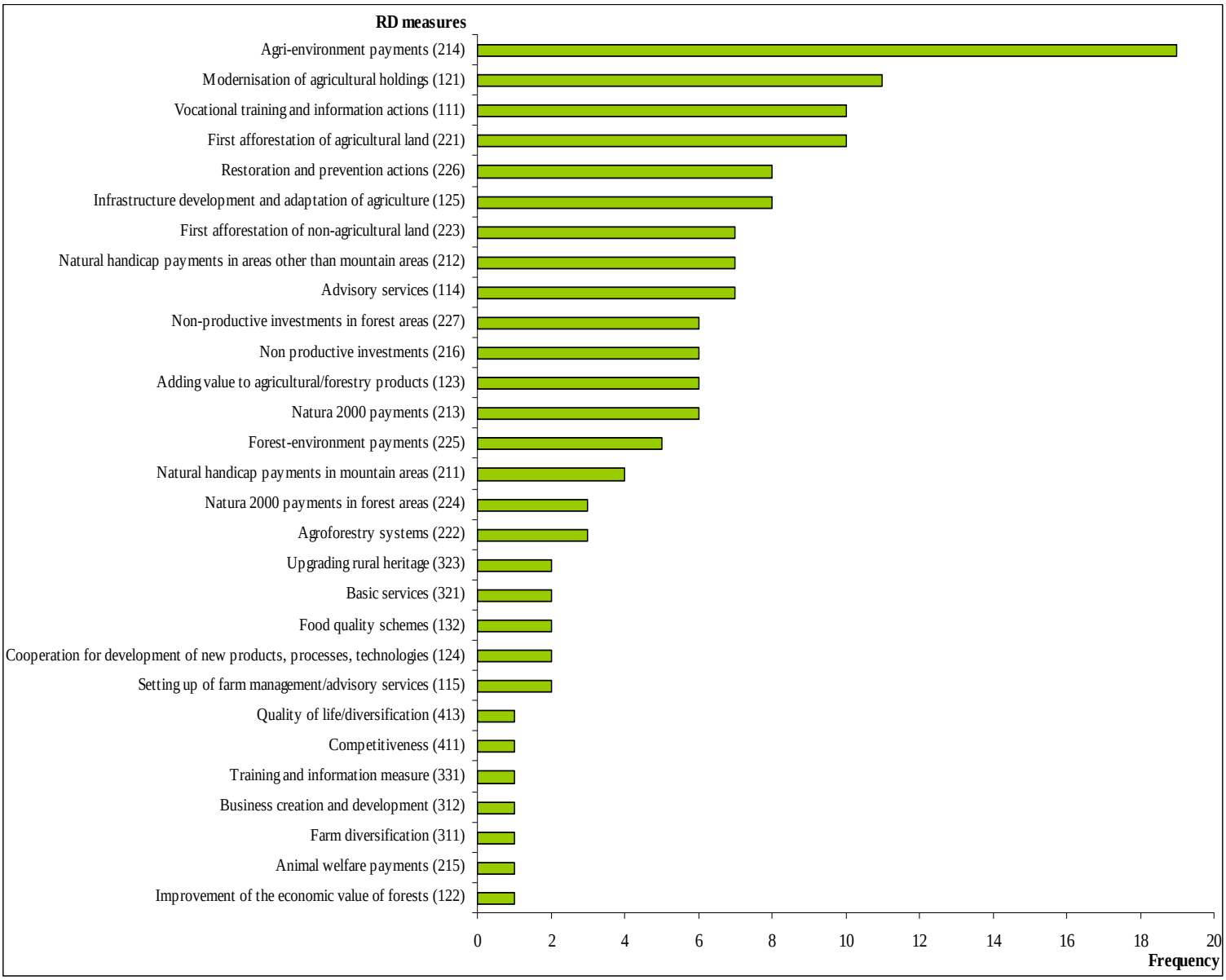


Figure 4 RD measures relevant to water quality

It can be seen that Axis 2 'Improving the Environment and the Countryside through Land Management' is considered as the main axis that contributes to the provision of water quality, with 59 % of all references to RD measures. Axes 1 'Improving the Competitiveness of the Agricultural and Forestry Sector' alongside Axis 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity' account 34% and 5% respectively.

Based on the evidence, across all reports reviewed, it appears that the AEMs, followed by farm modernisation (121), first afforestation of agricultural land (221), as well as training activities (111) are the four main RD measures that influence water quality.

Measures under Axis 2, particularly AEMs and afforestation measures, aim at improving water quality. Likewise investments related to new technologies and innovation have the potential to contribute to the sustainable management of water resources. The frequent reporting of Measure 111 can be explained by the useful contribution of training activities to improve environmental awareness of farmers.

2.5 Soil Quality

Among the 20 members states/regions examined, all have applied relevant measures which have an impact on the provision of soil quality, with the exception of Hungary, where according to the evaluation reports studied (ex post 2000-2006, mid term 2007-2013, SEA 2007-2013), none of the RD measures has the potential to deliver the specific public good. Out of all of 35 RD measures examined 29 have been identified as relevant to soil quality.

The range of RD measures that influence soil quality as well as the frequency each RD measure is mentioned in all RDPs are represented in the figure below (Figure 5).

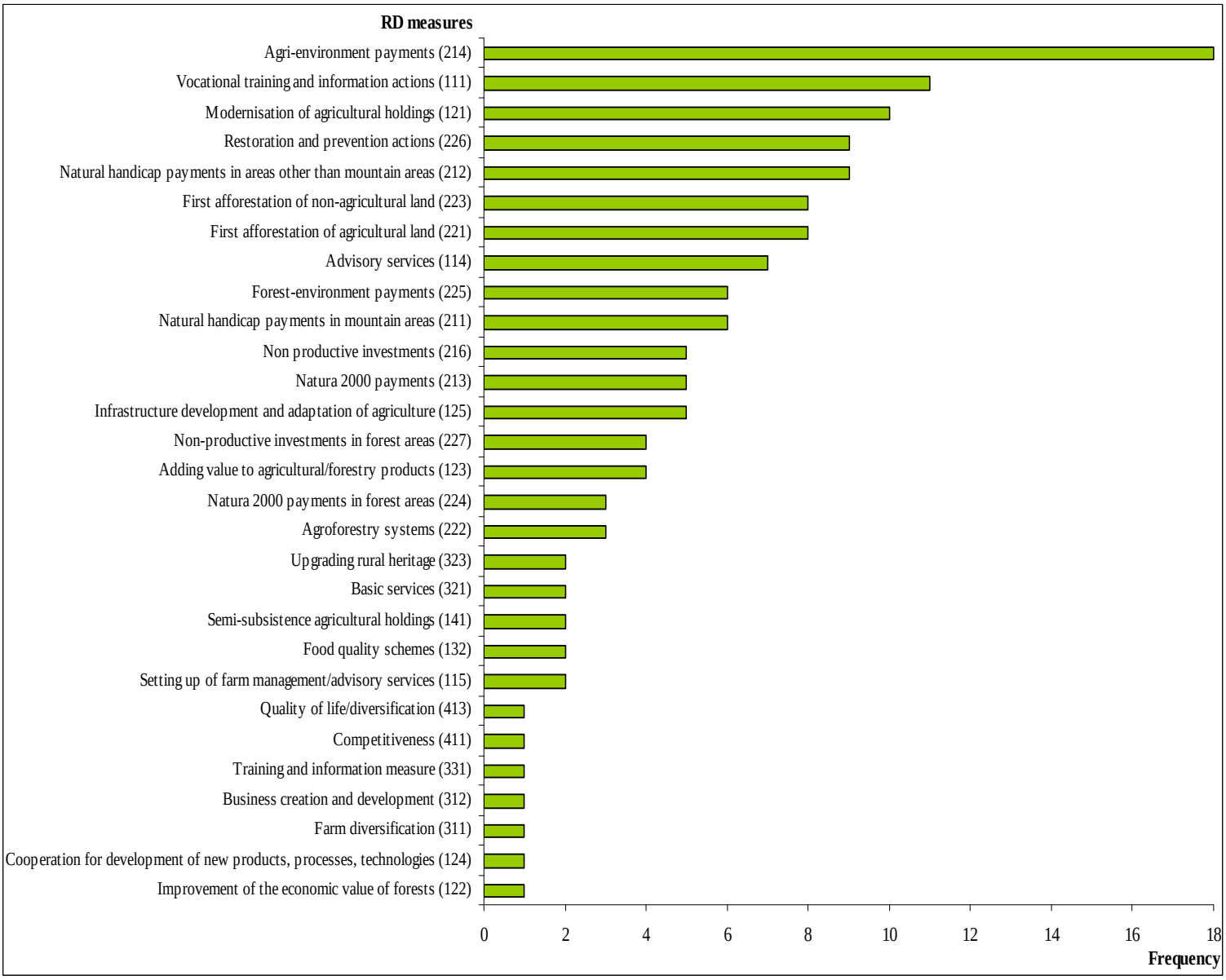


Figure 5 RD measures relevant to soil quality

It can be seen that the main Axes that have the potential to affect soil quality are 1 'Improving the Competitiveness of the Agricultural and Forestry Sector' and 2 'Improving the Environment and the Countryside through Land Management', with 33% and 61% respectively of references to RD measures.

Unsurprisingly, the AEMs are identified as the most frequently reported measures, demonstrating their important role for providing soil health. Furthermore, it is remarkable that vocational and information actions (111) have been reported more times than the farm modernisation measure (121), since the latter is aiming to support investments improving the overall performance of agricultural holdings, with specific focus on environmental protection. Thereby it should thought as having more direct impact on soil quality.

Other important, in the same sense, measures are considered to be the LFA payments (211 and 212), afforestation and forest restoration actions (221, 223 and 226 respectively), mainly due to the promotion of sustainable management of agricultural land and forest resulting in less surface soil loss. Based on evidence, it appears that evaluators have disregarded the unintended environmental impact of measures under Axes 3 and 4 on soil functionality and health.

2.6 Landscape

All member states/regions have applied RD measures which have an impact on the landscape, except for Latvia. According to the Latvian mid term evaluation report, none of the RD measures has the potential to deliver the specific public good. Out of all of 35 RD measures examined, 30 have been identified as relevant to landscape characteristics.

The following figure shows the range of the RD measures reported as influencing landscape and frequency each RD measure is recorded in all 20 RDPs (Figure 6).

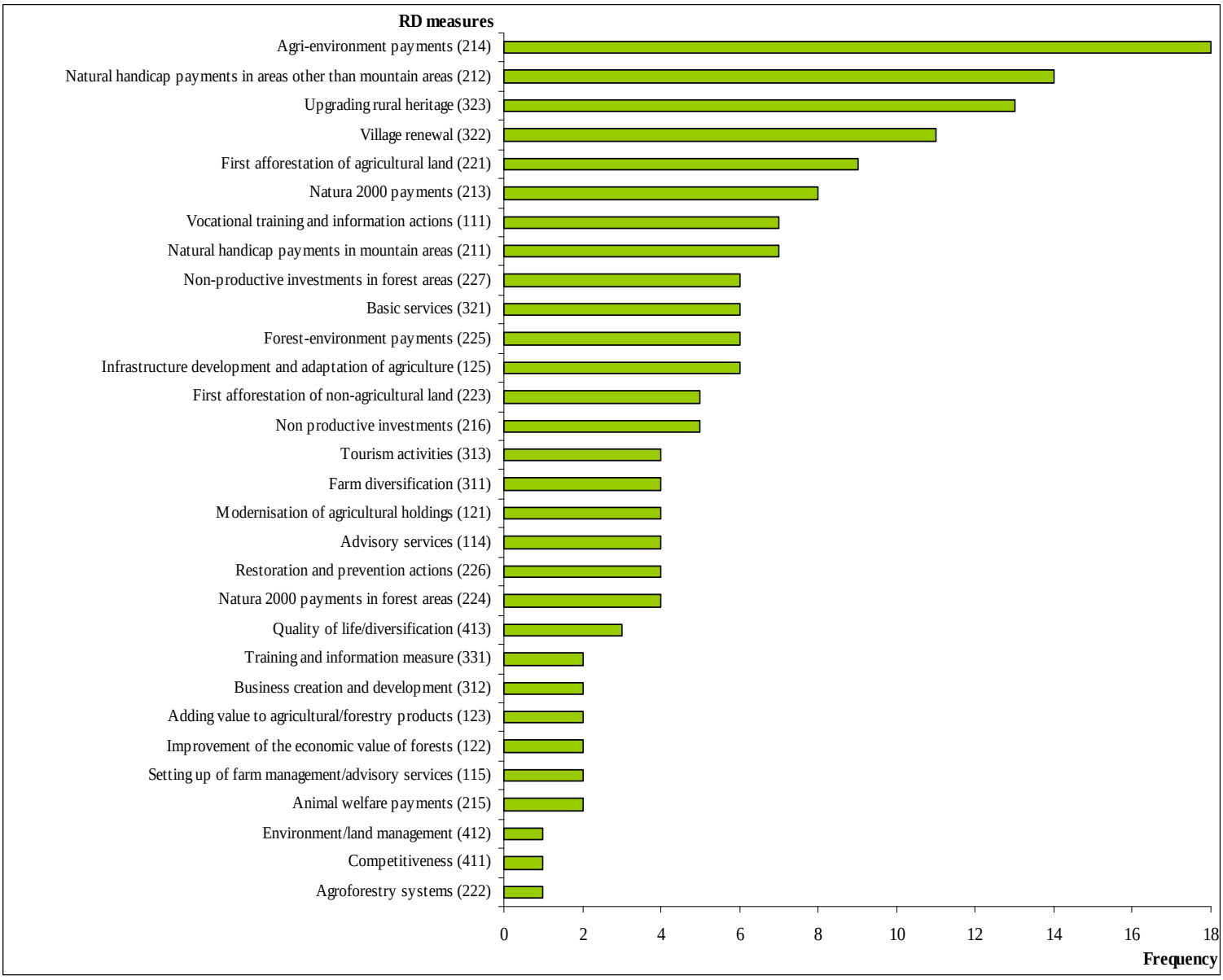


Figure 6 RD measures relevant to landscape

As can be seen, the most significant axis affecting landscape is Axis 2 'Improving the Environment and the Countryside through Land Management'. It accounts for more than half of references to RD measures (55%), while Axes 1 'Improving the Competitiveness of the Agricultural and Forestry Sector' and 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity' account for 17% and 26%, while the lowest proportion is allocated on Axis 4 'Leader' (3%).

Based on the evidence, it appears that the AEMs, followed by the measure 'payments in areas with handicaps other than mountain areas', alongside the measures under Axis 3, 'conservation and upgrading rural heritage' and 'village renewal and development' are the four most important measures that influence landscape. Findings seem reasonable, since

specific actions under AEMs are aiming to maintain or enhance agricultural landscape. Also, the measure of natural handicap payments in areas other than mountainous areas ensures the continued use of agricultural land, avoiding land abandonment and preserving the heterogeneity as well as specific characteristics of rural landscape. Moreover, measures under Axis 3 which mainly intend to reverse the negative trends of economic and social decline of rural areas, through actions with specific focus on the preservation and improvement of natural and cultural heritage, consequently upgrade rural landscape.

2.7 Animal Welfare

Among the 20 member states/regions examined, the delivery of animal welfare is identified as a possible impact of the RDP in 16 member states/regions. According to the examined evaluation reports, in the Netherlands (mid term and SEA 2007-2013,), Hungary (ex post 2000-2006, mid term and SEA 2007-2013) Lithuania (ex post 2004-2006, ex ante 2007-2013, mid term 2007-2013) and Latvia (mid term 2007-2013) none of the RD measures has the potential to deliver the specific public good.

Out of all of 35 RD measures examined only 18 have been identified as relevant to animal welfare, at least for one evaluation document. The range of RD measures that influence animal welfare as well as the frequency each RD measure as mentioned in all RDPs are represented in the figure below (Figure 7).

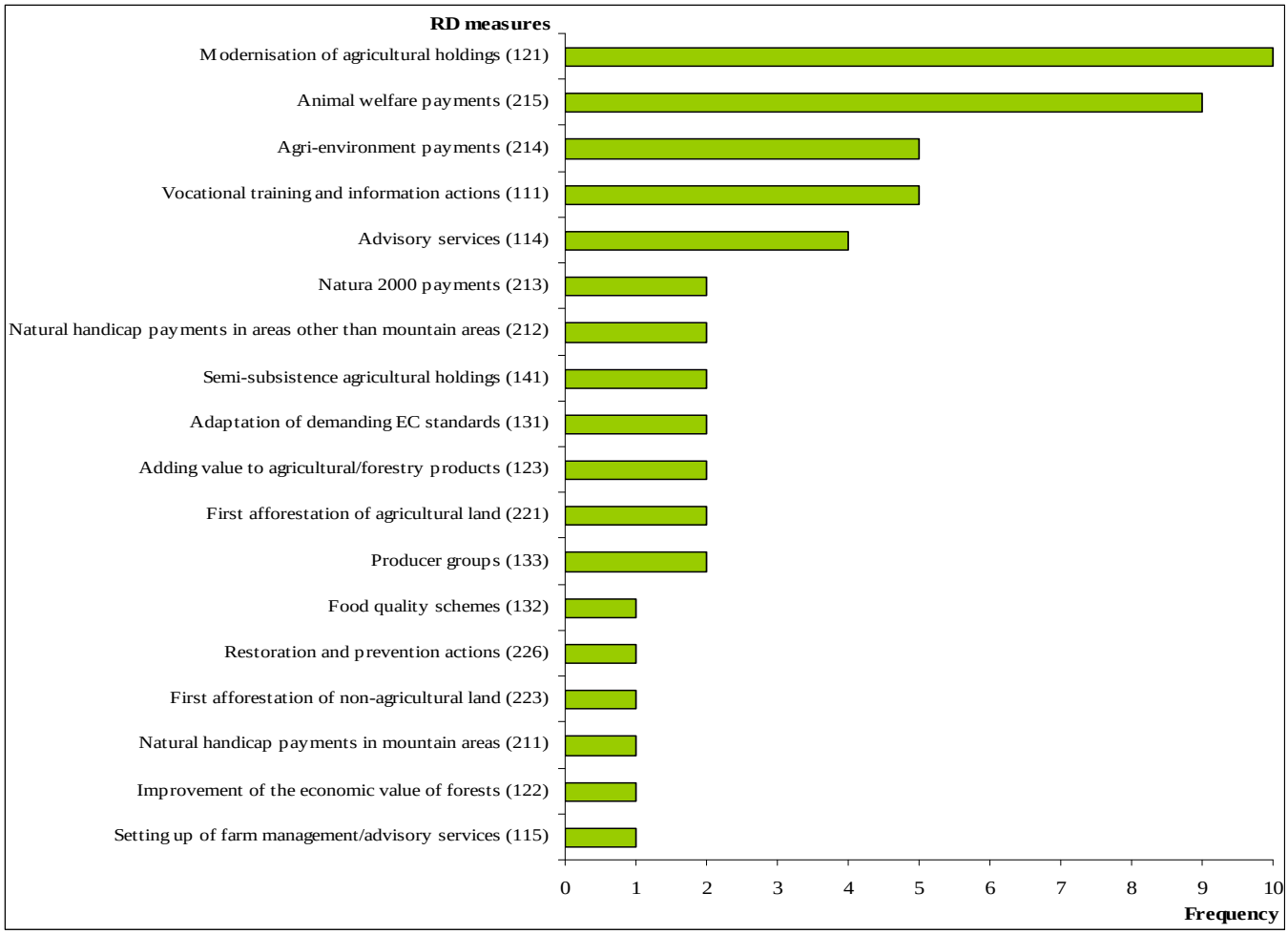


Figure 7 RD measures relevant to animal welfare

Based on the evidence, only Axis 1 'Improving the Competitiveness of the Agricultural and Forestry Sector' alongside Axis 2 'Improving the Environment and the Countryside through Land Management' include relevant RD measures to animal welfare. They account for 57% and 43% respectively. These findings seem reasonable as measures under Axis 1 support investments and encourage farmers to adapt their practices to demanding standards aiming at animal welfare protection. Similar, the measure of animal welfare payments and the promotion of sustainable farming management practices under Axis 2, for instance extensive farming systems and organic livestock farming, contribute to increasing animal welfare in husbandry systems.

Measure 121 'modernisation of agricultural holdings', followed by the measure 215 'animal welfare payments' are identified as the most frequently reported measures, as far as animal welfare is concerned. Given that the animal welfare payments are not applied by all member states/regions, the 'farm modernisation scheme' has been identified as the most frequently mentioned measure. Findings seem reasonable, since there is a

provision, under the farm modernisation measure, for investments aiming to improve the animal welfare status in holdings. In addition, animal welfare payments aim to protect the welfare of farm animals by adopting high standards for animal husbandry which go beyond the relevant mandatory standards.

2.8 General Comments

Within the scope of the reviews performed and hence of this report, seven public goods have been examined. Out of them, only two have been explicitly mentioned within the objectives in all the MS/Regions that have been thoroughly examined. Those have been climate change and biodiversity-wildlife. For four i.e. water and soil quality, landscape and biodiversity High Nature Value Areas, one of the MS did not include it within the explicitly stated objectives. In the case of animal welfare, there were 4 MS where the design of Pillar 2 measures did not aim at improving living conditions for farm animals.

Climate-change mitigation has been one of the environmental objectives of EU policies for some years now, but during the last decade it has acquired a prominent role. This can partly explain its presence in all RDPs examined together with the global character of the issue, affecting all areas and influenced by all farming activities. For biodiversity-wildlife, one could attribute the same fact to the existence of a large number of supporters like environmental NGOs, experts etc. with a long tradition of advocacy for biodiversity issues. The relatively new, for EU mainstream policy making, notion of High Nature Value farming, could explain the fact that it has not been included within all MS/Regions' priorities as a protection objective.

The fact that the some of the other public goods have not been prioritised in a few cases could be attributed to specificities related to conditions prevailing locally.

Finally, the fact that animal welfare is a public good, closely related to the intensity of livestock-raising productive systems, in the sense that the needs and the costs of compliance with welfare standards are generally greater the more intensive the production system is, could explain the fact that MS or Regions with less intensive livestock breeding have chosen not to implement relevant measures. However, in the case of the Netherlands, a possible explanation could be the prior existence of demanding statutory requirements at the national level.

The total number of Rural Development Measures, implemented under the four axes, and examined for the current report, was 35. Climate stability, wildlife protection and landscape conservation have been among the objectives in the case of 30 RD measures, water and soil quality in 29 RD measures, while maintenance of High Nature Value areas has been an aim in 25 cases. Finally, following the pattern identified when examining the MS/Regional RDPs, animal welfare has been identified as an important issue at stake in a considerably smaller number of measures.

Landscape protection seems to be the expected outcome of RD measures most referred to with 163 references, followed by climate change mitigation (156), water and soil quality (143 and 138 respectively), the two notions of biodiversity 134 references for wildlife and 127 for HNV areas). Finally only in 53 cases, specific RD measures have been associated with animal welfare.

As expected, the measures under axis 2 are the ones that are mostly referred in almost all public goods, since it is the one directed explicitly towards sustainable use of land. However, there was a notable exception, that of animal welfare, where first axis measures seem to be targeting more these issues. The fact that modernisation of agricultural structures and production systems was the main means proposed for the improvement of competitiveness could provide an explanation for this exception, since in most of the cases necessary improvements included investments in infrastructure and modifications in operating procedures.

Finally, the importance placed on axis 3 measures as far as landscape conservation is concerned could be attributed to the increased weight of measures for the protection of rural cultural heritage, which constitute an inseparable part of rural landscapes.

Furthermore, examining Table 1, one can see that some of the measures can be thought of as very specific in terms of the public goods, such as the measures 'adaptation of demanding standards based on Community legislation' (131), 'supporting producer groups for information and promotion activities for products under food quality schemes' (133) which seem to be focused on animal welfare, together of course with the 'animal welfare payments' (215).

Looking at individual measures one can see that the agri-environmental measures (214) are the ones that seem to be playing a prominent role in public goods since in 116 cases they are mentioned as influential for the public goods examined. Moreover they seem to

be the most important for all public goods except animal welfare. They are followed by LFA payments, which in their two modalities i.e. for mountainous (211) and other than mountainous (212) areas, are mentioned as important in 91 cases.

Vocational training (111) and use of advisory services (114) are ranked quite high in the influential measures, with 60 and 39 cases respectively. Their influence seems to be indirect through raising awareness among farmers and land managers in general, and the improvement of managerial skills, which in their turn result in a more rational and environmentally-friendly management of the enterprise and natural resources.

Forestry-related measures, either restoring potential and prevention of natural disasters (226) or afforestation of agricultural (221) and non agricultural land (223) as well as forest environmental improvement payments (225), seem to be another focus of attention of policy makers since in 52, 60, 46 and 31 cases they have been mentioned as an important factor for the provision of environmental public goods.

Investments in farming through the agricultural modernisation scheme (121), but also non-productive investments either in agriculture (216) or in forestry (227), represent another point of interest since the relevant frequencies observed were 59, 30 and 34 respectively.

Finally, the measures that were directed to Natura 2000 areas either under agricultural activities (213) or forestry (224), albeit their focus on biodiversity, have been mentioned as important for other public goods (42 and 23 cases respectively).

Table 1 Frequency of RD measures reported as relevant to public goods

Axis	RD measure	Climate stability	Biodiversity wildlife	Biodiversity HNV	Water quality	Soil quality	Land-scape	Animal welfare
1. 'Improving the Competitiveness of the Agricultural and Forestry Sector'	Vocational training and information actions (111)	12	7	8	10	11	7	5
	Use of advisory services by farmers and forest holders (114)	5	6	6	7	7	4	4
	Setting up of farm management/advisory services (115)	1	3	3	2	2	2	1
	Modernisation of agricultural holdings (121)	13	7	4	11	10	4	10
	Improvement of the economic value of forests (122)	2	2	3	1	1	2	1
	Adding value to agricultural/forestry products (123)	7	3	3	6	4	2	2
	Cooperation for development of new products, processes and technologies (124)	1	2	1	2	1		
	Improving and developing infrastructure related to the development and adaptation of agriculture and forestry (125)	5	2	1	8	5	6	
	Adaptation of demanding standards based on Community legislation (131)							2
	Supporting farmers who participate in food quality schemes (132)	2	2	2	2	2		1
	Supporting producer groups for information and promotion activities for products under food quality schemes (133)							2
	Supporting semi-subsistence agricultural holdings undergoing restructuring (141)	1	1	1		2		2
2. 'Improving the Environment and the Countryside through Land Management'	Natural handicap payments to farmers in mountain areas (211)	2	5	5	4	6	7	1
	Payments to farmers in areas with handicaps, other than mountain areas (212)	5	13	11	7	9	14	2
	Natura 2000 payments (213)	4	10	7	6	5	8	2
	Agri-environment payments (214)	18	20	18	19	18	18	5
	Animal welfare payments (215)		1	1	1		2	9
	Support for non productive investments (216)	2	7	5	6	5	5	
	First afforestation of agricultural land (221)	14	8	9	10	8	9	2
	First establishment of agroforestry systems on agricultural land (222)	3		2	3	3	1	
	First afforestation of non-agricultural land (223)	10	6	9	7	8	5	1
	Natura 2000 payments (224)	4	4	5	3	3	4	
	Forest-environment payments (225)	6	4	4	5	6	6	
	Restoring forestry potential and introducing prevention actions (226)	13	7	10	8	9	4	1
	Support for non-productive investments (227)	9	4	5	6	4	6	

Axis	RD measure	Climate stability	Biodiversity wildlife	Biodiversity HNV	Water quality	Soil quality	Land-scape	Animal welfare
3. 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'	Diversification into non-agricultural activities (311)	5	1		1	1	4	
	Support for business creation and development (312)	3	1		1	1	2	
	Encouragement of tourism activities (313)	1	1				4	
	Basic services for the economy and rural population (321)	3			2	2	6	
	Village renewal and development (322)	2	1				11	
	Conservation and upgrading of the rural heritage (323)	1	3	3	2	2	13	
	Training and information for economic actors operating in the fields covered by axis 3 (331)				1	1	2	
4. 'Leader'	Competitiveness (411)	1	1		1	1	1	
	Environment/land management (412)		1	1			1	
	Quality of life/diversification (413)	1	1		1	1	3	

3 Causal Relationships between Rural Development Measures and Public Goods

3.1 Climate Change Mitigation

Causal relationships were only identified for 15, half of all RD measures reported as being relevant for climate change mitigation. Causal relationships are recognized for six RD measures under Axis 1 and 2, and only three for RD measures under Axis 3.

As a first observation, it may be stated that the majority of member states/regions have reported at least one causal chain linking measure and climate change mitigation illustrating the rationale of this linkage.

Training activities and advisory services are reported as having an indirect impact on climate change mitigation, as these measures have the opportunity to increase public awareness on climate change issues. Also, reduction in fertiliser use has an indirect impact on climate change, due to the limited nitrous oxide emissions in the atmosphere.

The causal relationships between the climate change mitigation and the RD measures that reported as influencing the specific public good are shown in Table 2.

Table 2 Causal relationships between climate change mitigation and relevant RD measures

Axis	RD measure	Causal relationship reported
1. 'Improving the Competitiveness of the Agricultural and Forestry Sector'	111 Vocational training and information actions, including diffusion of scientific knowledge and innovative practises for persons engaged in the agricultural, food and forestry sectors	Promoting scientific information and innovation on renewable energy, sustainable land management and raising awareness for the protection of the environment in its broad sense.
	114 Use of advisory services by farmers and forest holders	Advice on statutory management requirements (SMRs), sustainable farming practices, good agricultural and environmental conditions (GAEC) within the cross compliance framework.
	121 Modernisation of agricultural holdings	-Investments in greenhouse horticulture based on innovation in air quality control and energy use contributing to the reduction of emissions. -Contribution to climate change mitigation through: • Innovations and new technologies that improve the environmental performance of agricultural holdings. • Implementation and use of environmental protective actions (low emissions of CO_2, low use of N). • Investments on waste management, especially on cattle and pigs farms. • Investments in the production of bioenergy. • Investments aimed at the production of renewable energy sources for own use.
	122 Improvement of the economic value of forests	Support for renewable energy through forest.
	123 Adding value to agricultural and forestry products	-The purchase and installation of innovative equipment could affect environmental protection. -Contribution to climate change mitigation through: • Promotion of the production of biofuels and use of bioenergy. • Application of new technologies that reduce air pollutant emissions.
	125 Improving and developing infrastructure related to the development and adaptation of agriculture and forestry	-Promotion of wood production implies more renewable raw materials and fuels enter the market having positive impact on climate. -Investments in rural electrification improve environment avoiding the use of pollutant energy sources, e.g. oil.

Axis	RD measure	Causal relationship reported
2. 'Improving the Environment and the Countryside through Land Management'	214 Agri-environment payments	-Restriction of the use of plant protection products and fertilisers contribute to reducing GHG emissions. -Organic farming and sustainable farming systems have a positive impact on climate change mitigation. -Biomass used for fuel has the potential to mitigate climate change. -Extensive farming systems, such as reduction in livestock density, reduce GHG emissions.
	221 First afforestation of agricultural land	-Increase in forest land contributes to carbon sequestration. -The aim of the measure is to decrease GHG emissions. -Extending forest land leads to the increase of renewable energy production from forestry.
	223 First afforestation on non agricultural land	Increase in forest land contributes to climate change mitigation through the sequestration of CO_2 .
	225 Forest-environment payments	Regeneration of forest stands improves the production of wood and increases the provision of renewable energy.
	226 Restoring forestry potential and introducing prevention actions	-Increase in forest land contributes to sequestration of CO_2. -Increase in forest land devoted to renewable energy contributes to climate change mitigation. -The aim of the measure is to decrease the GHG emissions. -Supported actions enhance sustainable management of forest areas contributing to climate change mitigation.
	227 Support for non-productive investments	-The protection of forest resources will contribute to combating the climate change through the increase in the capacity of CO_2 absorption. -The biological control of chestnut blight caused by the fungus *Cryphonectria parasitica* is linked to the achievement of environment objectives that contribute to mitigating climate change.
3. 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'	311 Diversification into non-agricultural activities 312 Support for business creation and development 313 Encouragement of tourism activities	-Investments aimed at the production of renewable energy sources for own use contribute to climate change mitigation. -Measure 312 promotes the production of the renewable energy sources that substitutes the use of fossil resources.

Further, the figure below shows the frequencies of identifications of these causal relationships in all RDPs (Figure 8).

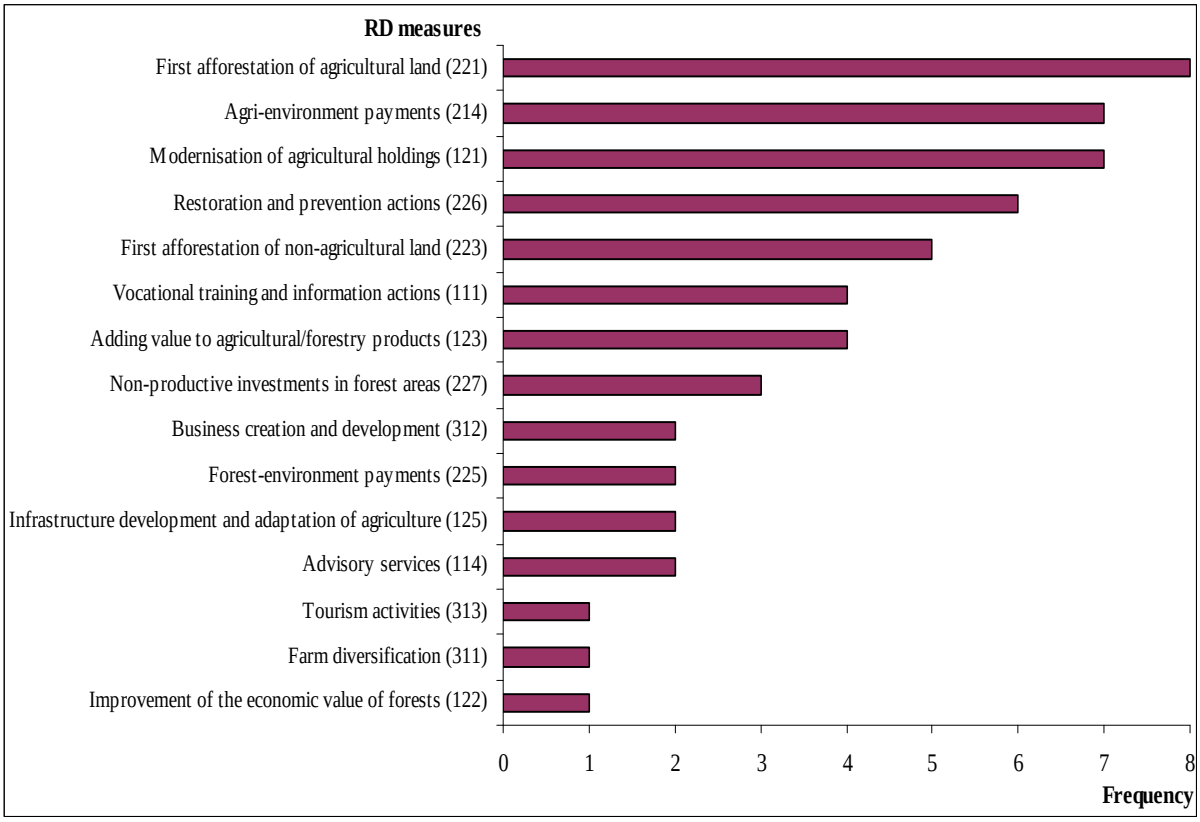


Figure 8 Frequencies of causal relationships between RD measures and climate change mitigation

3.2 Biodiversity Wildlife

Out of the 30 examined RD measures reported as being relevant for biodiversity wildlife, causal relationships were only identified for 13 measures. Most causal relationships are reported for RD measures under Axis 2 (8 measures), while five are linked to RD measures under Axis 1.

Causal relationships for AEMs have only described eight times and for Natura 2000 payments four times among the evaluation reports. As the primary objective of these measures is the improvement of biodiversity, it is concluded that the relationship is just too obvious to mention it.

Training and information actions, advisory services alongside the farm modernisation measure are reported that have an indirect impact on biodiversity-wildlife, which is reasonable.

The causal relationships between biodiversity-wildlife and the RD measures that reported as influencing the specific public good are summarised in Table 3.

Table 3 Causal relationships between biodiversity wildlife and relevant RD measures

Axis	RD measure	Causal relationship reported
1. 'Improving the Competitiveness of the Agricultural and Forestry Sector'	111 Vocational training and information actions, including diffusion of scientific knowledge and innovative practises for persons engaged in the agricultural, food and forestry sectors	Training and promotion activities related to biodiversity, sustainable land management and sustainable management of natural resources.
	114 Use of advisory services by farmers and forest holders	Advice on statutory management requirements (SMRs) and good agricultural environmental conditions (GAEC) within the cross compliance framework, including maintenance of biological diversity.
	115 Setting up of farm management, farm relief and farm advisory services, as well as forestry advisory services	Advisory services are expected to help development of diversification for the forestry sector and related environmental goods, e.g. biodiversity-wildlife.
	121 Modernisation of agricultural holdings	-The potential for this measure to contribute to sustainability is considered high as the demand for investments for particular policy targets, like biodiversity. -Investments to expand and/or rationalise dairy systems can reduce the extent of grazing activities and reduce the amount of grass fed to cattle which can induce the ploughing up of grassland with negative consequences for biodiversity.
	123 Improvement of the economic value of forests	One of the objectives is to preserve the ecological value of forests.

Axis	RD measure	Causal relationship reported
2. 'Improving the Environment and the Countryside through Land Management'	211 Natural handicap payments to farmers in mountain areas 212 Payments to farmers in areas with handicaps, other than mountain areas	-The adaptation of general environmental requirements and statutory management requirements contribute to maintenance of the biological diversity. -Organically managed land and extensive grazing land on LFA farms contribute to maintaining farmland biodiversity.
	213 Natura 2000 payments	-Natura 2000 areas designated contribute to the protection of biodiversity-wildlife through the conservation of natural habitats, wild flora and fauna. -Non-use of lands would affect over time the composition of species of the habitat and the biological diversity characteristics of agricultural land.
	214 Agri-environment payments	-Reducing pressures on natural resources (soil, water, air) from intensive agricultural activities by supporting sustainable farming systems contributes to protecting natural habitats and improving biodiversity of wildlife species. -Actions for keeping animals of local endangered breeds and maintenance of semi-natural habitats play an important role in biological diversity.
	216 Support for non productive investments	Establishment and restoration of stonewalls provide habitats for wildlife and increase biological diversity.
	221 First afforestation of agricultural land	Woodland creation through afforestation improves biodiversity in agricultural areas.
	224 Natura 2000 payments	Support contributes to the conservation of an adequate diversity of natural habitats and the maintenance of suitable breeding conditions for protected species.
	226 Restoring forestry potential and introducing prevention actions	Support for restoration and prevention actions in order to avoid loss of biodiversity and deterioration of natural habitats in forests damaged by fire.

Further, the figure below shows the frequencies of identification of these causal relationships linking biodiversity-wildlife and relevant measures (Figure 9).

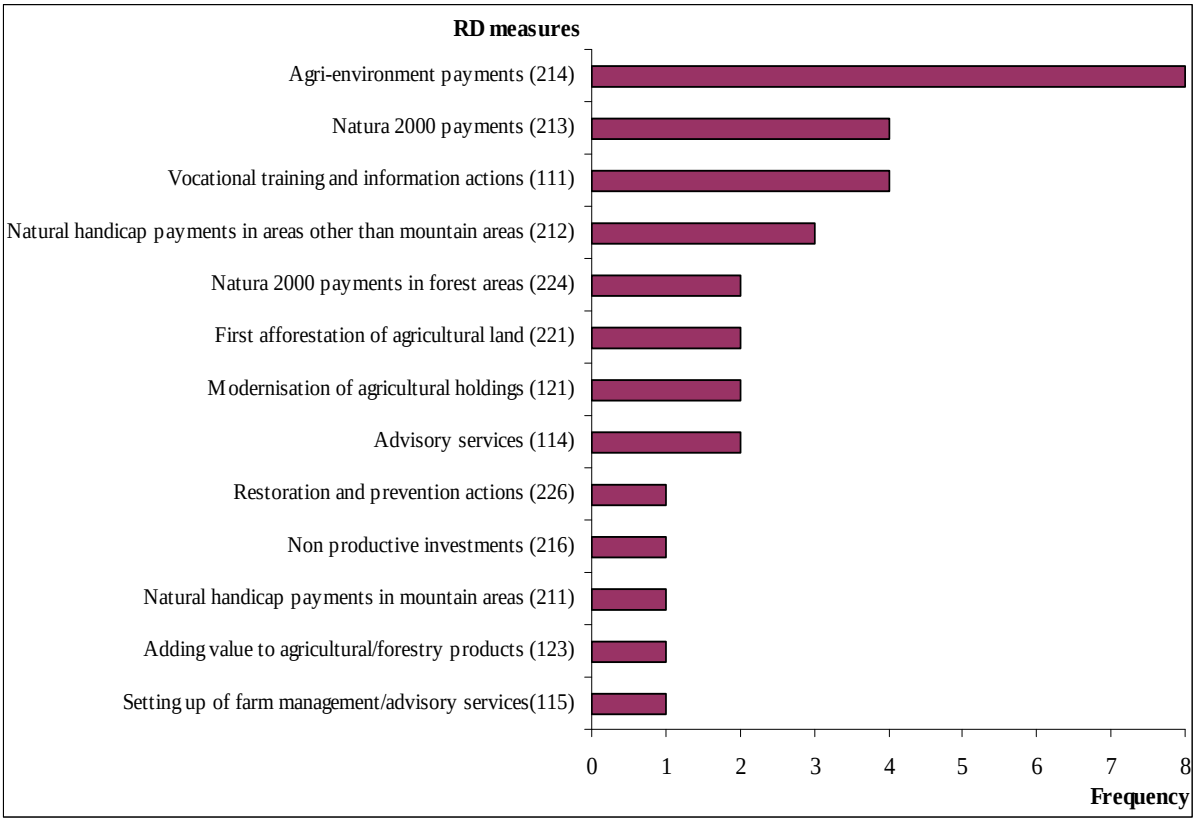


Figure 9 Frequencies of causal relationships between biodiversity wildlife and RD measures

3.3 Biodiversity-HNV

Out of the 25 examined RD measures reported as being relevant for biodiversity-HNV, causal relationships were identified for 13 measures. All causal relationships are reported for measures under Axis 2, except for two cases where are mentioned for Axis 1.

Most of them are related to the general objectives of the measures, however some more detailed relationships are reported regarding the AEMs. More specifically these include the action of maintenance of grassland (Latvia), supported non-productive investments (Greece) and the establishment of agroforestry systems (Cyprus). Only training and information actions alongside the advisory measures are reported that have an indirect impact on biodiversity-HNV, which is reasonable.

The causal relationships between biodiversity-HNV and the relevant RD measures are shown in the table below (Table 4).

Table 4 Causal relationships between biodiversity-HNV and relevant RD measures

Axis	RD measure	Causal relationship reported
1. 'Improving the Competitiveness of the Agricultural and Forestry Sector'	111 Vocational training and information actions	Training and promotion activities related to biodiversity, sustainable land management and sustainable management of natural resources.
	114 Use of advisory services by farmers and forest holders	Advice on statutory management requirements (SMRs) and good agricultural and environmental conditions (GAEC) within the cross compliance framework, including maintenance of biodiversity.
2. 'Improving the Environment and the Countryside through Land Management'	211 Natural handicap payments to farmers in mountain areas 212 Payments to farmers in areas with handicaps, other than mountain areas	-Support in LFAs in order to avoid land abandonment and promote successful land management leads at the same time in improving biodiversity of HNV farming areas. -The measure has impact on agricultural areas with high nature value since the latter are primarily semi-natural habitats in LFAs.
	213 Natura 2000 payments	-Natura 2000 areas contribute to the enhancement of biodiversity. -Non-use of lands would affect over time the composition of species of the habitat and the biological diversity characteristic of agricultural land. -Maintaining meadows and grasslands in NATURA 2000 areas is considered as maintaining the high nature value areas.
	214 Agri-environment payments	-Reducing pressures on natural resources (soil, water, air) from intensive agricultural activities by supporting sustainable farming systems contributes to protecting natural habitats and improving biodiversity of wildlife species. -Through the supported action the biological valuable grasslands are considered as high nature value areas for biodiversity.
	216 Support for non productive investments	The restoration of terraces aims to maintain the environmental value of the agricultural landscape and hence protect the biodiversity.
	221 First afforestation of agricultural land	Woodland creation through afforestation improves biodiversity in agricultural areas.
	222 First establishment of agroforestry systems on agricultural land	The supported actions of perimetric afforestation of cultivated lands in order to protect crops from wind and frost, windbreak establishment, have a significant impact on biodiversity.
	223 First afforestation on non agricultural land	The measure promotes the expansion of forest resources on non agricultural land with environmental problems due to fires and marginalisation.
	224 Natura 2000 payments	Support contributes to the conservation of an adequate diversity of natural habitats and the maintenance of suitable breeding conditions for protected species improving the biodiversity.
	226 Restoring forestry potential and introducing prevention actions	Restoration and prevention actions in order to avoid loss of biodiversity and deterioration of natural habitats in forests damaged by fire.
	227 Support for non productive investments	-Non productive investments aim to enhance the multifunctional role of forests and conserve its biodiversity. -The biological control of chestnut blight caused by the fungus *Cryphonectria parasitica* is linked to the achievement of environment objectives that contribute to the improvement of biodiversity.

Further, the following figure summarises the frequencies of identification of these causal relationships linking biodiversity-HNV and relevant measures (Figure 10).

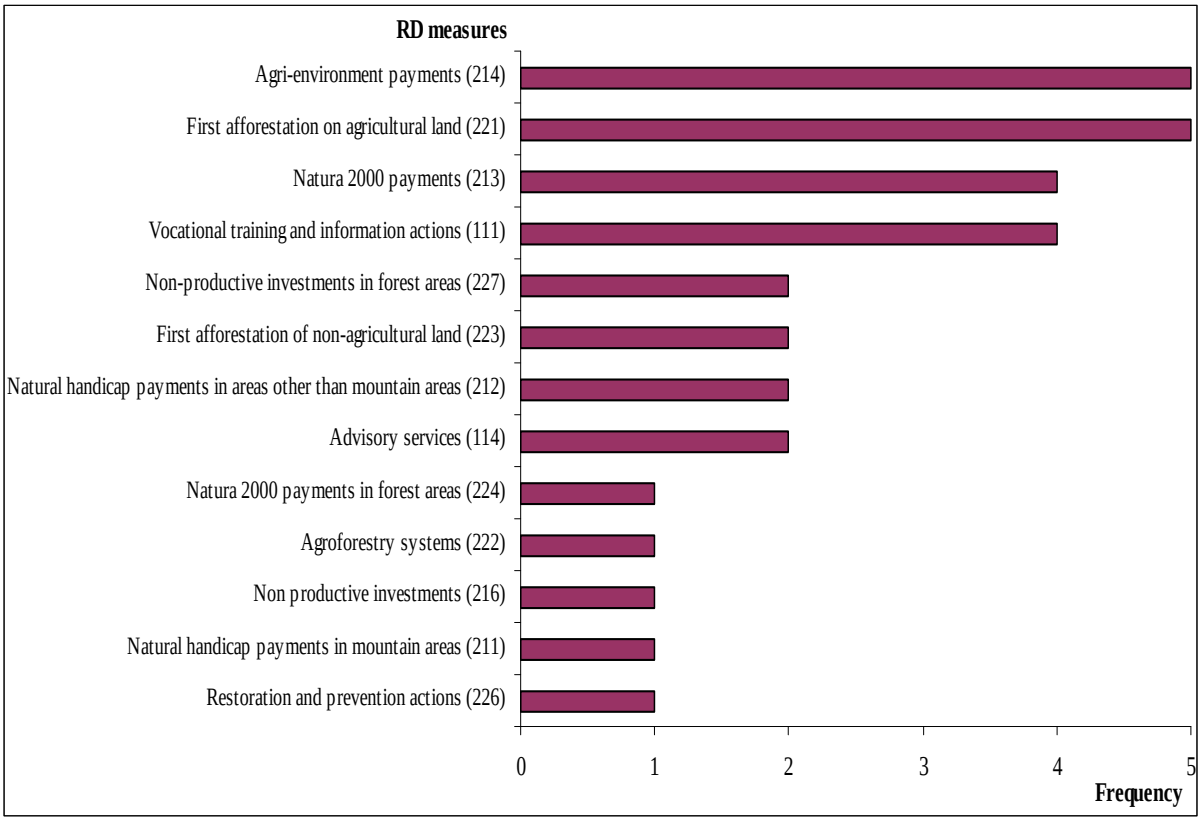


Figure 10 Frequencies of causal relationships between biodiversity-HNV and RD measures

3.4 Water Quality

Out of the 29 examined RD measures reported as being relevant for water quality, only 14 of them have explicitly reported causal relationships. Causal relationships are identified for eight measures under Axis 2, for five measures under Axis 1, and only one is mentioned for basic services measure under Axis 3.

Most causal relationships are referring to the set of measure goals, without establishing a specific linkage between measure and water quality, although some more robust relationships are identified in farm modernisation, infrastructural investments and forest-environmental measures. The contribution of measures under Axis 3 to water quality is reported only in the Polish RDP.

Training activities as well as advisory services impact indirectly on water quality; however, given the number of times that these relationships are identified, many member states/regions consider the potential benefits of these measures as crucial.

The causal relationships established between water quality and the RD measures, not always between measure and public good but also through linkages to indicator(s), especially in AEMs, when a causal chain is reported linking measure-public good-indicator, are summarised in the following able (Table 5).

Table 5 Causal relationships between water quality and relevant RD measures

Axis	RD measure	Causal relationship reported
1. 'Improving the Competitiveness of the Agricultural and Forestry Sector'	111 Vocational training and information actions	Training and promotion activities related to sustainable management of natural resources.
	114 Use of advisory services by farmers and forest holders	Advice on statutory management requirements (SRGs) and good agricultural and environmental conditions (GAEC) within the cross compliance framework.
	121 Modernisation of agricultural holdings	-Investments based on waste and water management of agricultural holdings. -Construction of livestock buildings, including manure, silage or fodder storage facilities.
	123 Adding value to agricultural and forestry products	Investments based on new technologies and innovation with emphasis on environmental protection may affect water quality.
	125 Improving and developing infrastructure related to the development and adaptation of agriculture and forestry	Improvement in water quality through the: • Spatial planning of livestock development in a rational manner and environmental protection. • Investments in infrastructure related to land reclamation actions, dam and reservoir constructions in order to address water scarcity issues.
2. 'Improving the Environment and the Countryside through Land Management'	211 Natural handicap payments to farmers in mountain areas 212 Payments to farmers in areas with handicaps, other than mountain areas	Through the avoidance of land abandonment and promotion of agricultural methods compatible with the sustainable use of agricultural land, e.g. extensive farming systems.
	213 Natura 2000 payments	Ensuring compliance with environmental requirements in Natura 2000 sites, e.g. reduction in plant protection products, fertiliser use and stock density (LU/ha).
	214 Agri-environment payments	Adopting environmentally friendly farming practices, e.g. organic farming, extensive and integrated management systems, crop rotation mainly through the reduction of pollutant inputs (less nitrogen input) and reduce the grazing load (LU/ha).
	221 First afforestation of agricultural land	Afforestation contributes to flood risk management and also to the deduction of water pollution diffusion.
	223 First afforestation on non-agricultural land	Expansion and improvement of forest resources prevent soil erosion and reduce polluted runoff into water bodies.
	224 Natura 2000 payments in forest areas	Promotion of sustainable management of forest resources contributes to water quality improvement.
	226 Restoring forestry potential and introducing prevention actions	Suitable projects targeting flood and erosion control in order to address water degradation resulting from forest fires.
3. 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'	321 Basic services	Investments in water supply, sewage and wastewater system for improving the conditions of life and economic activity in rural areas.

Further, the frequencies of identification of these causal relationships are shown in Figure 11.

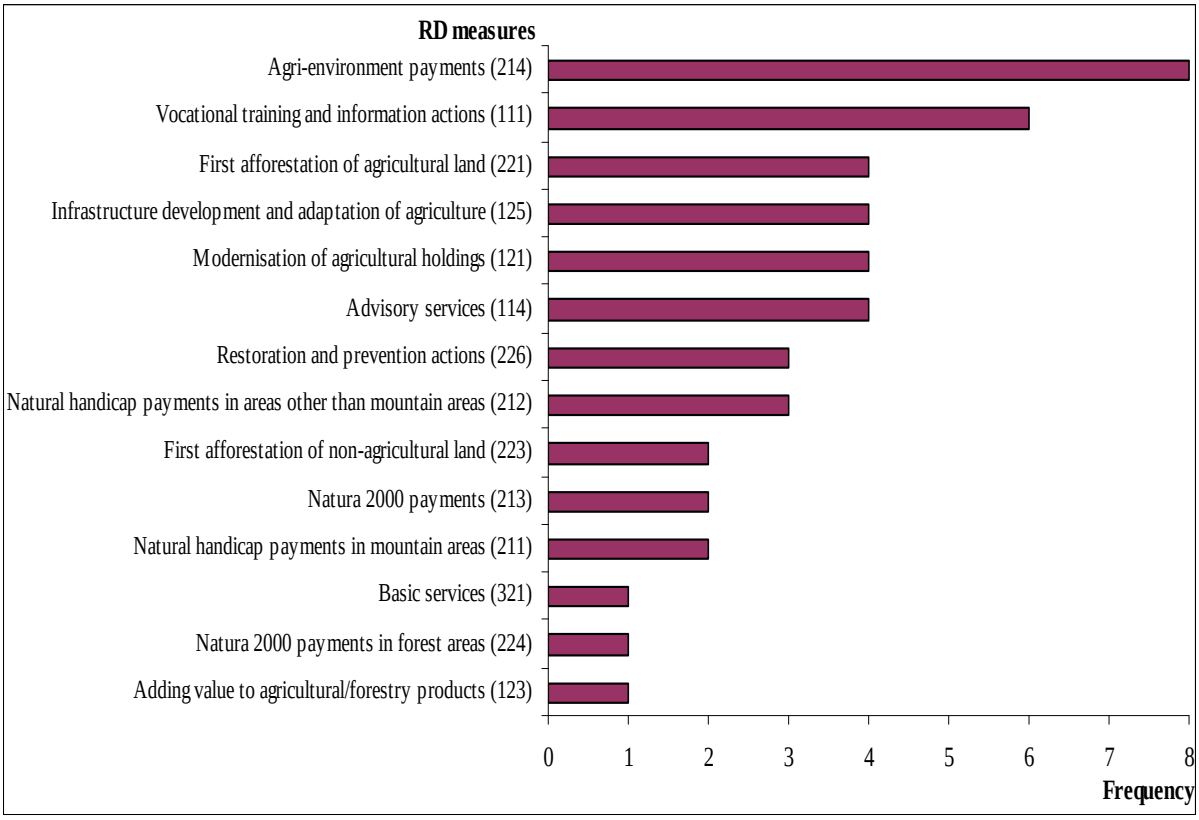


Figure 11 Frequencies of causal relationships between water quality and RD measures

3.5 Soil Quality

Out of the 29 examined RD measures reported as being relevant for soil quality, causal relationships were only identified for 14 measures. Causal relationships are related for four RD measures under Axis 1, for nine RD measures under Axis 2, and only one case is mentioned for Axis 3.

Most causal relationships have been recorded in the AEMs, which seems reasonable, as the measure promotes land management practices compatible with the preservation and improvement of soils. Once again, the indirect causal chains (vocational training) are identified more often than forest-environmental measures, which have direct and positive effects on soil functionality, through stabilisation of soil surface and prevention of erosion.

All causal relationships have direct impact on soil quality, except for training activities and advisory services.

The causal relationships between soil quality and the relevant RD measures, taking also into account and the causal chains through linkages to indicators, especially in AEMs and the farm modernisation measure, are summarised in the table below (Table 6).

Table 6 Causal relationships between soil quality and relevant RD measures

Axis	RD measure	Causal relationship reported
1. 'Improving the Competitiveness of the Agricultural and Forestry Sector'	111 Vocational training and information actions, including diffusion of scientific knowledge and innovative practises for persons engaged in the agricultural, food and forestry sectors	Information on environmental issues with emphasis on good agricultural practices and farming methods compatible with sustainable agricultural development.
	114 Use of advisory services by farmers and forest holders	Advice on statutory management requirements (SMRs) and good agri-environmental conditions (GAEC) within the cross compliance framework.
	121 Modernisation of agricultural holdings	-Investments based on waste management of agricultural holdings, especially in cattle and pig farms, protect soil quality. -Different cropping and land management practices affect the vegetation coverage of soils which has an influence on the risk and extent of soil erosion.
	125 Improving and developing infrastructure related to the development and adaptation of agriculture and forestry	-Promoting spatial planning of livestock development in a rational manner and environmental protection contributing thus to improvement of soil quality. -Support for investments in infrastructure, such as melioration actions positively affect the quality of agricultural soils.

Axis	RD measure	Causal relationship reported
2. 'Improving the Environment and the Countryside through Land Management'	211 Natural handicap payments to farmers in mountain areas 212 Payments to farmers in areas with handicaps, other than mountain areas	-Support in disadvantaged areas in order to avoid land abandonment, which is considered as a crucial factor of soil degradation, due to the steep land slopes. -Promoting sustainable farming systems, especially maintaining extensive farming, have a positive impact on soil quality.
	213 Natura 2000 payments	Restrictions concerning the use of biocides, plant protection products and fertilisers in Natura 2000 sites help to contribute to the preservation of the water and soil quality.
	214 Agri-environment payments	-Adopting environmentally friendly farming practices plays a key role in improving soil functionality and soil health (through limited use of plant protection inputs, less tillage, extensive farming systems, as well as integrated production and organic farming). -AEMs increase humus and nutrient contents in the soil, improving soil fertility and preventing risk of soil erosion. -Soil plays an important role in a number of key environmental, social and economic issues. It is relevant to the protection of water, air and biodiversity (habitat), as well as the conservation of the landscape and cultural heritage.
	221 First afforestation of agricultural land 223 First afforestaton on non-agricultural land	Increase in forest cover through afforestation leads to control soil erosion.
	224 Natura 2000 payments	Forest areas are more resistant to soil erosion processes.
	225 Forest-environment payments	-Protecting the social and ecological role of forest resources through sustainable management practices. -Forest areas are more resistant to soil erosion processes.
	226 Restoring forestry potential and introducing prevention actions	Afforestation of forest damaged by fire prevents erosion, at the same time, contributing to improvement of soil quality.
3. 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'	321 Basic services	-Small scale infrastructures are supported in order to address problems, caused by seasonal flooding of rivers or streams, which degrade agricultural land affecting thus soil functionality. -Investments in water supply, sewerage and wastewater system for improving the conditions of life and economic activity in rural areas.

Further, the frequencies of identification of these causal relationships among RDPs are shown in Figure 12.

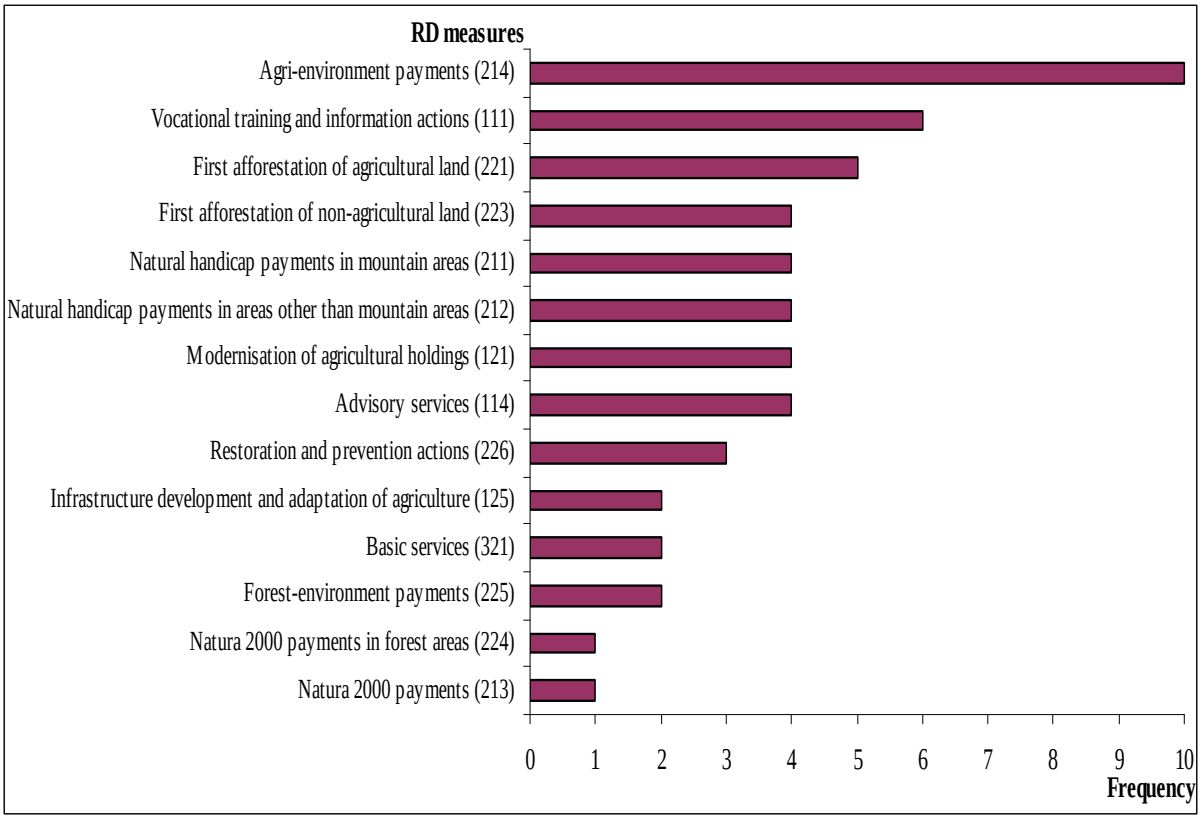


Figure 12 Frequencies of causal relationships between soil quality and RD measures

3.6 Landscape

Out of the 30 RD measures reported as being relevant to landscape, 18 have explicitly reported causal relationships. Most causal relationships are identified for measures under Axis 2 and 3, nine and five respectively, while three for measures under Axis 1.

Only in the Polish mid-term evaluation document, an indirect positive impact of measure 'quality of life/diversification' (413) under Axis 4 on landscape is highlighted, through the implementation of projects under the Local Development Strategy.

Causal relationships for measures under Axis 1 have indirect impacts on the landscape, although the primary objectives of these measures do not include the maintenance and improvement of the agricultural landscape. However, supporting investments and actions targeted at environmental protection may have a potential to deliver, albeit unintentionally, the specific public good. Nevertheless, also as mentioned by the Polish

evaluators, for the supported actions in infrastructure (measure 125), investments under this axis could lead to significant changes in the aesthetic and ecological values of landscape, with considerable loss of the diversity and richness of landscape features. It should be also noted that in the Scottish mid-term evaluation document, the objectives of measure 125 'improving infrastructure related to the development of agriculture and forestry' do not include benefits to environmental public goods, and therefore to landscape, although some positive impact could be expected.

On the other hand, AEMs seem to have a direct positive impact on agricultural landscape, supporting management practices (e.g. extensive farming systems, cultivation of traditional crops, maintenance of landscape features etc.) that preserve and enhance agricultural landscape values. Similarly, investments and actions supported by Axis 3 have direct effect on landscape through the maintenance and restoration of cultural elements that contribute to upgrading rural heritage.

The causal relationships between landscape and the relevant RD measures, including also some causal chains based on evaluators' expectations, are summarised in the table below (Table 7).

Table 7 Causal relationships between landscape and relevant RD measures

Axis	RD measure	Causal chain reported
1. 'Improving the Competitiveness of the Agricultural and Forestry Sector'	111 Vocational training and information actions, including diffusion of scientific knowledge and innovative practises for persons engaged in the agricultural, food and forestry sectors	Training and promotion activities related to sustainable management of natural resources and production practices are compatible with the maintenance and enhancement of landscape.
	114 Use of advisory services by farmers and forest holders	Advice on statutory management requirements (SMRs), sustainable farming practices and good agricultural and environmental conditions (GAEC) within the cross compliance framework.
	125 Improving and developing infrastructure related to the development and adaptation of agriculture and forestry	-Promoting spatial planning of livestock development in a rational manner contributes to the protection of agricultural landscape. -Support for investments in infrastructure, such as the creation and improvement of forest road network, ensures the sustainable development of forest areas increasing the ecotourism development and the access to aesthetic landscapes. -Support for land consolidation will result in negative changes on the landscape, such as loss of field margins and mid-field trees, changing thus rural landscape.
2. 'Improving the Environment and the Countryside through Land Management'	211 Natural handicap payments to farmers in mountainous areas 212 Payments to farmers in areas with handicaps, other than mountainous areas	-Maintaining agricultural activities in disadvantaged areas and preventing land abandonment contribute to the improvement of agricultural landscape. -Support for livestock based land use systems and forage area contributes to the maintenance of landscape diversity. -Low stocking density protects environmental sensitive areas and biodiversity.
	213 Natura 2000 payments	Preservation of NATURA 2000 sites also contributes to the preservation of landscape.
	214 Agri-environment payments	-AEMs have a positive impact on landscape diversity through the promotion of environmentally friendly managed sites. -Maintenance of semi-natural habitats directly contributes to the preservation of the landscape as well as of natural and cultural heritage. -Preservation of traditional grape varieties, indigenous bushes and trees enhance the Cypriot rural landscape. -Support for vineyards on steep slopes and dry stone walls plays a key role in the agricultural landscape. -Extensification of grassland use increases biodiversity, which has positives effects on landscape characteristics (e.g. increased diversity). -Actions of 'protection of traditional olive grove of Amfissa' and 'conservation of cultivation practices in vineyard of Thira' are targeted at the preservation of agricultural landscape that was formed by specific agricultural activities.
	215 Animal welfare payments	Support for animal grazing contributes to improving landscape diversity and maintain the grassland with high nature protection value.

Axis	RD measure	Causal chain reported
2. 'Improving the Environment and the Countryside through Land Management'	216 Non-productive investments	The restoration of terraces and stonewalls, as traditional elements of agricultural landscapes, aim to maintain the cultural and aesthetic value of the landscape.
	224 Natura 2000 payments 225 Forest-environment payments	Schemes that determine particular requirements from environmental point of view are also important for the preservation of landscape.
	227 Support for non productive investments	Protecting the social and ecological role of forests contributes to maintenance and improvement of landscape.
3. 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'	311 Diversification into non-agricultural activities 313 Encouragement of tourism activities	Non-agricultural activities related to nature conservation can have an impact on landscape.
	321 Basic services for the economy and rural population 322 Village renewal and development 323 Conservation and upgrading of the rural heritage	-Preserving, restoring and improving the cultural heritage of rural areas enhance the natural beauty and cultural value of the landscape and increase the attractiveness of these areas. -Positive impact on landscape through the demolition of unused agricultural buildings. -Important elements related to the traditional rural life, such as mills, bridges and oil presses are part of the landscape upgrading its natural and cultural heritage.
4. 'Leader'	413 Quality of life/diversification	Indirect impact on landscape through the implementation of projects under the Local Development Strategy, focusing on environmental objectives.

Further, the frequencies of identification of these causal relationships among RDPs are shown in Figure 13.

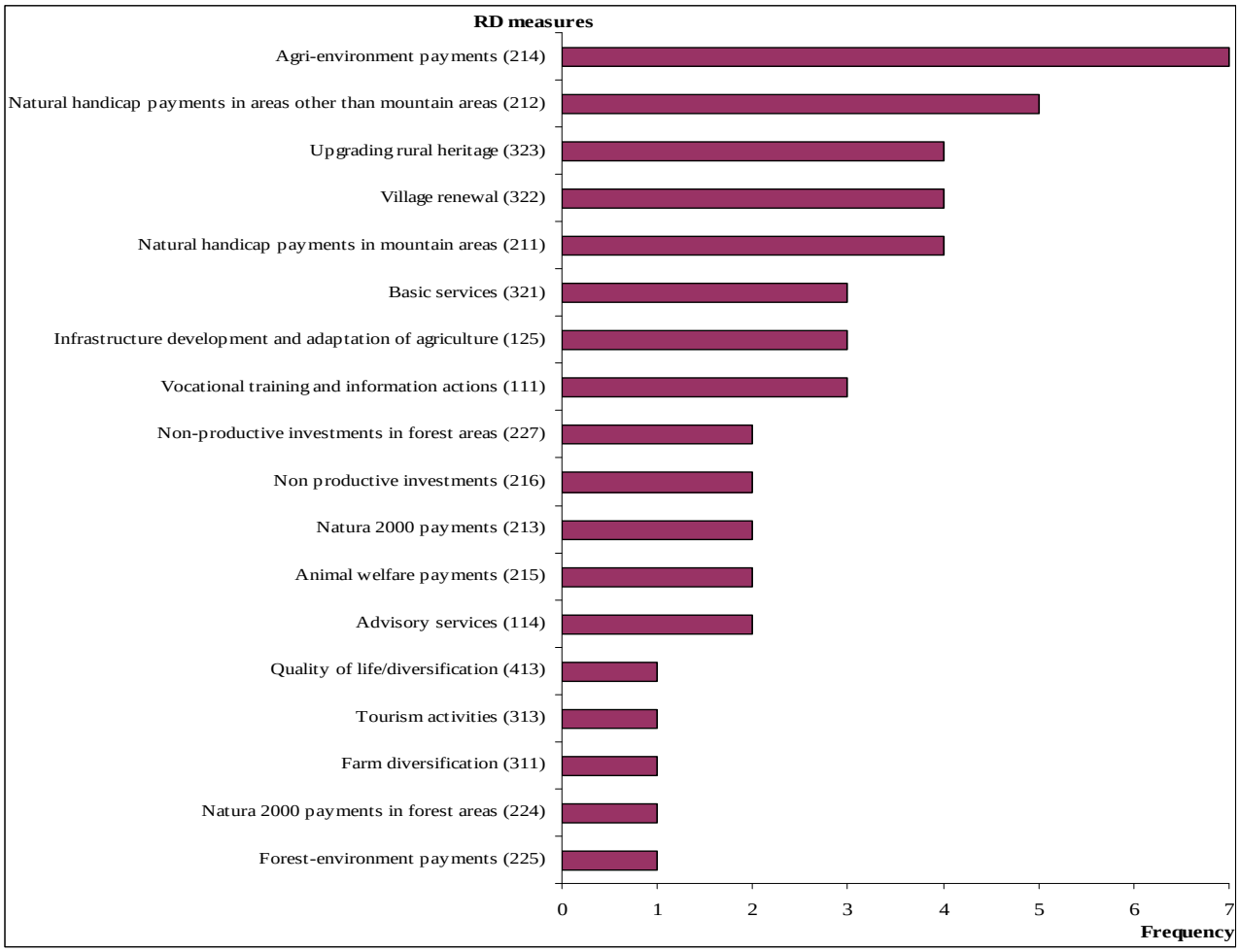


Figure 13 Frequencies of causal relationships between landscape and RD measures

3.7 Animal Welfare

Out of the 18 examined RD measures reported as being relevant for animal welfare, causal relationships were identified for 10 only measures. All causal relationships have been recorded in Axis 1, with the exception of animal welfare payments and LFA payments within Axis 2. Training activities and advisory services are reported to have an indirect impact on animal welfare, mainly by providing information and knowledge about sustainable farming practices and statutory management requirements and raising awareness of the animal treatment. Introducing investments and innovations in agricultural holdings as well as the adoption of demanding EC standards or food quality schemes targeted at animal welfare, seem to influence it more directly. Indisputably, the

measure 'animal welfare payments' has the most direct and positive potential to deliver the specific public good.

However all causal relationships are limited to the set of measure goals, without establishing a specific linkage between RD measure and animal welfare.

The causal relationships between the relevant RD measures and animal welfare are summarised in the following table (Table 8).

Table 8 Causal relationships between animal welfare and relevant RD measures

Axis	RD measure	Causal relationship reported
1. 'Improving the Competitiveness of the Agricultural and Forestry Sector'	111 Vocational training and information actions, including diffusion of scientific knowledge and innovative practises for persons engaged in the agricultural, food and forestry sectors	Promoting scientific information and raising farmers' awareness about animal welfare.
	114 Use of advisory services by farmers and forest holders	Advice on statutory management requirements (SMRs) and good agricultural and environmental conditions (GAEC) within the cross compliance framework.
	121 Modernisation of agricultural holdings	Support for investments in agricultural and livestock holdings in order to improve their competitiveness and meet the requirements of the EC relating to animal welfare.
	123 Adding value to agricultural and forestry products	Supporting small and medium sized enterprises engaged in the trading and processing of agricultural products in order to improve their competitiveness introducing new technologies and innovations and/or developing high quality products taking into consideration hygiene and animal welfare.
	131 Helping farmers to adapt to demanding standards based on Community legislation	-The measure aims to help farmers adopt the community standards regarding animal welfare, supporting the electronic identification of sheep and goats with ruminal bolus. -The electronic identification of animals enhances the improvement of animal welfare since there is timely and reliable diagnosis of animal diseases and avoidance of disease spreading.
	132 Supporting farmers who participate in food quality schemes 133 Supporting producer groups for information and promotion activities for products under food quality schemes	-Introducing innovative management projects with specific focus on 'quality certification in agriculture', 'computerization in agriculture' and 'food safety and traceability products'. -Supporting producer groups for information and promotion activities of agricultural quality products related to improved animal welfare conditions.
2. 'Improving the Environment and the Countryside through Land Management'	211 Natural handicap payments to farmers in mountain areas 212 Payments to farmers in areas with handicaps, other than mountain areas	The aim of the measure is to promote sustainable farming systems, especially maintain extensive farming.
	215 Animal welfare payments	The objective of the payments is to improve animal welfare, preserve and improve biological and landscape diversity as well as soil fertility of cultivated grasslands.

In some cases the frequency of identification of causal relationships completely coincides with the frequency that measures reported as being relevant, e.g., adding value to agricultural products (measure 123), adaptation of demanding standards (measure 131), food quality schemes (measure 132), LFA payments (measure 211), or is considered quite satisfactory, e.g. training actions (measure 111), advisory services (measure 114), farm modernisation (measure 121), with the only exception for animal welfare payments (measure 215), which is explicitly mentioned only in the Estonian mid term evaluation document. As this measure concerns only animal welfare improvement, it is concluded that it is too obvious to describe the causal chain.

Further, the frequencies of identification of these causal relationships among RDPs are summarised in Figure 14.

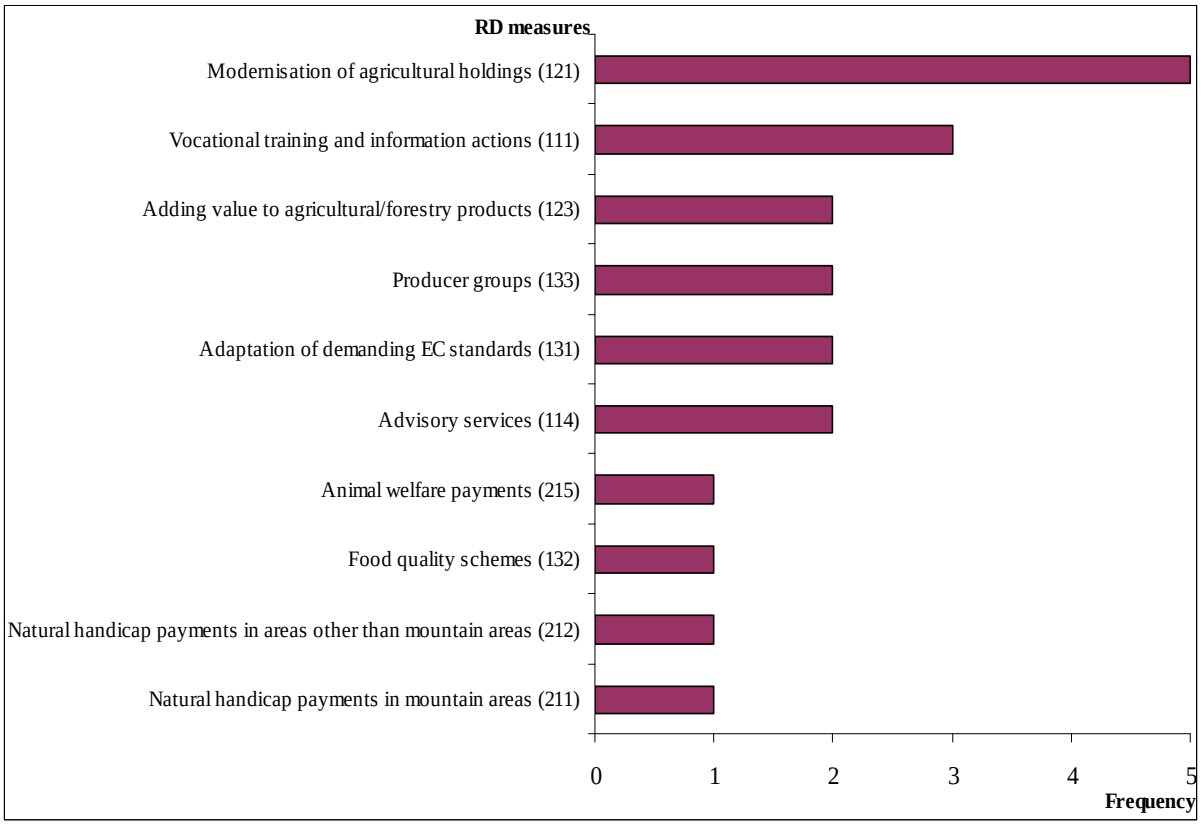


Figure 14 Frequencies of causal relationships between animal welfare and RD measures

3.8 General Comments

When looking for stated causal relationships between measures and public goods and then more expanded chains of reasoning between indicators – rural development policy interventions and public goods – there were 283 such causal chains identified (see Table

9). The overall number is relatively low, considering the total number of references to a RDP Measure – public good relationship (914). A first conclusion is that for less than one third of the stated relationships between public goods and RD intervention, there is a causal chain explicitly established within the evaluation documents.

The majority of them, 166 or almost 60% of the overall linkages, have been identified for axis 2 'Improving the Environment and the Countryside through Land Management', followed by axis 1 'Improving the Competitiveness of the Agricultural and Forestry Sector'. More than one third of the causal chains identified, were associated with this axis. Finally, only 7% of the causal chains had to do with axis 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity', however one should bear in mind that this axis had considerably less measures.

A second observation that could be made is that certain policy measures lack completely any causal chain that could relate them with any public good. Among these measures one can find measures under axis 1 as 'cooperation for development of new products, processes and technologies' (124) or 'supporting semi-subsistence agricultural holdings undergoing restructuring' (141), under axis 3 as 'training and information for economic actors operating in the fields covered by axis 3' (331) and also Leader approach measures such as 'competitiveness' (411) and 'environment/land management' (412).

Furthermore a considerable number of RD measures, are linked only with one chain of reason with any public good. Examples of such poor linkages are the schemes 'setting up of farm management/advisory services' (115), 'improvement of the economic value of forests' (122), 'supporting farmers who participate in food quality schemes' (132), 'first establishment of agroforestry systems on agricultural land' (222) and 'quality of life/diversification' (413) under the Leader approach.

Table 9 Frequency of causal relationships reported for RD measures

Axis	RD measure	Climate stability	Biodiversity wildlife	Biodiversity HNV	Water quality	Soil quality	Landscape	Animal welfare
1. 'Improving the Competitiveness of the Agricultural and Forestry Sector'	Vocational training and information actions (111)	4	4	4	6	6	3	3
	Use of advisory services by farmers and forest holders (114)	2	2	2	4	4	2	2
	Setting up of farm management/advisory services (115)		1					
	Modernisation of agricultural holdings (121)	7	2		4	4		5
	Improvement of the economic value of forests (122)	1						
	Adding value to agricultural/forestry products (123)	4	1		1			2
	Improving and developing infrastructure related to the development and adaptation of agriculture and forestry (125)	2			4	2	3	
	Adaptation of demanding standards based on Community legislation (131)							2
	Supporting farmers who participate in food quality schemes (132)							1
	Supporting producer groups for information and promotion activities for products under food quality schemes (133)							2
2. 'Improving the Environment and the Countryside through Land Management'	Natural handicap payments to farmers in mountain areas (211)		1	1	2	4	4	1
	Payments to farmers in areas with handicaps, other than mountain areas (212)		3	2	3	4	5	1
	Natura 2000 payments (213)		4	4	2	1	2	
	Agri-environment payments (214)	7	8	5	8	10	7	
	Animal welfare payments (215)						2	1
	Support for non productive investments (216)		1	1			2	
	First afforestation of agricultural land (221)	8	2	5	4	5		

Axis	RD measure	Climate stability	Biodiversity wildlife	Biodiversity HNV	Water quality	Soil quality	Landscape	Animal welfare
2. 'Improving the Environment and the Countryside through Land Management'	First establishment of agroforestry systems on agricultural land (222)			1				
	First afforestation of non-agricultural land (223)	5		2	2	4		
	Natura 2000 payments (224)		2	1	1	1	1	
	Forest-environment payments (225)	2				2	1	
	Restoring forestry potential and introducing prevention actions (226)	6	1	1	3	3		
	Support for non-productive investments (227)	3		2			2	
3. 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'	Diversification into non-agricultural activities (311)	1					1	
	Support for business creation and development (312)	2						
	Encouragement of tourism activities (313)	1					1	
	Basic services for the economy and rural population (321)				1	2	3	
	Village renewal and development (322)						4	
	Conservation and upgrading of the rural heritage (323)						4	
4. 'Leader'	Quality of life/diversification (413)						1	

Agri-environmental measures (214) is the RD measure where the most causal links (45) have been established in the evaluation documents. 'Vocational training' (111) and 'use of farm advisory services' (114) also present a high number of causal relationships established (30 and 18 respectively). Afforestation-related measures with 56 causal chains is another group of measures with established causal chains. Investments for modernisation, or environmental infrastructure is another category of measures that account for a significant part, 33, of the causal chains reported. Finally, considerable numbers of causal relationships seemed to have been established for LFA (31) and Natura 2000 (19) payments.

4 Indicators and Monitoring Systems used by the Member States/Regions

4.1 Climate Change Mitigation

The impact indicator 'Contribution to combating climate change' measured by the increase in production of renewable energy from agriculture and forestry (in 1000 tons of oil equivalent) is proposed by the CMEF as an assessment indicator. It is described as a quantitative and qualitative change in the production of renewable energy that can be attributed to the intervention once double counting, deadweight, and displacement effects have been taken into account.

Analysis of the review reports resulted to 159 cases where an indicator was used for assessing the impact on climate change mitigation. Out of all of 159 cases examined, 24 are referring to Axis 1, 117 to Axis 2, seven to Axis 3, two to Axis 4 and nine to programme level.

The majority of the assessments are qualitative, except for some when the monitoring data combined with survey findings of ad hoc surveys, literature reviews or expert interviews and assessments (Scotland, Finland, England, Netherlands, Bulgaria etc.). It should be mentioned that almost 20% of assessments are based on IACS, IPCC, RICA databases and/or other data coming from Paying Agencies, National Statistical Institutes and Inventories.

In the majority of the cases causal chains are mentioned; nonetheless in most cases they are either limited to the overall objectives of the relevant RD measures or based on intuitive approaches for the potential contribution of RD measures to climate change mitigation.

In general the indicators examined can be divided into the following categories:

- The CMEF impact indicator as described above, but measured by different data and using different methodology approaches. For instance, the data used varies from RICA and IPCC (France-measure 226 and Veneto region-measure 221 respectively) to the annual evolution of bird population in forest areas (IFEN, France-measure 226), and from the area size accounted (Lithuania-forest

environmental measures) to the number of projects (Finland-measures 111 and 123).

- Reduction of GHG emissions. Many indicators have been broken down according to the different emission released (CO_2, NH_3, N_2O, CH_4).
- Carbon storage through afforestation.
- The relevant CMEF baseline indicator, production of renewable energy from agricultural and forestry.
- Ha of UAA devoted to renewable energy production or ha of supported area under relevant RD measures.

Many other baseline, output CMEF or additional indicators, relevant or not relevant to climate change (e.g. number of beneficiaries, number of training days, Farmland Bird Index (FBI), financial uptake etc.).

In the Greek case, no indicator was defined for assessing climate change mitigation, since the measurement of the proposed CMEF impact indicator refers to the increase in production of renewable energy only from energy crops, e.g. oilseed rape and starch products, while such actions are not funded by the Greek RDP. The evaluators mentioned that not only energy crops could contribute to climate change mitigation, but also the same objective could be pursued by actions aiming at the production of renewable energy for own use, through measures as investments under farm modernisation (121) and measures under Axis 3. However it is not reported how an impact of these measures will be assessed.

4.1.1 Axis 1 'Improving the Competitiveness of the Agricultural and Forestry Sector'

In general, the assessments of measures under Axis 1 on climate change mitigation lack of causal chains and are based on survey results alongside unrelated baseline and output indicators (Poland, Bulgaria, Scotland).

The CMEF impact indicator is reported only in the Finnish and Lithuanian evaluation reports. It is measured by the number of projects (Finland, training activities and adding value to agricultural and forestry products) and ha of area size accounted (Lithuania, farm modernisation). In Lithuania, statistical data on production of renewable energy from wood, wood waste, woody material, bioethanol and biodiesel compared to baseline

figures, are provided. Given that data on primary energy production from areas where a specific measure is applied are not available, additional data are required.

Likewise, other member states/regions assessed the impact of farm modernisation (measure 121) but using different indicators.

For instance, in Austria, the additional indicator 'reduction of CO_2 equivalents' is proposed for assessing the impact of investments in biomass heating systems and storage of organic fertiliser and feedstuff on agricultural holdings, but the effects are not quantified.

In Baden Württemberg, it is reported that the farm modernisation measure (AFP), promoting biogas plants, is not an effective instrument for the reduction of GHG emissions. Many biogas plants for liquid manure are established without measure support, and it seems that other policies are more relevant (e.g. German Renewable Energies Act, EEG). However, only biogas plants that use liquid manure reduce CH_4 emissions from agriculture. Further the framework of emission trading with fixed limits of emissions is not effective, especially for solar energy plants and biogas plants based on biomass. The calculation of the reduction of GHG emissions could not be carried out due to difficulties in merging different data sets and lack of available data (promotion data). Also, a theoretically approach to the calculation of CO_2 reduction factors from different renewable energy sources is mentioned (Klobasa and Ragwitz, 2004).

In the Netherlands, this measure is only applied in the greenhouse horticulture, where innovation in air quality control and energy use is contributing to the reduction of emissions. The indicator 'achieved emission reduction' measures annual emissions of CO_2 and NH_3 using data from financial, output and result indicators.

4.1.2 Axis 2 'Improving the Environment and the Countryside through Land Management'

4.1.2.1 LFA payments

Only Bulgarian, Dutch and Spanish RDPs reported indicators for assessing the effect of LFA payments. For those indicators, a robust causal chain is lacking and they could only assess the indirect impact on climate change mitigation.

4.1.2.2 Agri-environmental measures

In Austria, an indicator that calculates humus balance (CO_2 balance) is proposed for the assessment of individual actions of AEMs (mulching and direct sowing, greening of arable land -abandonment of agricultural crop land- and organic farming). It is reported that the improved or reduced fertiliser application decreases the N_2O emissions and has a positive effect on the carbon balance in the soil. Another additional indicator is derived from a study on NH_3 losses during the application of farm fertiliser related to the AE sub-measure 'minimal loss application of farm fertiliser and biogas production from manure' (TIHALO Study, Amon et al., 2007, INVEKOS). Calculation of the reduced emissions is based on the share of farm fertiliser that was applied close to the ground in 2009. A reduction about 30% of NH_3 emissions is assumed by close to the ground application. Such AE actions are considered to have high potential for the climate protection, so the continuation and improvement of their databases are recommended for the ex post evaluation.

In Baden Württemberg, the climate change mitigation is not considered as one of the main objectives of AEMs. Nevertheless, it is stated that AE actions have the potential to contribute to climate protection and the assessment of their impact is based on the ha of area under the measure (result indicator).

In Lower Saxony, the impact of AE action 'environmental friendly liquid manure application' is based on estimations derived from literature analysis and international agreements (European Environment Agency, 2007, and National Inventory Report, NIR). The proposed indicator 'amount of reduced emissions of CO_2, CH_4, N_2O, NH_3 through the application of AEMs' has used the aggregation method of the areas under the measure, since data about nutrient inputs and emissions from animal husbandry are not available. The indicator that calculates the extent of additional CO_2 fixation in agricultural soils under organic farming and undersown catch crops is also derived from literature review (IPCC-Guidelines and Freibauer et al., 2004). It is mentioned that, since carbon fixation is easily reversible, it is not considered a useful component for long term climate protection strategies. It is argued that their potential impact is highly unsure. Moreover in the NIR, the impact of farm fertiliser and crop rotation on carbon balance are not available for the farms under the undersown catch crops scheme.

In the mid term evaluation reports of Veneto and Emilia Romagna regions, the impact of AEMs is assessed by the 'production of energy from renewable sources (Toe) and GHG emission reduction (milliogram CO_2 equivalent/year)' using data from literature, national and international agencies (e.g. IACS, IPCC and GIS data, Corine Land Cover, results of business surveys). It is stated that the effects of reduction of CH_4 emissions from livestock, due to the reduction of enteric fermentation, and the GHG savings, through the creation of more efficient power plants, have not been taken into consideration. These aspects would be addressed, according to the evaluators, in subsequent stages of the evaluation process. The methodology used lacks specific information for the calculation of GHG emissions. Also, the indicator 'change in annual regional emissions of GHG in the agricultural sector' is established in Emilia Romagna region, in order to fill the gaps of CMEF indicator, in terms of emissions' production. The assessment method is based on the simplified IPCC methodology, which estimated the impact of the measure in terms of tons of CO_2 equivalent/year.

Also, in Veneto origin, the methodological approach used for the estimation of N_2O emissions follows a standard simplified procedure of the load variations of mineral nitrogen fertilisers used in agriculture (IPCC, 1996). A reduction of nitrogen inputs (kg N) corresponds to a decrease of the N_2O emission from agricultural soils. There are numerous studies addressing the problem of a reliable conversion coefficient of N-fertiliser to N_2O emission. Besides, it is reported that the AE action aimed at increasing the organic matter content of soils has a positive impact on the atmosphere, since an average increase of 0.14% of the organic carbon content in agricultural Italian soils used by agriculture is equal to an absorption of more than 400 million tons of CO_2 equivalent, a quantity just lower than the national annual emissions (Ministry of Agricultural, Food and Forestry Policies, MiPAF).

In Puglia region, the impact of AEMs is measured by the IRENA indicator 'production of energy from renewable agricultural sources' using IPCC data. This indicator is described on the basis of acreage and biomass production. Biomass production involves significant environmental costs and benefits. The estimates of the Puglia region indicate that the production of renewable energy from agriculture is 7,000 KToe and may be increased by 20% at the end of the programming period.

In Lithuania, the AEMs effect is estimated by the CMEF impact indicator, but there is no data on primary energy production from areas where each measure is applied.

Different kind of indicators such as area under AEMs, number of beneficiaries, livestock density per ha of UAA, share of permanent grassland in UAA, FBI, balance carbon with a mathematic model (CENTURY), reduction of CO_2 emissions etc. are used in the Polish evaluation reports for assessing the impact on climate change mitigation. The assessment methods are based on desk analysis with statistical data, survey results and expert judgement.

A qualitative assessment is given by the Scottish evaluation document. The method of impact assessment is based on survey of beneficiaries, where some answers included the reduction in livestock in order to reduce CH_4 emissions, reduction in fertiliser application, planting trees for carbon sequestration.

In the Netherlands, there is no specific management package included with a stated objective to contribute to the mitigation of climate change. However assessment is based on the type and number of AEMs that contribute to mitigating climate change, literature research on additional indicators, interviews with experts and screening of applications. Biomass used for fuel is mentioned as having a potential contribution, but its impact is not measurable and is expected to be marginal.

4.1.2.3 Forest-environmental measures

The impact of forest-environmental measures is mainly assessed by the increased production of renewable energy. However, the Estonian RDP has not set the climate change mitigation as an objective; therefore monitoring data are not available and the relevant impact is not assessed. In Austria, it is mentioned that the impact of forest-environmental payments on climate is considered marginal. Moreover, in Lithuania, given that area supported does not provide quantitative estimation of impacts on climate change mitigation, other data are required.

The ex ante evaluation document for Veneto region mentioned that the methodology used in the case of the assessment of the production of renewable energy is based on a sophisticated geographical system analysis that presents few elements of complexity, imposing the use of a simulation model capable of capturing the differences in behaviour of different soils, particularly in terms of the balance between soil depth and runoff. Therefore the results obtained are considered as an approximation. The use of complex mathematical models is often questionable, due to the difficulty of providing empirical robustness, in the various territorial situations. Albeit, it should be noted that the macro

model used has already been applied in various other circumstances, and the results obtained can still be considered a valid reference to the current state. The evaluators, in a warning of caution, suggest that these aspects should be taken into account when using the results and particularly when comparing the effectiveness of other measures obtained by different methods.

The baseline CMEF indicator, which measures the average of annual increase in forest area, has been used in Lithuania. It is considered as a weak indicator; therefore the indicator 'increase of carbon capture by forests' using the IPCC methodology (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html) is suggested.

Moreover, an additional indicator is proposed by the French evaluators in order to capture the impacts on GHG emissions for the estimation of the UAA devoted to renewable energy sources.

Some member states/regions propose the sequestration of CO_2 or the C fixation through afforestation as an additional assessment indicator.

In Austria due to the limited application period of the programme, the quantification of the impact is not possible.

In Cyprus, the assessment of forest-environmental measures is based on the anticipated impact that these measures would have after the complete execution of the RDP. Therefore it is estimated that the supported actions will have a significant contribution to climate change mitigation, and the total increase in forest land will lead to an increase in the absorption of CO_2 (aerial biomass of the forests) by 10,627 tons annually (estimated at 22.5 tons per hectare).

For the calculation of carbon sequestration through afforestation, a model developed to Hungarian circumstances (Casmofor 3.0 model) has been used. The model takes into account forestry tending and timber production models for the individual species as its basis to determine C sequestration, including also natural dieback, decay and the impact of forestry technology. The data which provided the basis for the calculations was the land data for the individual types of tree stocks.

In Baden Württemberg, the assessment of the CO_2 fixation through afforestation was based on literature analysis (e.g. Paul et al., 2009) and considered a counterfactual

approach. It is reported that for the mid-term evaluation it was too soon to measure the impact, and the calculation of CO_2 fixation is estimated to be 27,000 tons over a period of 20 years. Also, it seems that the previous site utilisation influences the CO_2 fixation rate, with stronger effects in sparsely wooded areas.

In Italian regions (Veneto and Puglia), the methodological approach of indicators that measure the net C storage lacks in term of scientific knowledge; thus their estimations are considered slightly poor. Several investigations were conducted in Veneto region, in order to quantify the total C storage capacity of forest, but the results should be used with caution due to uncertainties related to the estimation methods proposed for various categories of management and the forest area.

Also, an additional regional indicator for the reduction of CO_2 emissions was created in Veneto in order to capture the GHG emissions. The estimate of the absorption of CO_2 and C fixation (t CO_2e year-1) is based on a simplified IPCC methodology. During the mid-term evaluation period, absorption through afforestation was estimated at 24,106 tons of CO_2 equivalent year-1, while the contribution of measure 221 in carbon sequestration represents 22% of the overall impact of the programme.

Furthermore, indicators from IRENA are used in the ex ante evaluation report for Puglia region calculating the NH_3 emissions coming from agriculture and the total absorption of CO_2. At the regional level, during the 1990-2000 period, there was a fluctuating trend of NH_3 emissions, between 4,000 and 4,400 tons/year. Also, during the current programming period, the creation of new woodland is estimated to result to an increase of CO_2 absorption capacity of about 10,000 to 11,000 tons/year.

On the contrary, in England, the assessment of forest-environmental measures is based on interpretation from indirectly related result and output indicators, since the impact on climate change mitigation is attributed to the wider programme level. The methodological approach that has been used is based on questionnaires completed by the evaluators alongside an extensive literature review. Same mixed assessments are also found in Bulgaria, Netherlands and Scotland.

In the Polish evaluation documents, it is reported that the analysis of indicators assessed shown a negligible impact on climate change mitigation. Thus afforestation measures do not constitute a major item on the CO_2 balance sheet.

In Andalucia, in order to assess the impact of the measures aimed at increasing afforestation, forest maintenance and reducing forest fires, the evaluators calculated the supported area that contribute to climate change mitigation as a function of the proportion of the financial uptake and the programmed target area. The level of uncertainty is high, thus the specific method cannot be considered robust.

4.1.3 Axis 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'

Only Austria, Finland and Latvia reported assessments of the impact of measures under Axis 3. The indicator 'reduction of CO_2 emissions' is reported by the Austrian and Latvian RDPs for estimating the impact of farm diversification (311), basic services (321) and business creation and development measure (312) respectively. In Finland, the effect of farm diversification, business creation and development, basic services and training/information (311, 312, 321 and 322 respectively) is based on expert assessment about the impact of these measures on air emissions.

4.1.4 Axis 4 'Leader'

Only in the Finnish review can a qualified assessment of measures under Axis 4 be found. The estimations of the impact of competitiveness and quality of life/diversification measures (411 and 413 respectively) are based on expert assessments about the influence of leader firm and project aids on air emissions.

4.1.5 Programme level

In Austria, the assessment of the impact at the programme level in the mid-term evaluation document is based on the CMEF impact indicator measured by the increase in renewable energy production from biodiesel, bioethanol, energy plantations, wood and waste and the resulting reduction of CO_2 emissions (in million kilograms of oil equivalent). However the use of these renewable sources for energy production is not promoted by the current RDP. As mentioned before, investments in biogas and biomass plants as well as certain agricultural management measures and environmentally friendly farm buildings are promoted contributing to reducing GHG and NH_3 emissions. The measures of farm modernisation, farm diversification and basic services (121, 311 and 321 respectively) primarily contribute to mitigate climate change. The reduction of CO_2 emission is estimated at 1.9 million tons per year. Further data about the impact of measures on climate change should be collected for the following evaluations.

Further, in Austria, during the previous programming period (2000-2006), the reduction of GHG emissions was not among the main objectives of the RDP. Nonetheless, some measures directly and indirectly had effect on the GHG balance. One research project was conducted to estimate the impact of organic farming practices on the GHG emissions, without a quantifiable assessment due to high uncertainties (e.g. different cultivation practices). Thus only the budget of the measures that contribute to climate change mitigation (in million Euros) and their share of the total programme budget (in %) is assessed.

4.2 Biodiversity Wildlife

The CMEF proposes the impact indicator 'Reversing biodiversity wildlife' to assess the change in trend in biodiversity decline as measured by farmland bird species population (FBI). Change in trend in biodiversity decline in area targeted by the intervention is the quantitative and qualitative change in species population that can be attributed to the intervention once double counting, deadweight, and displacement effects have been taken into account.

Analysis of the review reports resulted in 172 cases where an indicator was used for assessing the impact on biodiversity wildlife. Out of all of 172 cases examined, 22 of them refer to measures under Axis 1, 134 to Axis 2, and eight to Axis 3 and programme level respectively.

In general, the assessment of the impact of measures on biodiversity-wildlife is based either on CMEF impact indicator, measured by farmland bird species population or on baseline, output indicators combined with survey findings and judgements derived from literature reviews. Moreover, many member states have proposed additional indicators in order to capture the impacts of the AEMs on wildlife.

About a quarter of the assessments were based on monitoring data of bird population or other fauna and flora species, while some others use data from IACS and FADN databases (almost 10%). Also, due to lack of sufficient data, in almost 15% of all 172 cases a qualitative assessment is reported about the expectation of the potential impact on biodiversity-wildlife. In most of the cases a causal link is not established and a quantified value is not provided.

4.2.1 Axis 1 'Improving the Competitiveness of the Agricultural and Forestry Sector'

In particular, all assessments of the indirect impact of measures under Axis 1 lack an evidence base (e.g. Type of investments-Modernisation of agricultural holdings (121), Influence to endangered species-Adding value to agricultural/forestry products (123) and Cooperation for development of new products, processes, technologies (124), Number of beneficiaries whose agricultural holding is located in LFAs-Semi-subsistence agricultural holdings (141), etc.).

The only exception seems to be the additional indicator 'Change in grassland area' related to investments on dairy systems (Measure 121 'Modernisation of agricultural holdings') in Lower Saxony, which includes a causal link documented and a counterfactual approach. Although this indicator does not directly measure impact on biodiversity-wildlife, it is considered significant in terms of providing a proxy for evaluating potential negative impact of measures under Axis 1 on biodiversity, as their assessments are rarely included in evaluations reports. A reported weakness is its dependency on accuracy of filled IACS forms, which often show inconsistencies.

4.2.2 Axis 2 'Improving the Environment and the Countryside through Land Management'

4.2.2.1 LFA payments

Likewise, those member states that have estimated some impact of LFA and Natura 2000 payments (Measures 211/212 and 213 respectively) do not provide clear information all the time. For instance, given that the target area for Measure 212 is achieved, it is concluded that biological diversity has been preserved; in other cases evaluators merely report that the FBI is stable in LFAs and no further details are given.

Finally in another case a qualitative assessment is provided by stating that Measure 212 'probably' has contributed to the maintenance of sustainable farming and environment, encompassing thus all environmental goods, but only to a relatively small degree. The assessment is based upon related baseline indicators of farmland birds and tree composition, in a very generic and qualitative way. Also, some reference is made to the advantages of novel agricultural management of hay meadows, pastures, allotments/intakes and moorland to enhance biodiversity. The landscape level is

suggested in some evaluation documents, as the necessary bridge-level between micro and macro spatial scale for biodiversity.

As regards the additional indicators, all French indicators related to LFAs, number of farms in less favoured areas, abandonment rate, average operating profit by UAA (Utilised Agricultural Area) do not provide any information, except for the data used.

In Austria and Baden-Württemberg, although the indicators 'share of organic farmland and of extensive grassland in LFAs' and 'share of UAA under environmentally benign farming systems' respectively are not directly linked to biodiversity-wildlife, it is suggested that they can be used as proxies for potential impact of LFA payments on biodiversity.

4.2.2.2 Agri-environmental measures

All member states/regions reported assessments about the impacts of AEMs on biodiversity-wildlife. In the vast majority of evaluation documents, the FBI reported (except for Greece, where estimation for this indicator is not yet available although a system for monitoring has been established, for Bulgaria, Baden-Württemberg and Lower Saxony additional indicators are proposed, for the Netherlands output indicators are used and for Scotland and Cyprus surveys are conducted). In some cases where the CMEF impact indicator is mentioned, causal chains and/or actual measurements are lacking (e.g. Poland, Latvia, Lithuania, Finland).

In Austria, the application of multivariate logistic regressions has been used to analyse the causal relationships between the AE sub-measures and the spatial distribution of bird species of the FBI, including also climate, land cover, topography, marginal strips and land use as independent variables. Forty bird species were analysed and differentiated according to the main agricultural land use types. Given that for some species the number of samples and years are insufficient to calculate trends, only generic conclusions can be drawn about the impacts of AEMs on the FBI.

In French and Italian reports, the suitability of the FBI as an assessment indicator of individual AE actions is questioned, mainly due to:

(a) the limited spatial dispersion of the interventions of AEMs in the examined regions

(b) the low correspondence between the observation areas and the areas affected by AEMs

(c) the partial database of some monitored species, as many present an uncertain trend or oscillation

(d) the choice of bird species to be monitored (different series database of sources between Eurostat and IFEN), which, according to the evaluators, can strongly influence the observed trends.

In the French mid-term evaluation report, the assessment of biodiversity decline is measured by the STOC indicator (http://www.eea.europa.eu/soer/countries/fr/nature-protection-and-biodiversity-state/copy_of_natureFR06.jpg/view), -the temporal monitoring of common birds- measuring the relative change of common birds over time. It is reported that it is the only indicator that could be applied to all agricultural systems and is constructed on a basket of common birds in several types of environments (urban, forest and agricultural). The list of the agricultural STOC index represents species of different types of habitats. The aggregation index is convenient on a synthetic communication plan, but hides diverging trends between species (e.g. agricultural species may benefit from the decline of another, with a stable overall index). At national level, there was a decline of 28% of the populations of specialist bird species in agricultural areas between 1989 and 2007, against only 18% of all species. A specific treatment tried to refine these results by observing the temporal variations in the abundance of farmland species in each agro-ecosystem. The analysis conclusion put in evidence that the changes in the index significantly differ between the agro-ecosystems. Given the inherent limitations in tool (still being stabilized), these analyses should be confirmed in time.

In Italy, using data from 2000 to 2011 (part of the project MITO2000), the FBI calculated over 26 species of their agricultural environments shows a slight decline (-6%). However it is noted that the performance of all common species tend to be stable, confirming that farmland birds are at higher risk category (National Rural Network and Lipu 2010, 2011).

In Brandenburg, the assessments based on amphibian indicator, meadow birds and plant species indicators, include counterfactual approaches. The reported gap for the measurement of amphibians is that the trial areas are not covered by AEMs, hence the

indicator cannot assess their impact. Other reported weaknesses are related to the counterfactual analysis.

The counterfactual approach of 'crop diversification indicator' (Baden-Württemberg) is considered significant in order to define an additional indicator for assessing impacts of AEMs, when CMEF indicators cannot be used.

In Latvia, three indicators have been proposed for assessment of the i.e. ground beetle species, status of higher plants and butterflies population. They were all based on case studies comparing areas where specific AE actions applied to conventional farmland, without providing further information.

The indicator 'number of species' used in Lower Saxony presents a high correlation with species diversity on farmland and it is easy to monitor. While this approach has been successfully used in a number of extensive grassland measures, it often reflects only the existing species diversity (maintenance of extensive grasslands with already existing high species diversity) and the occurrence of the different species is subject to external influences which would need to be considered in counterfactual design.

The assessment of AEMs in Hungary using the indicator 'changes of the naturalness of the habitat patches' has a countrywide approach and based on existing data sets, but the botanical data represents only a 'snapshot' of the habitats; therefore before and after comparisons as well as trend analysis cannot be carried out. Also, the impact of specific AEMs targeted at the protection of the great bustard population (*Otis tarda*) is estimated using population census data. It is suggested that assessments of long-term trends are needed, since the causal links between the number of population and parcels contracted under AE actions are not strong enough.

The uncertainty of the indicator 'evolution of the population of 18 species of birds selected in agricultural areas at national level' by IRENA used in Puglia is related to the methodological approach and data used (ha of the surface measure object (SOI) on the total UAA).

In Estonia the indicator 'changes in environmental awareness of agricultural producers' is able to assess only indirect impact of organic farming on biodiversity-wildlife.

Moreover other member states/regions have used a lot of indicators based on evaluation questions of previous programming period (e.g. Veneto and Puglia regions, Hungary, Baden-Württemberg). In Veneto and Puglia regions all indicators measured by the ha of supported area without providing further information (for some cases the methodological approach is considered poor in terms of knowledge). The Hungarian indicator lacks of sufficient data for a scheme-level evaluation, and the indicator in Baden-Württemberg does not directly measure the impact of the environmental measures.

Some member states/regions have reported negative or positive impact on biodiversity-wildlife according to the indicators.

In Emilia Romagna, it is reported that the application of AEMs - alongside afforestation measures - has a positive effect on population of some species, notably higher increase was recorded in the hills compared to the mountains.

Also, in Estonia, the results of bird monitoring showed that the nesting bird diversity indicator (Shannon diversity index) is stable or slightly increased, regardless the type of the AEMs.

The findings of a survey conducted on farm bird population in Cypriot areas, where three AE submeasures –AE commitments in viticulture, arable and citrus crops– were implemented during the previous programming period, indicate that there is no evidence that AEMs, as currently applied, provide measurable benefits to the birds and to biodiversity in general. The survey identifies as an important problem that AEMs have not been adopted by a large number of beneficiaries and thus there is no substantial impact on biodiversity-wildlife. For this reason evaluators suggest AEMs should be more targeted to biodiversity.

In Estonia, the analysis of the earthworm species revealed that the parameters of earthworm habitats are influenced to some extent by soil parameters as well as agricultural activities. However, earthworm abundance showed no significant differences between crop cover. The results of the observation of bumblebees showed that the diversity of species of bumblebees and Shannon diversity index were higher in areas under actions of organic production and environmentally friendly management, although for the abundance of bumblebees such trends were not observed. Thus it seems that

pesticide use affects the diversity of bumblebees, but not their abundance regardless of species.

The indicator of vascular plant community on the one hand assessed the extent at which the actions of environmentally-friendly management and organic production have affected plant diversity and variety on field edges. In addition it attempted to estimate what is the natural variety of plant coverage on field edges in traditional agricultural areas. The results showed that the flora diversity of field edges slightly decreased in those of the monitored farms, with stronger downward trend in areas under action of environmentally friendly management, probably due to pesticide use and the narrower edges thanks to ploughing.

4.2.2.3 Forest-environment measures

Out of the total evaluation reports only 10 mention indicators for assessing the impact of the forest-environmental measures (Lithuania, England, Puglia, Poland, Latvia, Bulgaria, Estonia, Baden-Württemberg, Andalucia). Their assessments are based on CMEF impact indicator, measured by the FBI, related to the measures baseline/output/result indicators, survey findings and some additional indicators. FBI is considered an unsuitable indicator for the forest-environmental measures (Lithuania). The indicator 'area planted/regenerated/improved with indigenous tree species' as well as 'critical sites maintained/improved due to assistance' proposed in one case, seem to lack concrete methodologies. For above member states/regions stated an assessment, the impact is not actually calculated due to insufficient data.

Scotland and Baden-Württemberg made qualitative assessments based on interviews and literature review respectively. In Estonia, although the evaluators proposed the 'conservation status of forest habitat types and forest species' for assessing the impact of Natura 2000 payments, it is concluded that since monitoring data is very uneven the assessment is difficult. All Polish indicators can measure only the indirect impact on biodiversity-wildlife. In Andalucia, the evaluators, in order to assess the impact of the RD measures on biodiversity wildlife, calculate the supported area under biodiversity conservation as a function of the proportion of the financial uptake. The level of uncertainty is high, thus the specific method cannot be considered robust.

4.2.3 Axis 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'

Only Finland and Netherlands propose indicators for assessing the impacts of measures under Axis 3 ('influence to endangered species', 'ha of created natural area and km of ecological network connections' respectively). In Finland, an expert assessment is reported, and in the Netherlands, no project is conducted under Natura 2000 sites, and thus the impact is not assessed.

4.2.4 Programme level

In Lower Saxony, the assessment of the programme level impacts in the thematic module report for the ex-post evaluation is based on qualitative expert judgement based on a comparative analysis of key aspects of the measure and programme design and habitat requirements of indicator bird species. Farmland birds respond to changes in agricultural land management. However a number of other factors influence bird populations, and the mobility of birds adds to the complexity. It is noted that the FBI identifies changes in farmland bird populations but is less suitable for identifying causal relationships between the different drivers and the observed changes in the FBI. The collection of FBI data is not consistent with the criteria which drive the spatial distribution of supported and non-supported land. As a consequence, the number of measures and beneficiaries covered by the FBI sample can be very small. Additional FBI data alongside data on other groups (e.g. insects and plant species) are needed to be able to create robust counterfactuals.

Additionally the uncertainty of the assessments of SEA in Puglia using the evolution of the selected bird species as well as the percentage of Natura 2000 sites covered by habitats (the value of this indicator is 22%) is related to the methodological approaches in terms of knowledge.

4.3 Biodiversity-HNV

The CMEF propose the impact indicator 'Maintenance of High Nature Value (HNV) farming and forestry areas' for measuring the changes in HNV areas. Change in area targeted by the intervention is the quantitative and qualitative change in HNV areas that can be attributed to the intervention once double counting, deadweight, and displacement effects have been taken into account.

Analysis of the review report resulted to 123 cases where an indicator was used for assessing the impact of the RD measures on biodiversity-HNV. Out of all of 123 cases examined, 13 are referring to Axis 1, 99 to Axis 2, three to Axis 3, and eight to programme level.

Among evaluation documents, the CMEF impact indicator 'maintenance of HNV farming and forestry areas' is the dominant indicator used. However in some cases it is difficult to distinguish which indicator has been used among the two impact indicators 'maintenance of HNV farming and forestry areas' and 'FBI' or the result indicator 'area under successful land management contributing to biodiversity and HNV farming/forestry'.

Evaluation reports from all examined member states/regions have reported indicators, except for Andalucia and Cyprus (in Cyprus, the HNV areas have not yet been defined). However, in the majority of the member states/regions examined, the impact on biodiversity-HNV is not assessed, due to lack of data availability. Therefore evaluation is mainly based on output and result indicators, alongside beneficiaries' surveys, expert interviews, literature reviews wherever monitoring data are not available (Netherlands, Scotland, England). In almost 20% of all the cases examined, the data are based on IACS, RICA/FADN databases, regional land-use maps, Corine Land Cover system, GIS, national statistics of agricultural land etc.

4.3.1 Axis 2 'Improving the Environment and the Countryside through Land Management'

4.3.1.1 LFA payments

In Lithuania, the CMEF impact indicator is not suitable to assess the impact of Measures 212 'payments to farmers in areas with handicaps, other than mountain areas', since LFA payments do not support only HNV areas.

The same comment about LFA payments is reported also by the Latvian evaluators, given that it is a compensation measure and does not support activities to maintain or improve biodiversity.

In Estonia, the agricultural areas of high nature value are primarily semi-natural habitats. Although LFA payments are granted for these areas of semi-natural habitats, the impact on biodiversity-HNV cannot be accurately determined by the current database, since the

permanent grasslands have not been distinguished as semi-natural habitats. Also, it is reported that HNV area is preserved or increased measuring the change of habitats and biodiversity with the Shannon diversity index, bumblebee species population and richness of flora. HNV forestry areas have not yet been defined.

For assessing the impact of LFA payments on biodiversity-HNV, the Greek evaluators propose to measure the change in fertiliser and pesticide use in these areas. The indicator is considered doubtful, due to the non-representative FADN-RICA database and the rationale of the method, which can only give biased results. Although the extent of HNV areas in Greece have been identified, the CMEF impact indicator is not implemented due to lack of available data.

4.3.1.2 Agri-environmental measures

In Lithuania, the impact on biodiversity-HNV was assessed by the CMEF impact indicator 'Maintenance of HNV farming and forestry areas'. It is noted that the extent of HNV areas under agri-environment schemes is small, thereby the impact of the RD measures is considered insignificant. Change in the extent of HNV areas where RD measures applied could indirectly show the impact of these measures over time. The estimation of the extent of HNV areas does not provide qualitative information on the HNV status, hence additional data should be provided.

In the reports for certain Italian regions, the impact of AEMs on biodiversity-HNV is assessed by measuring the extent of agricultural land and farmland bird species population. The choice of the different methodological approaches used for the calculation of HNV farmland is considered important. In a recent paper (Trisorio et al., 2008), the value of the agricultural area depends on the existence of species and habitats of Community interest; therefore a combination of data related to land use (from CORINE Land Cover) with related dissemination data of vertebrate species (from the National Ecological Network-REN) is proposed.

In Puglia region, the indicator of the percentage of UAA with high nature value, calculated by data processing of the CORINE Land Cover, is 30%, while the estimated value according to FADN data stands at 12%. As regards the FBI, the limited diffusion of the interventions funded by AEMs and the low correspondence between the observation sample and the areas affected by the RDP are identified as its weaknesses.

4.3.1.3 Forest-environmental measures

In Lithuania the CMEF impact indicator is not suitable to assess the impact of Measure 227 'support for non productive investments', since the non productive investments are considered as a more infrastructure-oriented measure.

4.3.2 Axis 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'

Only Scottish and Dutch evaluation documents reported indicators (number of rural heritage actions, ecological network connections and created natural areas) in order to assess the impact of Measure 323 'conservation and upgrading of rural heritage'. However no project was conducted under Natura 2000 sites for the Netherlands. Thus the impact of the measure is not assessed, and the Scottish evaluation is based on survey findings.

4.3.3 Programme level

In Lower Saxony the CMEF indicator HNV farmland is used to assess the programme impacts on biodiversity-HNV differentiating between different HNV areas and elements classified into different HNV types. The quantitative part of the assessment is based on GIS-data analysis and statistical methods such as correlation analysis to analyse causal relationships between the extent of RD support and HNV farmland (focussing on measures 213 'Natura 2000 payments' and 214 'agri-environment payments').

The main gap identified in the thematic module report for the ex-post evaluation 2007-2013 is that only a part of the HNV types can be considered as methodologically relevant for RD evaluation, since only half of the HNV area corresponds with the agricultural land managed and registered under IACS. Established measure-specific monitoring activities of biodiversity impacts on certain wildlife, plant species and biotopes do not consider the spatial distribution of samples of programme impact indicators. Therefore the consistency and the overlap between the sample areas for the programme indicators and measure-specific monitoring activities are limited.

In Austria, no impact indicator defined; but aspects of landscape diversity and types of cultural landscapes are suggested as future indicators for landscape impacts.

In France, the demarcation of the different types of HNV farmland based on the IRENA methodology is considered questionable, since the assessment of areas with high proportion of semi-natural vegetation is made on the basis of satellite photos provided by the CORINE Land Cover system, which does not distinguish between extensive and intensive management grasslands. Due to the absence of sufficient instructions for the HNV indicator, the French mid-term evaluation report provides theoretical and methodological references, particularly to the repository agricultural component of the indicator, for the ex-post evaluation in 2013. Work on the investigation of HNV indicator highlights the diversity of combining approaches, given the variety of agro-ecological situations considered. For instance, the 'surfaces meadows and paths with a load less than 0.5 LU' is a relevant indicator for characterising HNV farmland in Mediterranean areas, because the thresholds pastoral charge recognized to allow good management of the valuable natural areas are low.

4.4 Water Quality

The impact indicator 'Changes in Gross Nutrient Balance (GNB)' is proposed by the CMEF as an assessment indicator of measures aimed at the improvement of water quality. It is described as a quantitative change in the estimations of GNB that can be attributed to the intervention once double counting, deadweight, and displacement effects have been taken into account. The GNB indicates potential nutrient losses to the water bodies likely to be detrimental for the quality of water.

Analysis of the review reports resulted to 199 cases where an indicator was used for assessing the impact of RD measures on water quality. Out of all of the cases examined, 30 refer to Axis 1, 151 to Axis 2, two to Axis 3, two to Axis 4 and 14 to programme level.

Only in Latvia, no indicator is defined for assessing the water quality, due to scarcity of data. Moreover in Greece the indicator 'pollution by nitrates and pesticides' is not yet available; hence the impacts on water quality have not been assessed.

In around half of the cases examined, mixed and qualified assessments are reported, using monitoring data alongside results derived from surveys and literature analysis. Causal chains linking measure-water quality-indicator are usually reported, especially in

AEMs where the indicator is tightly connected with water quality and the action. Nevertheless causal chains in other Axes are not always established.

In general, according to the cases examined, an assessment of RD measures affecting water quality can be derived using the following paths:

- CMEF impact indicator measured by the changes in gross nutrient balance (GNB)
- CMEF baseline indicator measured by the surplus of nutrient per ha, nitrogen and phosphorus (not always both of them)
- CMEF baseline indicator measured by the concentration of nitrate and phosphorus in surface and ground water (not always both of them)
- extent of the area where farming systems or practices have the potential to improve water quality
- and other baseline, output or additional indicators, related or non-related to water quality, combined most of the times with survey findings, expert or evaluator's judgement derived from literature reviews.

4.4.1 Axis 1 'Improving the Competitiveness of the Agricultural and Forestry Sector'

In Baden-Württemberg, it is assumed that the farm modernisation (AFP), through the promotion of improved plant protection techniques, has no important impact on water quality. It is assumed that the measure could have an impact on driftage and courtyard drain, but not on run off (main input path) and drainage. Change of behaviour is the main driver which cannot be reached by this measure.

In the Netherlands, the impact of the measure 'infrastructure development and adaptation of agriculture' (125) is assessed using output indicators (area of supported land, added value according to the type of land use and operation). Although some environmental impact on water quality can be expected, the objectives of the measure do not include benefits to this public good.

In Poland, the impact of measures under Axis 1 on water quality cannot be estimated, since the data used are too general.

In Lithuania, the impact of farm modernisation is measured by the GNB, the nitrate pollution and the pesticide pollution. It is mentioned that none of the indicators is suitable for assessing the impact on water quality. Given that calculations at national level do not reflect either spatial differences or temporal changes, additional measurements are required.

4.4.2 Axis 2 'Improving the Environment and the Countryside through Land Management'

4.4.2.1 Agri-environment and LFA payments

In Austria, the assessment of AEMs are calculated by the changes in nutrient balances (nitrate and phosphate) using the OECD method and the results of a Eurostat project until 2007, taking also into account land use, yields, nutrient removal, livestock, mineral and other fertilisers, nitrogen fixation, deposition and amount of seeds. Indicators (nitrate balances, application of mineral fertiliser, land use, livestock density) showed mainly positive trends at programme level, while it is not possible to determine the impact of the individual actions of AEMs, as the actions strongly depend on site and weather conditions. The impact of individual AEMs is assessed by summing up the ha of the supported areas.

In Rheinland-Pfalz, the impact estimation of AEMs on water quality is based on a counterfactual approach, comparing the changes in GNB between participant and non-participants. However, there is no real causality as this is solely based on the assumption that participating farms have a lower GNB associated with the participation in AEMs. It is reported that the GNB of organic farming is associated with high uncertainty (uncertainty of N-balance calculation). Nitrogen from atmosphere, different protein contents of the products yielded, that depend on different nitrogen fertiliser inputs as well as different time of harvest cannot be considered.

In Baden-Württemberg, in order to estimate the impacts of specific AEMs (extensive grassland management - extensive management of permanent grassland - grassland management in mountainous areas - organic farming), the evaluators proposed an additional indicator, which concerns the amount of organic fertiliser (stock density

LU/ha) combined with literature analysis and expert survey. The assessment represents a counterfactual, a quantitative comparison of stock density (LU/ha) of participating with non-participating farms. The impact of measure cannot be assessed exactly with this method, as no information is available if participants reduced their stocking density due this measure. Moreover the stocking density of non-participating farms was also quite low. The impact of individual AEMs is assessed by summing up the ha of the supported areas.

In Lower Saxony, the assessment of AEMs, measured by the GNB indicator, is based on expert estimation derived from literature review of previous studies (impact coefficients of measures were estimated/developed in studies of the Thünen Institute based on literature analysis and expert interviews). Since data is not sufficient to quantify the GNB, an overestimation of measures impact is anticipated.

In Finland, the impact of AEMs measured by the GNB is based on sold amount of fertiliser and regional crop data.

In Cyprus, a survey was conducted in order to identify the effects of AEMs on water quality. The maintenance or improvement on water quality is examined by the trend in the concentration of nitrates in ground water, comparing areas where three AEMs – commitments in viticulture, potato and citrus crops – were implemented with other areas. The survey showed that areas where a large number of agri-environmental measures are implemented have downward trends in nitrate concentrations in ground water. So the evaluators concluded that the implementation of agri-environment scheme has resulted not only in stabilising, but also in reducing nitrate concentrations in ground water.

In Estonia, the evaluators in order to assess the impact of AEMs (actions of environmentally friendly management and organic farming) conducted studies setting an additional indicator 'concentration of plant nutrients in drainage water'. The use of nutritional elements, pesticides load and plant nutritional elements concentration in drainage water analysed. The monitoring data, combined with interviews and focus groups, reveal a positive effect on water quality, mainly due to the restrictions of fertilisers use.

In Veneto region the assessment of AEMs measured by indicators coming from evaluations questions of previous programming period such as:

- reduction of agricultural inputs per ha thanks to agreements,
- nitrogen balance in kg/ha/year,
- share of area not irrigated thanks to agreement (ha),
    - of which due to direct limitation of irrigated area and
    - of which due to changed crop pattern/vegetation or farm practices

using information from FADN-REA database, could be considered as a counterfactual approach. The GLEAMS2 model that used is considered as the most efficient for estimating leaching of chemical fertilisers and pesticides (Siimes & Kämäri, 2003).

In Emilia Romagna and Veneto regions, the weaknesses of the assessments of AEMs measured by the gross nitrogen and phosphorus load (kg/ha), as well as the variation load of pesticides (kg/ha) are based on the limited extent of the area supported under AEMs (a total of less than 10% of the regional UAA). Therefore, the estimate of areas actually affected by AEMs provides only an indication of the effectiveness of requirements with respect to water quality objectives.

In Puglia region, the impact of LFA payments and AEMs is based on the result indicator (area under effective management contributing to water quality improvement). It is mentioned that it is an additional indicator in order to estimate the effect of principal fertiliser and pesticide use that cause water pollution in the territory, using data from agricultural census and regional databases. The index LIM (Level of pollution Macrodescriptors) has been used to assess the impact, without providing further information.

In France, it is reported that the impact of AEMs using the indicator 'excess in nitrogen use (kg/ha)' can be measured at different levels based on cropping and production systems. The analysis can be conducted both at the farm and national level of catchment basins or watersheds, even across large basins/aquifers observatory annual nitrate flux. Its measurement refers to the establishment of a network of cultivated land, regarding annual reference values of potentially leachable nitrogen or using leftovers input

(Vandenberghe & Marcoen, 2004) or on the basis of another robust, but generally more expensive, methodology (Benoit M. Vittel). Finally, its measurement may also be performed on the basis of a simplified model of nitrogen flow, based on local agricultural practices, like the STICS model, used to predict nitrate content in root by territory and thereby constituting a very good decision support method for the implementation of a tool. These same models can also represent nitrogen flow, simulating the effects of changes in practices related to the RDP. However, there are certain limitations to the use of this model mainly a) in the acquisition of information and b) the simplifications needed in order to manage the methodological tools. Also, it is noted that the method used in the case of indicator 'pollution by nitrates and pesticides (pollution index)' for estimating the impact of AEMs is poor and lacks of specific information about pesticide use in crop production.

In Poland, it is reported that LFA payments have a positive impact on water quality, since all indicators (FBI, patch density index, share of abandoned land in UAA, share of grain in arable land) presented higher values compared to non-beneficiaries. Moreover the AEMs seem to have contributed to effective land management in river basin areas, since livestock density is less than 1.5 per ha of UAA. The assessment method is based on desk analysis with statistical data and expert judgement.

It should be noted that in the Netherlands, water quality improvement is not defined as one of the main objectives of the AEMs; thus its impact on this public good cannot be measured. However the estimation of AEMs, through the current management contracts/agreements, which reduce the agri-chemicals and fertiliser use, will contribute to improvement of water quality. The assessment is based on output indicator (area under AEMs), expert interviews and literature research.

In Andalucia, the evaluators, in order to assess the impact of the RD measures on water quality, calculate the supported area that contribute to water quality (actions of green cover use and less soil tillage, reduced use of agro-chemicals and machinery/equipment) as a function of the proportion of the financial uptake. The level of uncertainty is high; thus the specific method cannot be considered robust.

In England, the assessment of AEMs on water quality is reported alongside soil, as they were considered a coupled system. The lack of relevant data above the field and plot level is mentioned, particularly at the catchment levels that are the most relevant ones for this

measure. Hence the estimation is based on interpretation of results and output indicators of CMEF and Natural England combined with further data derived from secondary literature analysis. Local, regional contingencies and targets are also accounted for, including effects of several protection/management options, such as buffer strips, field corner management, arable reversion, beetle banks, cover crops, tillage and tramline alterations.

As in the case of axis 1, in Lithuania concerning the impact of Natura 2000 payments, AEMs, none of the indicators are suitable for assessing the impact on water quality. Given that calculations at national level do not reflect either spatial differences or temporal changes, additional measurements are required.

4.4.2.2 Forest-environmental measures

In Austria, it is reported that the estimation of forest-environmental measures (afforestation, forest-environment payments, restoration and preventive actions) using the GNB indicator is not possible but a positive effect on water quality is assumed. Assessment is based on output indicator (supported area contributing to improve water quality).

In England the assessment of agroforestry measures is based on literature review.

In Poland, the assessment of afforestation measures is based on output indicators (supported area, number of beneficiaries, relationship between the index adjustment of agricultural soils (WWRPP) and the rate of preferential exclusion of soils due to afforestation (TI), carbon sequestration through forest, etc.). Hence these indicators can estimate only indirect impact on water quality. However, it is noted that afforestation has a measurable impact on water quality expressed by the significant reduction in nitrogen load reaching the surface. The impact of restoration and preventive actions on water quality cannot be assessed due to lack of data.

In Scotland, due to incomplete monitoring data, only qualitative assessments based on survey findings are reported. It is reported that water quality is not a direct objective of measure 227 (non-productive investments) although it could support the specific public good.

In Lithuania, once more, none of the indicators are considered suitable for assessing the impact of forest-environmental measures on water quality. Given that calculations at national level do not reflect either spatial differences or temporal changes, additional measurements are required.

4.4.3 Axis 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'

Only Poland reported assessments of the impact of measures under Axis 3. In the Polish review, the indirect impact of basic services (321) is assessed by the total volume of investments and the number of supported actions.

4.4.4 Axis 4 'Leader'

Only in the Finnish review an assessment of measures under Axis 4 can be found. The estimations of the indirect impact of competitiveness and quality of life/diversification measures are based on expert assessments about the influence of Leader projects on water emissions.

4.4.5 Programme level

In Austria, the assessment of the mid-term programme level is based on the changes in nutrient balances (nitrate and phosphate) using the OECD method and the results of a Eurostat project. Water quality indicators, as application of mineral fertiliser, land-use, livestock density, and nitrate balances, showed mainly positive trends.

In Baden-Württemberg, a qualitative assessment in the mid term is based on horizontal evaluation question. Programme impacts are discussed and differentiated among relevant measures.

The assessments of SEA at programme level in Puglia region are based on IRENA indicators (nitrogen excess in the field and concentration of nitrates and pesticides in surface water), using the dynamics of sold nitrogenous products in Puglia and type of crops on CORINE Land Cover basis. The first indicator was used in order to define the situation of deficit or surplus of nutrients per unit of cultivated area. The second one was intended to give an overview of the state of nitrates and pesticides in surface and ground water in European countries, between 1992 and 2001.

4.5 Soil Quality

Soil quality and health are not covered by the impact indicators of CMEF; however four indicators related to soil are mentioned:

1. 'area at risk of soil erosion', a baseline indicator which estimates the loss of soil in ton/ha/year,

2. 'area under organic farming', a baseline indicator measured by the ha of UAA under organic farming,

3. 'protective forests concerning primarily soil and water and other ecosystem functions', a baseline indicator measured by the Forest and Other Wooded Land (FOWL) area managed primarily soil and water protection in %,

4. 'area under successful land management contributing to soil quality', a result indicator measured by the number of ha under successful completion of land management actions contributing to improvement of soil quality.

Analysis of the review reports resulted to 143 cases where an indicator was used for assessing the impact of RD measures on soil quality. Out of all the cases examined, 24 refer to measures under Axis 1, 110 to Axis 2, two to Axis 3, and seven to programme level.

At the present time, given that CMEF does not provide an impact indicator for soil quality, some member states/regions based their impact assessment of RD measures on the above mentioned CMEF indicators or other additional ones. Other member states/regions provide mixed or only qualitative assessments derived from interviews and beneficiaries' surveys or expert judgments (e.g. Scotland, Netherlands, England, Poland etc.). In Greece, Cyprus, Finland and Latvia no indicator for soil quality was identified.

In the cases examined, the assessments on soil quality are based on the risk erosion indicator (in ton/ha/year), extent of agricultural land (ha) under the relevant measure, estimates of the carbon factor, organic matter content or plant nutrients. Half of the cases examined are based on other baseline, output and additional indicators, related or unrelated to soil quality, as well as beneficiaries' surveys and expert judgements.

In the majority of indicators, causal chains linking indicator-measure-soil quality are reported, especially in the measures under Axis 2 (AEMs and forest-environmental measures), where some indicators are strongly related to soil quality (e.g. soil erosion, humus and nutrient contents).

4.5.1 Axis 1 'Improving the Competitiveness of the Agricultural and Forestry Sector'

In Baden Württemberg, the farm modernisation scheme's impact on soil quality was measured by the estimation of carbon factor for soil erosion, calculating and comparing the crop management factor and soil quality equation of beneficiaries' farms with a hypothetical control group, using IACS data. This is an example of a counterfactual approach. Although the indicator is based on a robust causal relationship, further information about the situation of the soil is required. In order to calculate the actual prevented soil loss, information about the stages of erosion needs to be included in the submitted IACS data.

In Bulgaria, the assessments of measures under Axis 1 are mainly based on survey findings. Also, all Polish indicators of RD measures under Axis 1 could only estimate indirect impact on soil quality.

4.5.2 Axis 2 'Improving the Environment and the Countryside through Land Management'

4.5.2.1 LFA and Natura payments

In Bulgaria, the assessment of LFA payments are based on output indicators and beneficiaries' survey.

In Poland, it is reported that LFA payments have a positive impact on soil quality, since all indicators (i.e. stocking density expressed as LU/ha of UAA, stocking density granivorous livestock LU/ha UAA, modelling equation for universal soil loss in kg/ha/year) presented higher values compared to non-beneficiaries. All the above indicators have been measured by the number of beneficiaries and the amount of payments realised.

In Estonia, the impact of Natura 2000 payments on soil quality, is estimated by the 'changes in plant nutrient balance' using monitoring sample data. It is reported that there

is no essential impact; however evaluators assume that the measure contributes to the preservation of water and soil quality, due to the fertiliser restrictions in the protected areas.

In the Lithuanian mid-term evaluation review, indicators for estimating impact on soil quality are not explicitly reported. Nonetheless, effects of the RD measures on soil and water quality are jointly mentioned. The indicators 'increased number of areas where use of pesticides and mineral fertilisers is limited' and 'reduced number of territories at risk of soil erosion' were based on the simple method, which was considered inexpensive, that aggregates the area devoted either to limited pesticide and fertiliser use (restrictions or no use) or to control soil erosion (restrictions of ploughing). It is reported that the first indicator is easily measurable and can estimate the indirect impact of limited input use, while the second one is unsuitable in Natura 2000 areas, as soil erosion is not expected to happen in these specific sites due to the environmental requirements that restrict ploughing of the soil. Similar comments have been made when the baseline indicator 'area at risk of soil erosion' was used.

In Baden Württemberg, for the assessment of Natura 2000 payments, (positive impact on soil quality mainly through the promotion of extensification), only result indicators are used, due to lack of available data. However, a counterfactual approach is recommended for the ex post evaluation document using FFH-monitoring data and comparative field mapping (with - without comparison).

In the Netherlands, the assessment of natural payments in areas other than mountain areas (212) is mainly based on survey findings among beneficiaries and interviews with experts. The output and result indicators (number of management contracts and area of maintained landscape) are also used in order to estimate the success of the measure.

In Andalucia, the evaluators, in order to assess the impact of the LFA payments on soil quality, calculated the supported area that contribute to soil quality (actions of green cover use and less soil tillage, reduced use of agro-chemicals and machinery/equipment) as a function of the proportion of the financial uptake and the programmed target area. The level of uncertainty is high; thus the specific method cannot be considered robust. (The same indicator estimates and the impact of AEMs).

4.5.2.2 Agri-environmental measures

In the English mid-term evaluation document it is reported that the non-productive investments (measure 216) are strongly linked to AEMs; thus these measures are estimated together. Water and soil are considered as a interconnected system. Therefore soil quality can be addressed through estimating the impact on water quality and effects of runoff in arable and grassland systems using output and result indicators linked to water quality and the CMEF soil indicators (area at risk of soil erosion and UAA under organic farming). Since monitoring field data are not available, the assessment is based on secondary evidence derived from literature review analysis. Since the indicators need a strong and ample network for monitoring results at the plot/farm level, the upscaling of results is considered difficult and costly.

In Austria, the evaluators propose an additional indicator measured by the increase of humus content, for the assessment of AEMs on soil quality. For the ex-post evaluation, the results of the impacts of sub-measures on soil quality parameters and erosion protection should be verified further and extended to other regions in Austria (until now only regional testing in the Steiermark and Kärnten). Moreover, soil acidification and soil compaction, reported as increasing in certain regions, should be analysed more in detail. The impact of individual actions such as organic farming, environmentally friendly land use of arable land and grassland, integrated production of potatoes, beet, vegetables and strawberries, mulching and direct seeding, catch crops on arable land, erosion protection on arable land, reduced or zero tillage, assessed by the extent of promoted areas, taking into account the soil pH, phosphorus and humus content.

In Baden Württemberg, since actual data collection and accompanying studies about the effectiveness of AEMs are not available, the assessment of the impact of AEMs is based on ha of promoted area, funding data, literature analysis and expert survey.

In Lower Saxony, the impact of specific agri-environmental actions, such as organic farming, no-till farming and catch crops, is assessed by the same indicator proposed in Baden Württemberg for the farm modernization impact (see p. 91 Axis 1).

In another German region, in Thüringen, an additional indicator that calculates the annual soil loss (in t/ha) is derived from literature analysis and considered a counterfactual approach. However there is no real causality as this is solely based on the assumption that areas under AEMs have a reduced soil loss rate.

In Estonia, the evaluators measured the impact of organic farming and environmentally friendly management by 'the changes in soil fertility' taking into account soil pH, content of soil nutrients (phosphorus and potassium) and organic matter. Research evidence suggested that, although the impact of these agri-environmental actions on soil quality is noticeable, valid conclusions cannot be drawn, since a) changes in soil fertility can be detected after many years and b) soil conditions vary within the different sample regions. A soil loss indicator is proposed, using GIS analysis and a Universal Soil Loss Equation model, in order to determine the areas at risk of soil erosion.

As mentioned above, in the Lithuanian evaluation documents, indicators for soil quality are not explicitly mentioned. The indicators 'increased number of areas where use of pesticides and mineral fertilisers is limited' and 'reduced number of territories at risk of soil erosion' are based on the simple method that aggregates the ha of the area under the measures. It is argued that this method is an inexpensive way for assessing the indirectly impact of actions aimed at reducing farm input and ploughing on soil and water quality.

In France, the impact of AEMs is estimated by the ha of UAA under friendly environmental farming systems, such as organic farming, integrated production and pasture with less than 2 LU/ha as well as the actions aimed at preventing/reducing soil erosion due to water, wind and tillage. Moreover, in the ex post evaluation document (2000-2006), the assessment of soil quality is based on indicators concerning the sensitivity to erosion and organic matter content. About the risk of erosion, a database established by the GIS Soil, in order to identify erosion hazard areas but not to measure the risk evolution of the situation (erosion risk). The organic matter content is also followed by the GIS Soil over different periods of time.

In certain Italian regions (Puglia and Veneto), the assessment of the AEMs impact is based on ha of areas under farming systems either aimed at reducing/preventing leeching, run-off or sedimentation of farm inputs or aimed at preventing/reducing soil loss. On the other hand, in the above regions and Emilia Romagna, there are also indicators that measure the organic carbon content in the surface layer (0-30 cm), the maintenance/increase of organic matter content, or the risk of soil erosion (these indicators originating from CMEF and IRENA), using mainly IACS data, CORINE Land Cover, regional land use maps or erosion risk maps.

It should be mentioned that in the Netherlands, the activities under this measure do not include as one of their main objectives to improve soil quality; thus their impact has not

been actually measured. However, the current management contracts that reduce agri-chemicals and fertiliser are expected to contribute to improvement of soil quality. Therefore the estimation of the impact of AEMs is based on monitoring data (ha of agricultural land under AEMs), expert interviews and literature research. Also, in Scotland there no specific, direct actions targeted at soil quality.

In Poland it is reported that the AEMs contribute to improving soil quality, mainly due to the extensive farming systems and the limited use of pesticides and fertilisers per ha UAA.

4.5.2.3 Forest-environmental measures

In Austria, the impact of afforestation and forest-environment payments is assessed by an additional indicator that calculates the risk of soil erosion. The assessment is mainly based on the extent of the area under the measures. Given that the application of these measures was low, their impact is expected to be insignificant. The application of the measure about forest restoration and preventive actions is considered to be more successful in terms of acceptance by land users. Its impact is estimated by output and result indicators.

In England the impact estimation of forest-environmental measures is based on interpretation from indirectly related result and output indicators, secondary literature and scientific reporting, with no linkages between these indicators and soil quality, established. Some additional information is hereby provided on the effects of protected areas (Sites of Special Scientific Interests, Natura 2000 & Native Woodland) over soil quality.

Also, in Scotland it is mentioned that, although the measure 227 (non-productive investments in forest areas) could support the specific public good, soil quality does not constitute a direct objective.

In Poland, it is reported that afforestation measures (221 and 223) have a positive impact on soil quality. Forests areas act as a natural filter for pollutants and are also preventing wind and water cause soil erosion.

4.5.3 Axis 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'

In the Polish report, the indirect impact of basic services is assessed by the total volume of investments and the number of supported actions. It is mentioned that investments related to sewage and waste management may contribute to the protection of soil health.

4.5.4 Programme level

In Austria, the programme impact on soil quality in the ex post evaluation document is based on the budget projected for the measures that contribute to improvement of soil quality.

In Puglia, the assessment of the programme impact in the SEA is based on certain IRENA indicators namely: a. organic carbon content in the surface layer (0-30 cm) and b. annual, water caused, soil erosion risk. High organic carbon content, limits erosion and at the same time shows enhanced ability of CO_2 absorption. Soils with organic content of between 1% and 10% can be considered of high agricultural value, while soils with contents less than 1% are at risk of desertification. The estimation for Puglia soils is about 1.17%, which is considered good. Regarding the soil erosion indicator, any soil loss of more than 1ton/ha/year can be considered as irreversible within a period of 50-100 years. The value for Puglia is 0.72 t/ha/year, which is considered low, mainly due to the climatic conditions and its morphology.

4.6 Landscape

At the present time the CMEF does not include specific indicators for assessing the effects of RD measures on landscape. Therefore the impact of RD measures on landscape is estimated by various indicators according to the type of the supported action.

Analysis of the review reports revealed that in some member states/regions no indicator is identified for assessing the impact of the relevant RD measures on this public good (Cyprus, Greece, Emilia Romagna, Andalucia, Lower Saxony, Finland). In Greek and Cypriot mid-term evaluation documents, landscape and its characteristics are addressed through evaluation questions and based on evaluators' estimations and judgements. They

state that since measures or actions promote explicitly maintenance of traditional cultivation practices and preserve traditional trees and bushes, thus these actions have contributed to the improvement of rural landscape and its features. Also, in Finland the effects of RD measures on landscape are based on expert assessments and farmers' enquiry.

Analysis of the reports resulted in 135 cases where an indicator was used for assessing the impact of RD measures on landscape. Out of all these cases 11 refer to Axis 1, 85 to Axis 2, 28 to Axis 3, seven to Axis 4, and four to programme level. About a quarter of the cases examined estimate the impact of the RD measures combining the monitoring data with survey results and literature analysis. Moreover almost 15% of the cases are based on IACS database and national statistics on agricultural production.

All assessments of measures under Axis 1 are based on output indicators, where in some cases the monitoring data are combined with survey results. Similar, the estimation of effects of measures under Axis 2 on landscape are mainly based on budgeted expenses, output indicators (ha of agricultural land, number of beneficiaries, number of supported actions), alongside beneficiaries' surveys, expert judgements and literature review when data are not adequate for assessing the effect. Moreover, in some cases different indicators have been used, such as the livestock density per ha, willingness to pay, carbon sequestration though afforestation, employment created due to supported actions etc. Only in fewer than 10 cases is the indicator targeted at specific landscape features (Patch Density Index (PDI), flora and fauna species, habitats, hedgerows, cultural historical elements) or visual complexity resulting from different land uses that contribute to a higher landscape diversity. The effect of measures under Axis 3 on landscape is mainly assessed by measuring the supported actions, amount of expenditure realised or amount of value created in these areas which are thought of as enhancing the attractiveness of rural areas.

As a general rule one could state that causal chains among measure, landscape and indicator lack of robust linkage.

4.6.1 Axis 1 'Improving the Competitiveness of the Agricultural and Forestry Sector'

Polish and Bulgarian indicators could only assess the indirect impact on landscape through the wider environmental impact of measures under Axis 1.

In the Netherlands, the impact assessment of infrastructure related to the development and adaptation of agriculture and forestry (measure 125) is estimated using output indicators (ha of area of land affected by the measure and added value according to the type of land use and operation). Based on the evaluation answers, the environmental impact of this measure on public goods is not mentioned. Although impact can be expected, the objectives of this measure do not include the benefits to any public goods.

4.6.2 Axis 2 'Improving the Environment and the Countryside through Land Management'

4.6.2.1 LFA and Natura payments-non productive investments

In the Austrian mid-term evaluation document, the impact of LFA payments on landscape is assessed using the share of area under organic farming. It is reported that cultural landscapes are strongly influenced by agricultural land use; therefore livestock-based land use systems and forage area can contribute to the maintenance of landscape. Moreover, the livestock unit per ha of forage area in different regions was compared to the baseline (2006) and the national average. However, according to the review, there is no real causality as this is solely based on the assumption that the low livestock density/ha have positive impacts on the maintenance of landscape. The actual impact is not measured.

In Poland, the assessment of LFA payments effects on landscape is based on number of beneficiaries, ha of supported area, share of permanent grasslands per ha of UAA, Patch Density Index (PDI) and share of ecological compensation areas in UAA. According to the evaluators, in areas under these measures all indicators presented higher values, in relation to areas without support.

There is no landscape indicator described, as such, in the Lithuanian mid-term evaluation document. However, according to the information provided, a landscape indicator 'preservation of traditional landscape features' is proposed which is very similar to the HNV indicator and in many cases there is overlap between them. The proposed indicator is based on the prerequisite that schemes that determine particular requirements from environmental point of view are important also for the preservation of landscape.

However the term 'landscape' can be considered broader e.g. including also areas that are not of high nature value. The simple method of calculating the areas under relevant environmental requirements for landscape protection is used. Also, it is mentioned that, the comparison of areas where these environmental requirements are not applied is considered important for assessing the programme impact. Since in the previous programming period no environmental impact indicators were used, the assessment of the LFA payments was based on a survey among measure beneficiaries.

In the Netherlands, assessment of payments to farmers in areas with handicaps, other than mountain areas is based on a survey among beneficiaries and interviews with experts, as well as output and result indicators (number of management contracts, area of maintained landscape).

Also, in Scotland, given that quantitative data are not available for environmental indicators, there is insufficient evidence to assess the impact on landscape; hence a subjective assessment of beneficiaries about landscape features is only reported.

4.6.2.2 Agri-environmental measures

In Bulgaria, the impact of AEMs on landscape is estimated using output indicators and survey results. Also, in England the assessment is mainly based on literature analysis (Primdahl, 2010; Boatman et al, 2010 and ADAS, 2000) and survey results (English Heritage, 2009) with insufficient linkages between landscape and measure impact.

In the Netherlands, the impact of AEMs is estimated using the area under agri-environmental support, as well as expert interviews and literature research. Nevertheless, it is stated that it is too early to assess the impact since no data are available.

Likewise, in Scotland, given that quantitative data are not available for environmental indicators, there is insufficient evidence to assess the impact on landscape; hence a subjective assessment of beneficiaries about landscape features is only reported.

In Poland, the effect of AEMs are estimated by the number of beneficiaries, area covered by measure, stocking density of traditional breed livestock in LU/ha, land covered by organic farming and the PDI. The assessment method is based on desk analysis of statistical data of beneficiaries and non-beneficiaries, survey and expert judgement.

As mentioned above, in the context of the Lithuanian mid-term evaluation, there are no clear differences between the proposed landscape indicator 'preservation of traditional landscape features' and the HNV indicator, with the exception that the landscape indicator does not cover areas under forestry restoration actions and non-productive investments (measures 226 and 227 respectively). The impact assessment of the AEMs is based on the simple method that aggregates the area under actions related to landscape protection.

In Estonia, the evaluators propose the indicators 'changes in the structure of the landscape in terms of point, linear- and areal elements' and 'changes in the general upkeep of the farms' in order to assess the extent at which the actions of organic farming and environmentally friendly management have affected the visual attractiveness, coherence, cultural characteristics and homogeneity/diversity of agricultural land. Landscape elements are indicated on a field map and farms are identified by photos and descriptions. The qualitative impact of the supported actions will be estimated by comparing the changes between the first and the last year of the programme implementation.

In Hungarian mid-term evaluation document, the evaluators preferred to use botanical data instead of using common bird monitoring data for assessing the impact on landscape measuring the changes of the naturalness of the habitat patches related to AEMs. The indicator is aimed at finding correlation between the naturalness of different habitat patches inside the formerly designated landscape districts and parcels contracted under AE support. A survey carried out, covering the whole country, in order to evaluate the percentage of the survey plots (MÉTA hexagons) including different natural/semi natural habitats and AE contracted parcels related to the total number of survey plots per landscape district concerned. The data used have been IACS contracted parcels and the spatial database of habitats in Hungary (MÉTA, http://www.novenyzetiterkep.hu/?q=en/english/node/55). The estimation has a countrywide approach and based on existing data sets. However, given that the botanical data represents a 'snapshot' of the habitats, before and after comparisons and trend analyses cannot be carried out.

In Austria, the impact assessment of the AEMs is based on the maintenance of a diverse landscape and its features. A study was conducted comparing the changes in landscape

features (e.g. tree rows, hedgerows) that are visualised through orthophotos between 1994 and 2008 in 5 regions of Austria. Changes in landscape are assessed qualitatively with the participation data of AEMs in addition to farmers' interview, regarding their attitude towards AEMs and their impact on landscape. However the specific method could not assess the individual agri-environmental sub-measures.

In Rheinland-Pfalz, the assessment of the sub-measures related to grassland is based on the characteristics of the landscape including a counterfactual approach. The estimation method is based on the landscape indicator, which sums the distance effect (the optic structure of landscape, e.g. existence of trees, hedgerows etc.) and close-up effect (grassland, blossoms etc.) using the results of a floristic and faunistic survey of 470 selected areas covering participants and non-participants under AEMs (frida database DLR RNH, rural service center of Rheinhessen-Nahe-Hunsrück). Areas under grassland-related AEMs have a higher landscape-index than areas without AE support, except for measure 'conversion of arable land in grassland'. Also, hay meadows and species-rich grassland are considered as sites with higher value of nature protection. However there is no real causality as these are based on assumptions.

In Baden Württemberg, the contractual nature conservation measures (LPR) are considered as the most important measures and have positive effects on the landscape, according to the results of a stakeholders' survey that was undertaken in the frame of ex post evaluation document (2000-2006). Its assessment is based on area indicators (supported area in ha) using IACS data. Also, the EC indicator 'farmland under agreement contributing to perceptive/cognitive, in particular visual, differentiation (homogeneity/diversity) in the landscape' was used in order to estimate the impact of the AEMs (MEKA). The indicator takes into account the visual complexity, environmental features such as flora, fauna or habitats and man-made objects (hedgerows, ditches, tracks) resulting or introduced/preserved by the supported actions. The ex post evaluation report only quantified area indicators (supported area) and the potential AEMs impacts on landscape are qualified. Maintenance of coherent an differentiated landscapes through the measure 'maintenance of cultural landscapes' promoting organic farming, crop rotation and maintenance of biotopes. Also, support for vineyards on steep slopes and for dry stone walls plays a key role.

The same indicator was also used in the French and Italian evaluation documents (ex-post 2000-2006). The assessment method is based on the Shannon Index, which is one of the indices used to determine the complexity of a community and the degree at which the diversity of species present in a given area, taking into account the number of species and relative abundances. Higher value of Shannon Index indicates greater biodiversity and therefore also greater perceptual/cognitive differentiation in the landscape. However this index can give only an idea of the variability in terms of landscape area, and not a clear idea of the landscape diversity.

In their recent evaluation documents different indicators are used. In French the on-going evaluation document mentions that the impact of AEMs is estimated measuring the effect of abandonment on the landscape, using data from national statistics on agricultural production and agri-environmental system commitments. Also, in the Italian mid-term evaluation documents, the impact of AEMs is estimated by a contingent valuation method, that of 'Willingness to pay', for conservation of components and landscape attributes. The assessment method is based on discrete choice experiment and data analysed using a Random Parameter Logit Model.

4.6.2.3 Forest-environmental measures

In the Polish mid-term evaluation, the estimation of environmental impacts for afforestation measures is mainly based on output indicators alongside the index of carbon sequestration and the relationship between the index adjustment of agricultural soils (WWRPP) and the rate of preferential exclusion of soils due to afforestation (TI). The assessment method is based on desk analysis and beneficiaries' survey. It is reported that there is significant impact on landscape and, due to afforestation, the attractiveness of rural areas has been increased. On the other hand, given the early implementation stage of the measure for forest prevention and restoration actions, the impact could not be measured.

In Austria, the assessment of the forest environmental measures is based on the amount budgeted and area under each measure. Due to the low application rate of the afforestation measure and forest-environment payments, their impact is expected to be marginal.

In Baden Württemberg, the impact of forest environmental payments on landscape is assumed to be marginal, according to an expert survey.

In the Netherlands, the assessment of the afforestation measure is based on the CMEF evaluation questions, using beneficiaries' survey and expert interviews in order to analyse the management agreements.

In England, the impact assessment of the forest-environmental measures provides insufficient information about the landscape. Effects of the afforestation measure targeted on the restoration of industrial land, enhance landscape and public access to valuable landscape are just mentioned but no conclusions are reported. Moreover, some additional information is provided about the effects of the inclusion in the protected areas status (Sites of Special Scientific Interests, Natura 2000 & Native Woodland) on landscape features.

In Scotland, the impact assessment is mainly based on survey results, since the monitoring data of the output indicators (area supported under the measures) are incomplete.

In the ex post evaluation document for Veneto region, the impact assessment of afforestation measure using the indicator 'additional attractive/valuable areas or sites due to assistance' was based on the monetary aid. A positive effect on the landscape view was mentioned. In the specific region almost 80% of the afforestation of a permanent arboriculture for wood was established in lowland areas where the landscape is undergoing a process of evolution due the strong anthropogenic pressures especially intensification of agriculture resulting in irrational land use. In this context, the conversion of arable land to forest assumes a differentiator for visual and aesthetic value more than in marginal, hills and mountains areas, where the forest vegetation is the dominant land use. Thus a specific evaluation of the visual impact in terms of landscape was considered as important for the future application of the measure. The same indicator was also used in the Puglia region.

4.6.3 Axis 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'

In Poland, the impact assessment of the measures concerning renewal of villages and conservation of rural heritage, are based on, CMEF output indicators related to the measure (number of actions supported and total volume of investments), which could only provide a rough estimation of the indirect impact on landscape. It is mentioned that

more qualitative assessments and logical assumptions should be considered for estimating the effects on landscape.

In Austria, the assessment of the measures under this axis (provision of basic services, village renewal and conservation of the rural heritage) taking into account the maintenance of valuable landscape elements (e.g. mountain pastures, dry grassland, pollarded willows, old trees) is mainly based on the budget and ha of the supported actions. The sub-measures a) nature protection and b) national parks of measure 323 focus on nature conservation. Therefore their assessments of the impact on landscape are considered difficult. Increase of attractivity and awareness raising measures are expected to have positive impacts in the mid and long term.

During the previous programming period 2000-2006, the French evaluation documents mentioned that a landscape strategy is poorly defined and the issue of landscape has not received the appropriate attention, neither any assessment methods nor indicators have been studied sufficiently. However some contribution to the maintenance of mountain landscapes, as well as to diversity of landscapes and maintaining the identity of LFAs was recognised and hence a positive effect was attributed to relevant measures. In the ex ante evaluation for the 2007-2013 period, the impact of measures under this axis is estimated by the indicator 'net value creation in rural areas on the basis of Purchase Power Parity'. It is mentioned that the creation of micro-enterprises can be measured at regional and sub-regional level and compared with the total institutions on the territory or the average rate of creation. The 'basic services' measure (321) clearly shows an encouragement of transactions with a positive effect on certain environmental dimensions as in waste management, renewable energy and better management of the environment and promotion of biomass at the regional level. For the measure of 'village renewal and development' (322) the indicator specifies the funded projects, number of villages and financial investments, material (work, catering e.g.) as well as intangible (feasibility studies). Also, the effects of village renewal and development was estimated by 'measuring the attractiveness of the area from the economic residential and tourist point of view', linking the monetary aid and the impact on landscape, showed a positive impact of the afforestation on landscape view. The limitation of this indicator is the difficulty in connecting with the direct impact of the programme. However, it indicates the attractiveness of regions. It has the advantage of being an easily mobilised and reliable

indicator to the INSEE (pay basis for SIRENE SITADEL)[2]. The specific indicator can be used at the regional (or sub-regional) and national levels. It will be interesting to compare the territories and regions with structural similarities and thus highlight the actions under the programme especially if they coincide with other planning policies.

In England, the assessment of the measure conservation and upgrading of the rural heritage is indirectly addressed through output indicators, such as the number of natural and cultural heritage actions supported.

In the Netherlands, the measure of diversification into non-agricultural activities and encouragement of tourism is not evaluated as no projects have been completed under these measures. Since the non-agricultural activity is related to nature conservation (recreation and forestry), this is seen as relevant to landscape. However the SEA has reported that these measures are not expected to have any impact on public goods. The proposed indicators are based on number of supported activities and created tourism/recreational infrastructure (km). Likewise, the impact of measure conservation and upgrading the rural heritage using the output indicators (ha of created natural areas and km of ecological network connections) is not assessed, since no project was conducted under Natura 2000 sites.

Moreover, the Scottish assessment of measure conservation and upgrading the rural heritage (323) measuring by the output indicator (number of rural heritage actions supported) is mainly based on survey results.[3]

4.6.4 Axis 4 'Leader'

In the Polish mid-term evaluation document, the impact of projects under the Local Development Strategy and contribution of Local Action Groups (LAGs) on landscape is measured by output related to the measure indicators. However given the indirect influence to this measure on landscape, impact is not reported. Although the positive effect of LAGs, through the mobilisation/encouragement of environmental actions, is mentioned, a more qualitative approach is recommended for landscape assessments.

[2] INSEE is the National Institute for Statistic and Economic studies, and the SIRENE register provides regional statistics by sector.
[3] According to RD evaluation network documents a landscape indicator was suggested for Scotland: Safeguarding the sensitive aspects of landscape character.

4.6.5 Programme level

In Austria the assessment of the impact at programme level in the ex post evaluation document is mainly based on the budget of relevant support measures (in Million Euros) and their share of the total programme budget (in %). It is stated that different measures have positive, direct or indirect, impact on landscape. However the main impact is expected through the AEMs, LFA payments and water protection measures.

The assessment of SEA at programme level in Veneto is based on additional regional indicators measuring the degree of distribution of forestry in lowlands, hills and mountains, as well as the density (ratio) of the communications infrastructure (roads and railways) and the constructions (residential and non-residential) presented in Natura 2000 sites. No further information is provided.

4.7 Animal Welfare

At the present time the CMEF does not include specific indicator for assessing the impact of RD measures on animal welfare. This could be a plausible explanation for the fact that in some member states/regions the effects of RD measures on animal welfare are not estimated.

Analysis of the review reports revealed that in Andalucia, Estonia, Cyprus, Greece, Finland, Lower Saxony, North Rhine Westphalia and Mecklenburg Western Pomerania no indicator is identified for assessing the impact on animal welfare.

Analysis of the reports resulted to 46 cases where an indicator was used for assessing the impact of RD measures on animal welfare. Out of all these cases, 28 are referring to Axis 1, 13 to Axis 2 and five to programme level. Also it should be noted that the impact of animal welfare payments have been reported in these assessments only four times.

The majority of the assessments are based on monitoring data as well as on common baseline and output indicators. They are usually combined with survey results. In about a quarter of the cases examined, the data used are derived from IACS, FADN/RICA or national/regional agricultural databases. Only in few cases, causal chains among measure, public good and indicator seem to have strong linkages.

4.7.1 Axis 1 'Improving the Competitiveness of the Agricultural and Forestry Sector'

In the Polish evaluation documents, it is mentioned that the impact assessment of measures under Axis 1 based on output and result indicators could only estimate the indirect impact on animal welfare as the data used are too general to capture the effect on animal welfare.

Also, in Bulgaria, the effects on animal welfare are indirectly assessed by output and result indicators and surveys.

In England, the measure of vocational training is also indirectly assessed through additional output indicators related to financial support. Some weak information about livestock-related regional entities is derived from pertinent secondary literature and beneficiaries' survey, but no concrete conclusions are reported. The impact of farm modernisation on animal welfare was also quite unclear.

In Austria, as well as in Baden Württemberg, during the ex post evaluation for 2000-2006, the assessment of how animal welfare requirements defined in the relevant measures payments went beyond already existing animal welfare laws was initially planned as the first main task of the evaluation. It could not be performed, however, as at that time no relevant national law was in place for dairy cattle and fattening pigs. Therefore a large set of ethological indicators, differentiated by functions i.e. social behaviour, movement, rest and sleep, food intake, excretion, reproduction, comfort and exploration and animal species i.e. cattle and pigs, assessed the impact of farm modernisation measure.

An indicator based on a national assessment framework for husbandry systems was developed by the Association for Technology and Structures in Agriculture (KTBL) and could be considered incorporating a counterfactual approach. In the ex-post evaluation of measure 121 in Baden Württemberg the assessment of animal welfare benefits was based on analysis of changes in 139 husbandry systems before and after support. Animal welfare changes or different levels of animal welfare can be observed and measured through behavioural indicators. Moreover, different husbandry systems affect animal behaviour and allow animals to show different extents of natural behaviour patterns which can be measured through ethological indicators, which are widely accepted as a sensitive measure of animal welfare. Data to assess the husbandry systems and the

selected indicators can be relatively easily collated through farmer surveys (in comparison to direct measurements on the animals). Information on the husbandry systems (e.g. type of barn, feeding and access to outdoor grazing) can be used to draw conclusions on the impact of the measure on animal welfare and behaviour. Recommendations for future applications include farm visits and the development of outcome-based indicators to assess animal welfare impacts.

In Baden Württemberg, during the current evaluation period, the indicator type of animal husbandry system after support taking into account the share of particularly livestock friendly husbandry systems and the conversion from 'stanchion barns' to 'free stall barn' was only reported in an overview table on target values of the farm modernisation measure (121). However, changes in the indicator and impacts on animal welfare have not been assessed, and animal welfare aspects were only referred to in the synopsis of the assessment.

In the Veneto region, the ex post evaluation for the 2000-2006 proposed the indicator 'share of assisted products sold with quality label according to the origin of the quality scheme -EU, national or other-' for assessing the measure 133 'supporting producers' groups for the promotion of products under food quality schemes' considering a counterfactual approach. The method of disaggregate analysis was used. The same indicator is also reported in the French evaluation document for 2000-2006 period for the impact of measure 132 'food quality schemes support'.

In Veneto region, another indicator was also used for estimating the impact of measure 133 concerning the 'share of animals on assisted holdings enjoying improved welfare thanks to assisted investments' according to the type of impact (e.g. direct or collateral to animal welfare, related to national or EU welfare standards). Supported investments have led to the improvement of working conditions (84.7% of farms benefiting in Veneto Region) and animal welfare, in particular pigs and dairy cattle. The effects of investment on improving the quality of the products were limited to companies that had already adopted quality systems. In these cases an increase in the value of the quality of the totality of the production was confirmed. The incidence of supported farm holdings adopting systems of quality of products recognised at Community level has remained essentially unchanged in the period following the investment. On the contrary the introduction of food safety procedures for the production processes (HACCP) presented a higher occurrence. In this specific case there is a relationship between animal welfare

linked to the product, such as milk or meat, and the quality control such as HACCP. The data were collected by the evaluator through a direct survey on a sample drawn from farms having received aid for investments.

4.7.2 Axis 2 'Improving the Environment and the Countryside through Land Management'

4.7.2.1 LFA payments

In Poland the estimation of effects of LFA payments are based on the number of beneficiaries and the ha of area under the supported measures using table analysis of statistic data of beneficiaries and non-beneficiaries. It is mentioned that since the data are very general then the impact on animal welfare could not be estimated.

In Scotland the impact assessment of payments to farmers in areas with handicaps, other than mountain areas, is based on evaluation questions using results from beneficiaries' survey since no quantitative data were available.

4.7.2.2 Agri-environmental measures

In Bulgaria, the impact assessment of AEMs is based on output indicators which can only capture the indirect effects of sustainable farming systems on animal welfare.

In Puglia region, during the ex post evaluation for 2000-2006 period, the impact assessment of agri-environmental actions has been based on the share of endangered animal breeds and the ha of area supported under this action. The action of 'breeding animal species in danger of extinction' is aimed at protecting the regional livestock genetic biodiversity.

Similarly, in the ex post evaluation for 2000-2006 period for the Veneto region, the impact of AEMs on animal welfare was assessed by the area under agreement for that specific measure, in particular with the livestock farm present in the area, types of crop (including associated livestock), crop-combinations and size of uniform fields maintained/reintroduced thanks to assisted actions.

During the current programming period, the indicator regarding the animals in danger of extinction is used to estimate the effects of the agri-environmental actions aimed at the recovery and conservation of animals in danger of extinction (Action 1) and addressed to the protection of biodiversity. It should be noted that the results of action 1 can be

expressed, of course, not in terms of the surface but also in terms of number of animals belonging to endangered breeds, subject of aid. The estimation method takes into account the counterfactual, comparing farms that received the aid and farms without aid support. The other aspects of conditionality, required, likewise, from beneficiary firms, are subject to criteria relating to public health, animal and plant health and animal welfare. Relevant indicators could be considered as important since they are aimed at ensuring food safety, preventing the spread of harmful substances in food and the transmission of diseases on farms and from these to the population. They are also important because they are closely related to objectives such as avoiding unnecessary suffering to animals through coercion and inadequate facilities to the physiological requirements and the natural behaviour of animals.

4.7.2.3 Animal welfare payments

Given the late introduction of this measure during the 2007-2013 programming period in Scotland, the uptake was very low; thus the mid-term evaluation is heavily dependent on limited survey data.

In the current RDP of Austria, no impact indicator was defined. Therefore only output indicators were assessed (number of supported farms and number of contracts) using IACS data. In addition to the quantification of these output indicators, interviews with 200 participating farmers were carried out to assess the efficiency and effectiveness of the measure. Examined proxy indicators for improvements of animal welfare were access to outdoor areas and access to grazing land.

Moreover in the mid-term evaluation for 2007-2013 for the Veneto and Emilia Romagna regions in Italy, the assessment of animal welfare payments are based on the same method that estimates the agri-environmental action conservation of animals in danger of extinction based on a counterfactual analysis, using IACS and FADN data.

In North-Rhine Westphalia in Germany, measure 215 was only implemented in 2010 and was thus not included in the mid-term evaluation. Similarly, animal welfare payments were only implemented for one year in 2003 and then reopened in 2009 in Mecklenburg Western Pomerania. Because of insufficient data the measure was not included in the mid-term evaluation. Current evaluation tasks in both Federal States focus on developing suitable impact indicators for the ex-post evaluation at the end of this period, which is

anticipated to include counterfactual-based assessment of supported and non-supported farms.

4.7.2.4 Forest-environmental measures

Only in Puglia region an assessment for the impact of afforestation measure on animal welfare was reported. In the ex post evaluation for the 2000-2006 period, the additional indicator 'change the target areas of intervention for the presence of wild animal and plant species typical of the area' is related to the action of animal species in danger of extinction that contribute to the preservation of the regional livestock genetic material. The monitoring data used was based on IACS data and agricultural regional database.

4.7.3 Programme level

The assessment of SEA at programme level in Puglia region is based on IRENA indicators measuring 'the relationship between intensification and extensification' as well as 'the percentage of UAA under organic farming in the total regional UAA'. The first indicator is used to evaluate the increased pressure of agrochemical in agriculture. The increase/decrease in milk production between 1990-2000 variable is used as an estimation for the intensity of farming practices. Regarding the second indicator and the percentage of UAA under organic farming, the Puglia region presents a slightly lower value than the national average, 7.4%, and it is the fifth Italian region with a positive impact on animal welfare. The latter was also used in the ex ante evaluation document for 2007-2013 period for assessing the impact at programme level.

4.8 General Comments

A preliminary conclusion when looking at Table 10, reporting on the number of indicators used in the various evaluation documents for the 20 RDPs studied, is that there are indicators available for all public goods examined. Also the distribution is satisfactory since, with the exception of indicators to assess measures in terms of their impact on animal welfare, there is no public good with less than 100 cases where indicators have been proposed or applied in the different evaluation reports.

However, if one breaks down the results by axis in order to assess the impact of the measures under the specific axis, one can see that there are cases of public goods where

no indicator whatsoever is available. An example for this is animal welfare in the case of axis 3 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity' and both facets of biodiversity and soil quality in the case of 'Leader approach' (Axis 4).

The impression is similar when the individual measures are examined in relation to the public goods, since there are four measures for which no indicator for any public good is proposed in all the 53 evaluation documents consulted. Those of 'Setting up of farm management/advisory services' (115) and 'Adaptation of demanding standards based on Community legislation' (131) under Axis 1, 'First establishment of agroforestry systems on agricultural land' (222) of the 'environmental' Axis 2 and 'Environment/land management' (412) of the Leader axis. What is worth noting at this point is the fact that the two later are directly related to the environment.

Table 10 Number of times indicators used for each RD measure and public good examined (total of 53 evaluation reports reviewed)

Axis	RD measure	Climate stability	Biodiversity wildlife	Biodiversity HNV	Water quality	Soil quality	Land-scape	Animal welfare
1. 'Improving the Competitiveness of the Agricultural and Forestry Sector'	Vocational training and information actions (111)	6	4	4	4	4	3	4
	Use of advisory services by farmers and forest holders (114)	2	2	2	2	2	2	2
	Setting up of farm management/advisory services (115)							
	Modernisation of agricultural holdings (121)	8	6	1	12	8	1	10
	Improvement of the economic value of forests (122)			1				
	Adding value to agricultural/forestry products (123)	7	5	4	4	4		
	Cooperation for development of new products, processes and technologies (124)		1					
	Improving and developing infrastructure related to the development and adaptation of agriculture and forestry (125)				4	2	4	
	Adaptation of demanding standards based on Community legislation (131)							
	Supporting farmers who participate in food quality schemes (132)							4
	Supporting producer groups for information and promotion activities for products under food quality schemes (133)							3
	Supporting semi-subsistence agricultural holdings undergoing restructuring (141)	1	4	1	4	4	1	5
2. 'Improving the Environment and the Countryside through Land Management'	Natural handicap payments to farmers in mountain areas (211)	4	9	11	8	9	8	2
	Payments to farmers in areas with handicaps, other than mountain areas (212)	5	17	13	11	10	12	2
	Natura 2000 payments (213)		4	4	3	5	1	
	Agri-environment payments (214)	32	58	25	70	40	24	4
	Animal welfare payments (215)							4
	Support for non productive investments (216)	1	1	4	2	1	1	
	First afforestation of agricultural land (221)	33	17	15	18	12	15	1
	First establishment of agroforestry systems on agricultural land (222)							
	First afforestation of non-agricultural land (223)	24	16	13	14	14	11	
	Natura 2000 payments (224)		4	4	3	2	2	
	Forest-environment payments (225)	4	3	2	5	5	3	
	Restoring forestry potential and introducing prevention actions (226)	17	2	6	13	9	7	
	Support for non-productive investments (227)	4	3	2	4	3	1	

Axis	RD measure	Climate stability	Biodiversity wildlife	Biodiversity HNV	Water quality	Soil quality	Land-scape	Animal welfare
3. 'Improving the Quality of Life in Rural Areas and Encouraging Diversification of Economic Activity'	Diversification into non-agricultural activities (311)	2	1				3	
	Support for business creation and development (312)	2	1				2	
	Encouragement of tourism activities (313)		1				5	
	Basic services for the economy and rural population (321)	2	1		2	2	3	
	Village renewal and development (322)	1	1				6	
	Conservation and upgrading of the rural heritage (323)		3	3			8	
	Training and information for economic actors operating in the fields covered by axis 3 (331)						1	
4 'Leader'	Competitiveness (411)	1			1			
	Environment/land management (412)							
	Quality of life/diversification (413)	1			1		7	

Furthermore one can see that there are quite a lot of cells that are empty in the above table. A combination of tables 1 on the relationships identified among measures and public goods reveals that there are numerous cases where although, at least once in the evaluations studied, an impact of the specific measure on the specific public good was identified (in some most of the cases more than once), no indicator seems to be proposed to assess this impact between a measure and a public good.

The following Table 11 summarises this frequency of a lack of indicators for the different measures in the current programme period in the 16 Member States included in the review. As it can be seen it is not a rare phenomenon since, in 21 out of the 35 evaluated measures, there is one case at least.

Table 11 Frequency of lack of indicators/measure

RD measure		Frequency of absence
1	Setting up of farm management/advisory services (115)	7
2	Improvement of the economic value of forests (122)	6
3	Supporting farmers who participate in food quality schemes (132)	5
4	First establishment of agroforestry systems on agricultural land (222)	5
5	Cooperation for development of new products, processes and technologies (124)	4
6	Animal welfare payments (215)	4
7	Improving and developing infrastructure related to the development and adaptation of agriculture and forestry (125)	3
8	Environment/land management (412)	3
9	Conservation and upgrading of the rural heritage (323)	3
10	Competitiveness (411)	3
11	Training and information for economic actors operating in the fields covered by axis 3 (331)	2
12	Support for business creation and development (312)	2
13	Quality of life/diversification (413)	2
14	Natura 2000 payments (213)	2
15	Diversification into non-agricultural activities (311)	2
16	Adding value to agricultural/forestry products (123)	2
17	Restoring forestry potential and introducing prevention actions (226)	1
18	Natura 2000 payments (224)	1
19	First afforestation of non-agricultural land (223)	1
20	Encouragement of tourism activities (313)	1
21	Adaptation of demanding standards based on Community legislation (131)	1

What should be stressed in that case is that some of the measures are directed towards environmental improvements, like NATURA 2000 payments (213) and agroforestry (222). A more difficult issue is the lack of indicators for assessment of their impacts of environmental goods over which they were stated to have an influence.

Examining the same problem, but from the angle of the public goods concerned one can see that this problem arises for all public goods, and is especially acute when trying to evaluate impacts on natural resources.

Table 12 Frequency of lack of indicators for the different public goods (in the current programme period in the 16 Member States)

Public good	Frequency
Climate stability	10
Biodiversity wildlife	8
Biodiversity HNV	7
Water quality	10
Soil quality	11
Landscape	7
Animal welfare	7

5 Concluding Comments

The following key points can be derived from the review and inventory assessment:

- Complexity of multiple linkages between RD measures and public goods:
  - Almost all measures examined are multi-objective. That is, they aim to provide more than one public good.
  - All public goods seem to be susceptible to the intervention of more than one measure.
- Lack of established robust causal relationships between measures, public goods and indicators:
  - A robust causal chain is established only for less than one third of the suggested linkages and relationships between public goods and RD interventions. Thus existing lacks in indicators cannot be supplemented with the use of robust causal relationships. This is the case for many public goods as well as measures.
- Lack of (impact or environmental outcome) indicators:

- Although there is a relationship specified between certain measures and public goods, there are no indicators for the particular combination. This is the case in 60 combinations.

- Furthermore for two axis, axis 3 'Quality of life and Diversification' and axis 4 'Leader', there is an absolute lack of indicators for specific public goods. The problem is more acute for axis 4, where there are four public goods lacking indicators.

Recommendations

Data availability is a key constraint for indicator and method uses in impact assessments of RD measures and programmes. In addition, there are certain gaps that have to be addressed with priority and need to be taken into account in the public good case studies. These are:

a. Lack of robust causal chains for the relationship that could link the RD measure that is to be evaluated with the practices affecting the public goods and the indicators available. The priority of establishing robust causal chains was also confirmed by the findings of the stakeholder consultation carried out in WP9 and the stakeholder workshop which emphasised the importance of robust causal chains for the evaluation of environmental impacts of RDPs.

b. Absence of indicators in order to evaluate the impact that certain measures have on specific public goods, especially natural resources, although evaluators and policy makers have explicitly mentioned that there was such an impact. The relevance of this priority was also highlighted in the discussions at the stakeholder workshop. It was emphasised that the output and result indicators are not sufficient, and more environmental impact indicators and monitoring need to be used and implemented to assess the environmental impacts of RD measures.

c. Impossibility to assess the impact of whole Rural Development Axes on certain public goods.

The findings from this report and the identified key gaps and priorities will provide the basis for the selection of specific indicators in the public good case studies, once the case study areas and to be tested methods are defined in the next steps in WP3 - WP6.

6 Recommendations for Suitable Indicators

One of the objectives of this report is to recommend suitable evaluation indicators to be incorporated into the methodological frameworks of the evaluation tools and tested in the public good case study areas.

The key finding of the summary report reveals the absence of indicators to assess the impact between certain combination of measures and public goods, especially in Axes 3 'Quality of life and Diversification' and 4 'Leader', even though an influence has been specified. Therefore for the suggestion of suitable indicators priority needs to be given to those 60 cases, where particular gaps were identified.

The process of selecting indicators for those aforementioned RD measures that lack indicators can be broken down into the following stages:

a. Identification of combinations where there was a gap.

b. Using the lists of indicators for each public good that were built on the review of evaluation reports (see Appendix A), the most relevant indicators were suggested. The criteria of suggestion have been based on the relation of the general objectives of the measures as well as the measurement of the indicators and their characteristics.

c. In some cases there was need for adaption of the proposed indicator to the specific measure. In those cases a comment is indicating this.

d. Several indicators have been estimated using different approaches by different authorities. In those cases all alternative approaches for the estimation are presented.

The outcome of this approach can address the issues concerning the absence of indicators and is summarised in tables linking RD measures and proposed indicators for each public good (see Appendix B).

Moreover, since the common indicators defined by the CMEF are not always detailed or specific enough to reflect the wider benefits of a measure, the need for additional and more flexible indicators dealing with site specific circumstances has been emphasised. In order to exploit the potential offered by other frameworks, suggested in studies or

research projects as well as the latest version of context and impact indicators provided by the Commission services, an effort was made to examine them and construct a list of alternative suitable indicators per public good. Indicators in this list are classified into sub-categories according to their relevant farming/environmentally features (see Appendix C).

The final selection of appropriate indicators will depend on which evaluation method will be used, data availability and environmentally circumstances in each case study area.

7 References

AE-FOOTPRINT (2005). Defining a blueprint for an Agri-environmental Footprint Index (AFI).

Amon B, Hörtenhuber S, Fröhlich M, Amon T (2007) Manure management system distribution in Austria and consequences on the ammonia emission inventory. http://www.ramiran.net/doc08/RAMIRAN_2008/Barbara_Amon.pdf

Andersen E., Primdahl J, Oñate JJ, Peco B, Cummings C, Aquirre J, Schramek J, Knickel K (1999) Environmental effects of Agri-environmental Measures Implemented under Reg. 2078/92. In: Schramek J, Biehl D, Buller H, Wilson G (Eds.) Implementation and Effectiveness of Agri-environmental Schemes Established under Regulation 2078/92. Final Consolidated Report. Project FAIR 1, CT95-274, Vol.1. Institut für ländliche Strukturforschung, Frankfurt: 135-162.

Baldock D, Lowe P (1996) The Development of European Agri- Environment Policy. In: Whitby M (Ed.), The European Environment and CAP Reform: Policies and Prospects for Conservation. CAB International, Wallingford: 8-25.

Berends, B.R., Urlings, H.A.P., Snijders, J.M.A., VanKnapen, F. (1995). Identification and quantification of risk factors in animal management and transport regarding Salmonella spp in pigs. International Journal of Food Microbiology 30 (1-2), 37-53.

Boatman N, Green M, Holland J, Marshall J, Renwick A, Siriwardena G, Smith B, de Snoo G (Eds.) *Agri-Environment Schemes – What Have They Achieved and Where Do We Go From Here*? Aspects of Applied Biology 100, Association of Applied Biologists, Warwick

Buller H (1999) Regulation 2078: patterns of implementation. In: Buller H, Wilson GA, Höll A (Eds) Agri-environmental Policy in the European Union. Aldershot: Ashgate: 219-253.

Carey PD, Short C, Morris C, Hunt J, Priscott A, Davis M, Finch C, Curry N, Little W, Winter M, Parkin A, Firbank L (2003). The multi-disciplinary evaluation of a national agri-environment scheme. *Journal of Environmental Management* 69: 71–91.

Cooper T, Hart K, Baldock D (2010) The provision of public goods through agriculture in the European Union, Report prepared for DG Agriculture and Rural Development, Contract No 30-CE-0233091/00-28, Institute for European Environmental Policy: London.

Damianos D, Giannakopoulos N (2002). Farmers participation in agri-environmental schemes in Greece. *British Food Journal* 104(3/4/5): 261-273.

DIS4ME (2005). Desertification Indicators System for Mediterranean Europe, UNCCD, Bonn. http://www.kcl.ac.uk/projects/desertlinks/downloads.htm

ELISA (2002). Agri-environmental indicators for sustainable agriculture, European Centre for Nature Conservation (ECNC), Tilburg, Netherlands.

European Commission (1998) State of application of regulation (EEC) No 2078/92: Evaluation of Agri-Environment Programmes, DGVI COMMISSION WORKING DOCUMENT, VI/7655/98. European Commission, DG Agriculture, Brussels.

European Commission (1999) Impact of agri-environment measures. Collated by Frank Fay, http://ec.europa.eu/agriculture/envir/report/ en/2078_en/report.htm

European Commission (2000a) Common Evaluation Questions with Criteria and Indicators Part A. European Commission, DG Agriculture, Brussels.

European Commission (2000b) Common Evaluation Questions with Criteria and Indicators Part D. European Commission, DG Agriculture, Brussels.

European Commission (2000c) Indicators for the integration of environmental concerns into the common agricultural policy (COM (2000) 20 Final). Communication from the Commission to the Council and the European Parliament. European Commission, DG Agriculture, Brussels.

European Commission (2001) Statistical information needed for indicators to monitor the integration of environmental concerns into the common agricultural policy (COM (2001) 144 Final). Communication from the Commission to the Council and the European Parliament. European Commission, DG Agriculture, Brussels.

European Commission (2005) Agri-environment Measures. Overview on General Principles, Types of Measures and Application. Directorate General for Agriculture and Rural Development. Unit G-4 - Evaluation of Measures applied to Agriculture, Studies. March 2005.

European Commission (2006) Rural Development 2007-2013 Handbook on Common Monitoring and Evaluation Framework Guidance document. European Commission, DG Agriculture, Brussels.

European Commission (2009) Agriculture in the European Union - Statistical and economic information 2008.

European Environmental Agency (2005a) Agriculture and environment in EU-15 – the IRENA indicator report. Report No. 6/2005. European Environment Agency, Copenhagen.

European Environmental Agency (2005b) IRENA Indicator Fact Sheet, IRENA 1 – Area under agri-environment support. European Environment Agency, Copenhagen.

European Environmental Agency (2006) Integration of Environment into EU Agricultural Policy – the IRENA indicator-based assessment report. Report No. 2/2006. European Environment Agency, Copenhagen.

European Parliament (1998) Report on the report from the Commission to the Council and the European Parliament on the application of Council Regulation (EEC) no. 2078/92 on agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside. (COM 97-620 final). European Parliament, Brussels.

Finn JA, Kurz I, Bourke D (2008) Multiple factors control the environmental effectiveness of agri-environmental schemes: implications for design and evaluation. *Tearmann: Irish Journal of Agri-Environmental Research* 6: 45-56.

Finn JA, Bourke D, Kurz I, Dunne L (2007) Estimating the environmental performance of agri-environmental schemes via use of expert consultations Final report of the ITAES project. http://merlin.lusignan.inra.fr/ITAES/website/Publicdeliverables.

Finn JA, Bartolini F, Bourke D, Kurz I, Viaggi D (2009) Ex post environmental evaluation of agri-environment schemes using experts' judgments and multi-criteria analysis. *Journal of Environmental Planning and Management* 52: 717-737.

Freibauer A, Rounsevell MDA, Smith P, Verhagen J (2004) Carbon sequestration in the agricultural soils of Europe. *Geoderma* 122: 1-23.

Halberg, N., Verschuur, G., Goodlass, G., (2005). Farm level environmental indicators; are they useful? An overview of Green Accounting Systems for European farms. Agric. Ecosyst. Environ 105, 195–212.

Hutchison, M.L., Thomas, D.J.I., Moore, A., Jackson, D.R., Ohnstad, I. (2005) An evaluation of raw milk microorganisms as markers of on-farm hygiene practices related to milking. Journal of Food Protection 68 (4), 764-772.

IRENA (2004). Indicator Report on the Integrated Environmental Concerns into Agricultural Policy, EEA, Copenhagen, Denmark. http://themes.eea.eu.int/IMS_IRENA/Topics/IRENA/indicators

Juntti M, Potter C (2002) Interpreting and Reinterpreting Agri-environmental policy: Communication, trust and knowledge in the implementation process. *Sociologia Ruralis* 42(3): 215-232.

Juntti M, Wilson G (2004) Actor networks and the implementation of policies affecting desertification in Southern Europe. In: Wilson G, Juntti M (Eds.) *Unravelling Desertification. Policies and Actor Networks in Southern Europe*. Wageningen Academic Publishers: 191-221.

Kleijn D, Sutherland WJ (2003) How effective are European agri-environment schemes in conserving and promoting biodiversity? *Journal of Applied Ecology* 40: 947-969.

Kleijn D, Berendse F, Smit R, Gilissen N (2001) Agri-environment schemes do not effectively protect biodiversity in Dutch agricultural landscapes. *Nature* 413(6857): 723-725.

Kleijn D, Baquero RA, Clough Y, Diaz M, De Esteban J, Fernandez F, Gabriel D, Herzog F, Holzschuh A, Johl R, Knop E, Kruess A, Marshall EJP, Steffan-Dewenter I, Tscharntke T, Verhulst J, West TM, Yela JL (2006) Mixed biodiversity benefits of agri-environment schemes in five European countries. *Ecology Letters* 9: 243-254.

Klobasa M, Ragwitz M (2004) Large scale integration of renewable energy resources into the EU energy system. Final report, Karlsruhe Fraunhofer ISI.

Louloudis L, Beopoulos N, Vlahos G (2000) Greece: late implementation of agrienvironmental policies. In: Buller H, Wilson G, Höll A (Eds.) Agri-environmental Policy in the European Union. Ashgate, Aldershot: 71-93.

Lowe P, Clark J, Seymour S, Ward N (1997) *Moralising the Environment: Countryside Change, Farming and Pollution*. Routledge, London.

Morrow K, Silgram M, Nisbet T (2010) Can woodland measures in agri-environment policies assist in meeting WFD objectives? In: Boatman N et al. (Eds.) *Agri- Environment Schemes – What Have They Achieved and Where Do We Go FromHere*? Aspects of Applied Biology 100, Association of Applied Biologists, Warwick.

Oréade Brèche (2005) Evaluation Of Agri-Environmental Measures. Auzeville, France. http://ec.europa.eu/agriculture/eval/reports/measures/ex_sum_en.pdf.

Organisation for Economic Cooperation and Development (OECD) (1997) *Environmental Indicators for Agriculture - Volume 1: Concepts and Framework*.

Organisation for Economic Cooperation and Development (OECD) (1998) *Towards Sustainable Development Environmental Indicators*. OECD: Paris.

Organisation for Economic Cooperation and Development (OECD) (1999) *Environmental Indicators for Agriculture - Volume 2: Issues and Design*.

Organisation for Economic Cooperation and Development (OECD) (2000) *Environmental Indicators for Agriculture- Volume 3: Methods and Results*.

Organisation for Economic Cooperation and Development (OECD) (2003) *Multifunctionality: The Policy Implications*. OECD Publishing.

PAIS (2001), Proposal on agri-environmental indicators, Landsis, Luxembourg http://www.landsis.lu/projects/download/PAIS%20Summary.pdf

Paniagua Mazorra A (2001) Agri-environmental policy in Spain. The agenda of socio-political developments at the national regional and local levels. *Journal of Rural Studies* 17: 81-97.

Park JR, Stabler MJ, Mortimer SR, Jones PJ, Ansell DJ, Parker G (2004) The use of a multiple criteria decision analysis to evaluate the effectiveness of landscape and habitat enhancement mechanisms: an example from the South Downs. *Journal of Environmental Planning and Management* 47: 773-793.

Paul C, Weber M, Mosandl R (2009) Kohlenstoffbindung junger Aufforstungsflächen, Karl Gayer Institut and TU Muenchen.
http://www.prima-klima-weltweit.de/grafiken/downloads/paul_studie.pdf

Peco B, Suárez F, Oñate JJ, Malo JE, Aguirre J (2000) Spain: first tentative steps towards an agri-environmental programme. In: Buller H, Wilson GA, Höll A (Eds): *Agri-environmental Policy in the European Union*. Aldershot: Ashgate: 145-168.

Peschard D, Galan MB, Boizard H (2004) Tools for evaluation the environmental impact of agricultural practices at the farm level: analysis of 5 agri-environmental methods. OECD expert meeting on farm management for agriculture and the environment. New Zealand 8-12 March.

Primdahl J, Peco B, Schramek J, Andersen E, Oñate JJ (2003) Environmental effects of agri-environmental schemes in Western Europe. *Journal of Environmental Management* 67: 129-138.

Primdahl J, Vesterager JP, Finn JA, Vlahos G, Kristensen L, Vejre H (2010) Current use of impact models for agri-environment schemes and potential for improvements of policy design and assessment. *Journal of Environmental Management* 91: 1245-1254.

Siimes, K. & Kämäri, J. (2003) A review of available pesticide leaching models: Selection of models for simulation of herbicide fate in Finnish sugar beet cultivation. *Boreal Environment Research* 8: 31-51.

Stoate C, Baldi A, Beja P, Boatman ND, Herzon I, van Doorn A, de Snoo GR, Rakosy L, Ramwell C (2009) Ecological impacts of early 21st century agricultural change in Europe – A review. *Journal of Environmental Management* 91: 22–46.

TEPI (2005), Towards European Pressure Indicators, Environment Aid and Information Liason and EUROSTAT, European Commission, Brussels. http://www.e-m-a-i-l.nu/tepi

Trisorio, A., Povellato, A., and Borlizzi, A. (2008) High Nature Value Farming Systems in Italy; A policy perspective. Paris: OECD.
Available online: http://www.oecd.org/tad/sustainable-agriculture/45447828.pdf

Vandenberghe C, Marcoen JM (2004) Transposition de la Directive Nitrate (CE) en Région wallonne: azote potentiellement lessivable de référence pour les sols cultivés en Région wallonne. In: *Biotechnologie, Agronomie, Société et Environnement (BASE)* 8(2): 61-152.

Velthof GL, Oenema O, Postma R, van Beusichem ML (1997) Effects of type and amount of applied nitrogen fertilizer on nitrous oxide fluxes from intensively managed grassland. *Nutrient Cycling in Agroecosystems* 46: 257–267.

World Trade Organisation (1994) Uruguay Agreement: Agreement on Agriculture: Annex.