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Agri-environment Measures and Soil Erosion in Europe

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2.24.1 INTRODUCTION

All present pan-European soil erosion assessment methods and accompanying maps agree that the highest erosion rates occur in southern Spain, Italy, Sicily, Sardinia and Greece (see Chapter 2.13). An analysis of the PESERA map per country shows that 16.7 % of the EU-15, excluding Sweden and Finland, is susceptible to considerable erosion risk with highest rates occurring in the Mediterranean area (Figure 2.24.1). In comparison, the EEA estimated that about 12 % of the EU-15 (115×10^6 ha) is prone to risk of water erosion and 4 % of the EU-15 (42 million hectares) is prone to wind erosion (EEA, 2001). Furthermore, the highest erosion rates are observed and predicted by erosion models on agricultural land and particularly on arable land (Gobin *et al.*, 2003). With about 62 % of agricultural land under intensive agricultural cultivation (IEEP, 1995; Bignall and McCracken, 1996, 1995), many European farmers' fields are at risk of serious soil degradation.

In Mediterranean Europe, the problem of maintaining, or improving, the physical, chemical and biological quality of soil, while reducing soil erosion, is particularly difficult to solve. The strong risk of soil loss is caused by the high rainfall intensity and the frequent occurrence of extreme events, by the high relief energy and the vulnerable condition of soil when erosive events occur. Furthermore, the intense agricultural exploitation of soil on highly mechanised farms, drought conditions, forest fires, land abandonment in marginal areas and overgrazing increase the risk of soil degradation (Wells, 1981; Albaladejo *et al.*, 1991;

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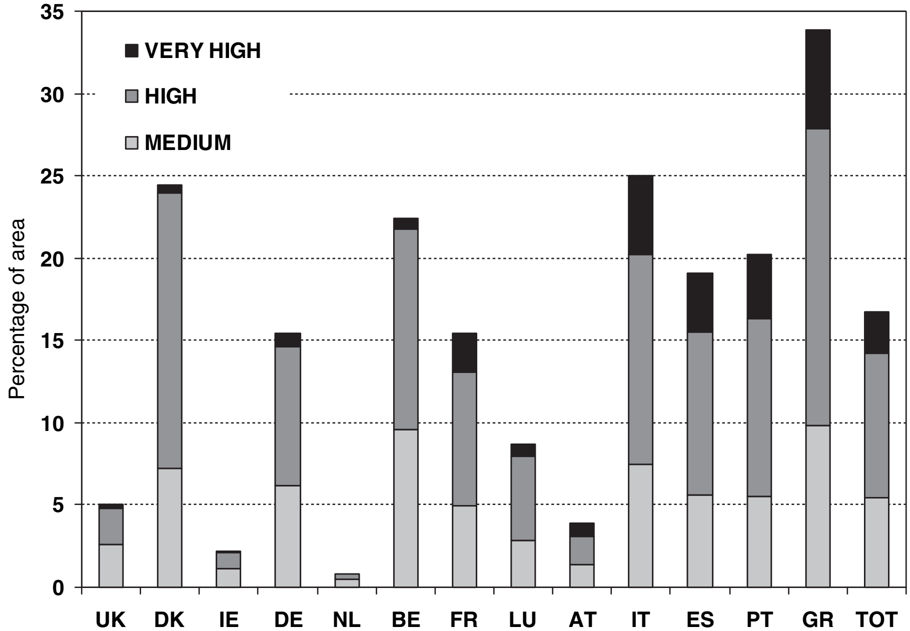


Figure 2.24.1 Risk of erosion by water in Europe, based on PESERA predictions

Kosmas *et al.*, 1996). High air temperature, combined with ploughing and harrowing, favours the loss by mineralisation of soil organic matter (Kirschbaum, 1995; Kätterer *et al.*, 1998), which is a key factor for conserving soil health (Kononova, 1966; Follett, 1987; IPCC, 2000).

Certain trends or changes in European agriculture such as technological improvements, agricultural land use and livestock management greatly influence soil erosion. Technological and transport improvements have encouraged agricultural specialisation in areas with the lowest production costs, with consequent intensification of chemical and mechanical inputs. The reforms that have been introduced by the European Common Agricultural Policy (CAP) have led to land-use changes that may affect land degradation and in particular erosion. Agricultural production has been artificially constrained by mechanisms such as milk quotas and compulsory set-aside for arable crops. Although this is *prima facie* environmentally beneficial, many of the statistics show otherwise.

Over the past 20 years, the area of land under productive agriculture has fallen by 2.5 %. An analysis between Farm Structure Survey (FSS) Census data between 1990 and 2000 shows that all-agricultural land-use classes decreased in area, but the amount of arable land increased at the expense of permanent grassland. The class permanent grassland declined by 5 %, permanent crops by 4 % and arable land only by 0.7 %. Traditional crops in rotation declined and mono-crop farming systems increased. Particularly fodder maize for silage increased, with a consequent increased risk of soil erosion.

Oldemann *et al.* (1991) demonstrated that overgrazing is one of the major causes of soil degradation worldwide. Based on FSS census data for 1990 and 2000, sheep stocks declined by 3 % and cattle by 5 % throughout the EU-15. However, these figures hide national differences. The countries where overgrazing is most risky in terms of soil degradation (soil erosion, compaction and landslides) are located in Mediterranean Europe. In 1995, nearly 50 % of goats were located in Greece, with another 33 % in Spain and Italy. About 40 % of EU sheep are in Greece, Spain and Italy (EUROSTAT, 2001).

A policy of subsidies for fallow land (set-aside) was introduced to contribute to market balance by reducing surplus production. Crops intended for non-food use (biomass and biofuels) are permitted on set-aside land. In cases where set-aside land is used for non-food row crops (industrial set-aside) or when the land remains tilled and uncultivated, soil quality may decrease and the risk of soil erosion may increase. In contrast, when set-aside land remains covered by natural or sowed grass, the physical and chemical soil properties can ameliorate. Between 1975 and 1997, the area under cereals decreased by 7 % in the EU-9 as a result of set-aside. However, industrial set-aside increased from 11.2 % in 1999 to 15.5 % of the total set-aside in 2003. The total area of set-aside land, whether rotational or non-rotational (fixed) and voluntary or not, increased by 34 % between 1997 and 2003.

2.24.2 AGRI-ENVIRONMENT PROGRAMMES AND MEASURES

Agri-environment programmes were introduced into the CAP during the mid-1980s as an optional policy instrument to support specific farm practices that help to protect the environment and maintain the countryside. Agri-environment programmes aimed to cover all aspects of agricultural activity that interact with the environment, i.e. air, soil, biodiversity, landscape, land and water. In particular, they focused on environmental problems on farmland under intensive agricultural systems and the management of adjacent zones, such as field margins.

The McSharry reform of the CAP in 1992 introduced agri-environment programmes throughout the territory (Council Regulation No. 2078/92). These programmes stimulate and pay farmers, for a 5-year minimum period, to produce environmental services through environmentally beneficial activities (EEC, 1998) that go beyond ‘good farming practice’. In response to Regulation 2078/92, the European Commission approved more than 130 different programmes containing over 2000 distinctive measures presented by the 15 Member States prior to 1998.

In 1999, the Agenda 2000 reform included agri-environment measures as an obligatory part of rural development programmes (Council Regulation 1257/1999) to be designed at national, regional or local level. Agri-environment measures are the main instrument for the integration of environmental concerns into the CAP. Examples of commitments covered by national/regional agri-environment measures include environmentally favourable extensification of farming, management of low-intensity pasture systems, integrated farm management and organic agriculture, preservation of landscape and historical features such as hedgerows, ditches and woods and conservation of high-value habitats and their associated biodiversity.

European agricultural regions vary widely with regard to landscape, farming types/structures and agri-environment issues, resulting in corresponding differences in specific regional requirements. This in turn leads to differences in implementation; it is therefore clear that the evaluation of agri-environment measures and programmes depends on the development and application of methodologies which are both regionally specific and, only to a certain extent, cross-nationally comparable. An additional difficulty is that there are very few explicit data on what is really happening, more in particular on the links between certain agricultural practices and soil erosion.

In 1998, 20 % of the utilised agricultural area in Europe was covered by agri-environment measures (Figure 2.24.2); in 2002, this was 25 %. The target in the 5th Environmental Action Program (EAP) of at least 15 % of EU farmland under agri-environment agreement by 2000 was exceeded, but implementation remained below 15 % in six Member States in 1998 (EEC, 1998). The 2002 data clearly show the upward trend in the uptake of agri-environment measures, apart from Italy and Germany, where a downward trend is observed. Luxembourg, Austria, Finland and Sweden clearly outperform the European average, whereas Greece, The Netherlands and Spain remain far below the European average.

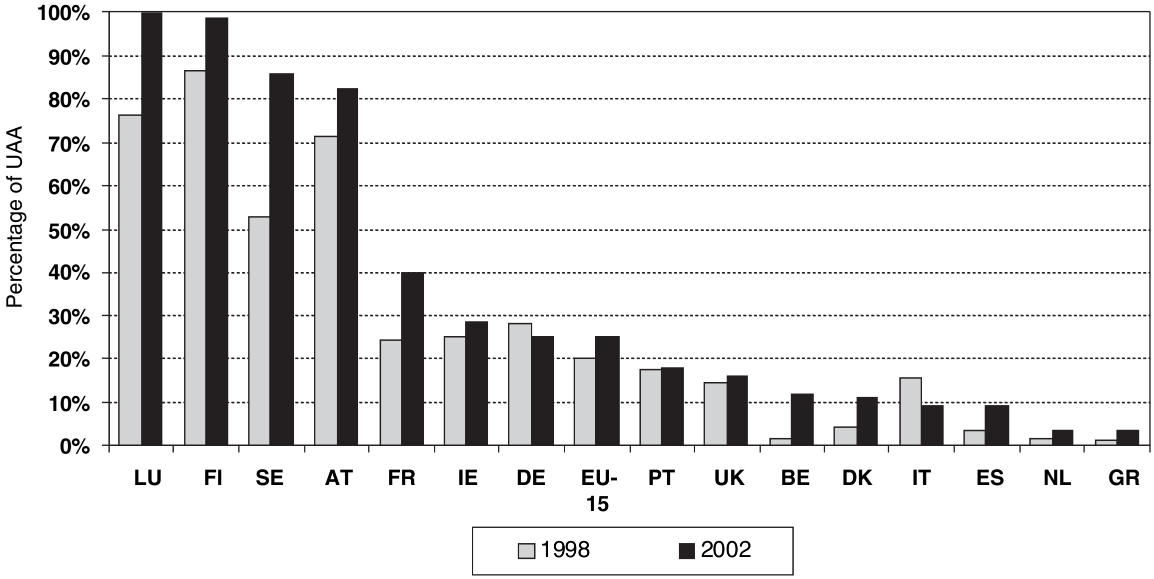


Figure 2.24.2 Percentage of utilised agricultural area (UAA) under agri-environment measures (AEM) in 1998 and 2002

The different agri-environment measures are commonly divided into the following groups: organic farming; input reduction, crop rotation and extensification, landscape and nature; and plants under genetic erosion and other more site-specific measures. For the EU-15, input reduction, crop rotation and extensification account for 32 % and organic farming for 6.5 % of the total area under agri-environment measures (Figure 2.24.3). Landscape and nature (15 %) and other measures (40.5 %) are region specific and are therefore more difficult to discuss in a European-wide context. Plants under genetic erosion (6 %) are obviously not related to soil erosion. Most of the Member States have agri-environment measures related to organic farming, input reduction and extensification.

2.24.3 AGRI-ENVIRONMENT MEASURES AFFECTING SOIL QUALITY

2.24.3.1 Organic and Integrated Farming Systems

Organic farming is an approach to agriculture where the aim is to create integrated and environmentally and economically sustainable agriculture systems (Lampkin and Padel, 1994; Rigby and Cáceres, 2001). Integrated farming systems put together technologies to produce site-specific management systems for whole farms, incorporating a higher input of management and information for planning, setting targets and monitoring progress (Pretty, 1998). Integrated farming represents a step from high-input farming to organic agriculture.

The aim of the organic farming measure, first introduced and regulated by EEC Regulation 2092/91, is to help farmers manage ecological and biological processes in a framework of self-regulating agro-ecosystems that use locally or farm-derived renewable resources. The use of external inputs, whether inorganic and organic, is reduced as far as possible. Organic farms have lower inputs and concentration of nutrients compared with conventional farming practices, which leads to reduced leaching into water and reduced emissions to the atmosphere. The increased input of organic matter, broad rotations and omission of pesticides contribute to the protection and preservation of soil biodiversity (Mader *et al.,* 2002). Indicators of soil quality,

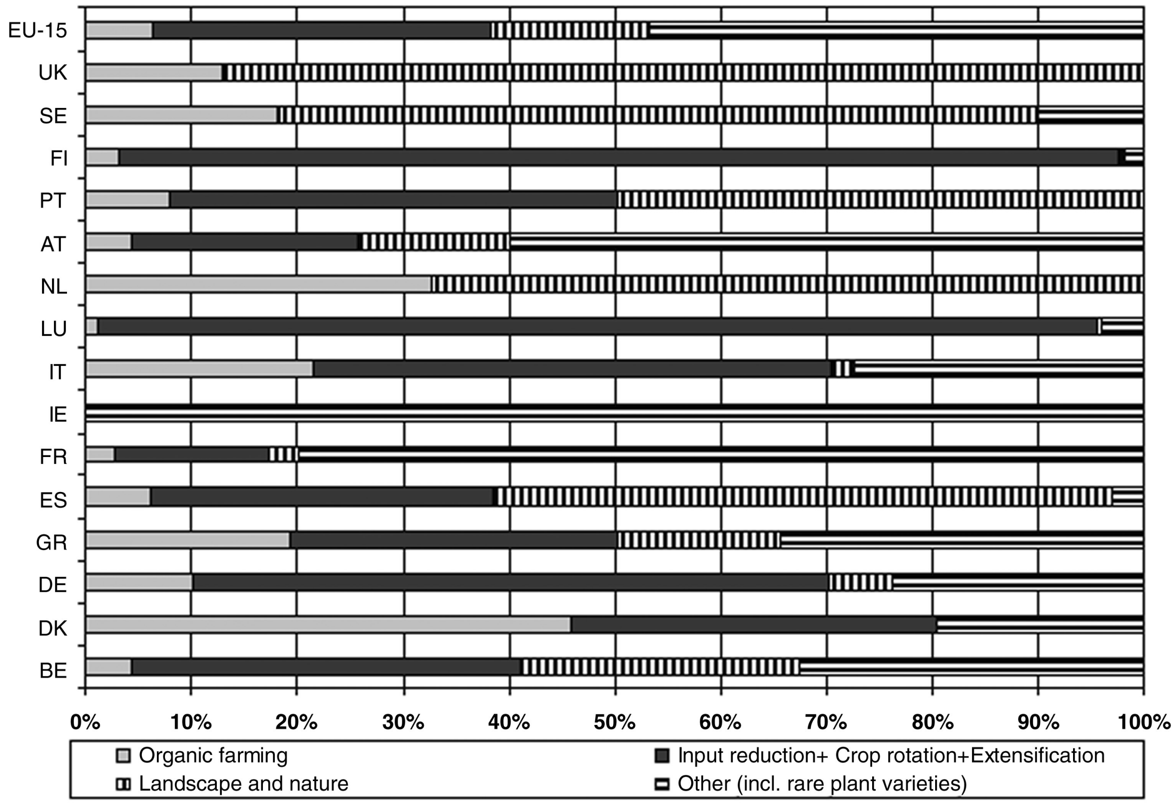


Figure 2.24.3 Division according to type of agri-environment measure (2002)

e.g. dehydrogenase activity (DHA) and bacterial and fungal counts, are higher on soils under organic management than on inorganically fertilised soils (Bardgett *et al.,* 1997). Long-term benefits associated with organic farming include greater topsoil depth, more moisture retention and reduced soil erosion (Reganold *et al.,* 1987).

The environmental impact of 29 agri-environment measures was compared against the reference standard of good agricultural practice (study by the University of Göttingen for DG-Agriculture; EEC, 1998) in terms of preservation of water, soil, atmosphere, diversity of fauna, flora, biotopes, landscape and cultural aspects. The results showed that measures with a high positive impact on the preservation of environmental resources include the omission of fertilisers and plant protection products (pesticides), especially in environmentally sensitive areas, and the conversion of arable land to extensive grassland. The *status quo* of agricultural management performed worse than good agricultural practice and integrated farming slightly ameliorated environmental resources. The impact of integrated farming in low mountain ranges was less significant due to the fact that extensive farming methods are already applied in these areas.

In Tuscany, a study was carried out by Pacini *et al.* (2003) to evaluate the sustainability of organic, integrated and conventional farming systems on three farms with widely ranging climatic and soil conditions. The study applied a holistic, integrated economic–environmental accounting framework through the measurement of a number of indicators and pedo-climatic variables. Organic farming systems performed better than conventional and integrated farming systems and were more profitable. However, the environmental responses of the three different systems are highly affected by pedo-climatic factors both at regional and farm scale.

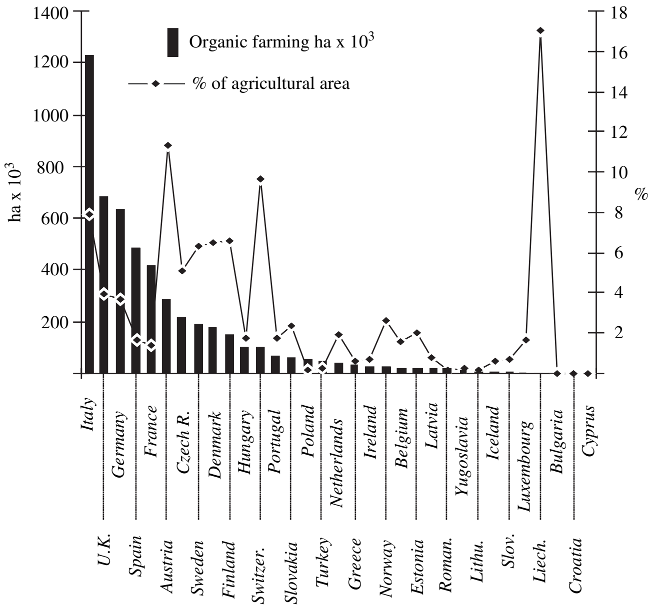


Figure 2.24.4 Hectares and percentage of utilised agricultural area under organic farming in Europe in 2001

Data published by three services of the European Commission: Eurostat, DG-Agriculture and DG-Environment (EU, 2003), show that in 2000 (Figure 2.24.4), the area devoted to organic farming (fully converted and in conversion) covered 3.8×10^6 ha in the EU-15, whereas in 1998 it covered only around 2.3×10^6 ha. This represents an increase of 67 % over the period 1998–2000 and can be considered a reliable indicator of soil quality improvement. The organic farming area reached 3.0 % of the total utilised agricultural area (UAA) of the EU-15 in 2000, up from only 1.8 % in 1998.

The dominant organic crops in the EU's Nordic countries (Denmark, Finland and Sweden) in 2000 were cereals, forage plants, pastures and meadows, each covering around one-quarter of the combined organic area. The prevalence of these crops has fluctuated only slightly since 1998, although the total organic area has increased by almost 50 %.

In western European countries (Austria, Belgium, Luxembourg and The Netherlands), organic farming on pastures and meadows covered around 75 % in 2000, whereas both cereals and forage plants remained below 10 %.

In southern Europe (France, Greece, Italy, Portugal and Spain), the organic area has grown by around 70 % during the period 1998–2000 (Figure 2.24.5). Dominant organic crops in 2000 are pastures and meadows, forage plants, cereals and olive plantations. Vineyards represent 3 % of the organic crops.

In Austria, Finland and Italy, the increase in organic farming area has been due to, or coincided with, expansion of the agri-environment programmes (Figure 2.24.2). The countries with an increase in organic farming area lower than the EU-15 average were The Netherlands, Luxembourg, Spain, Germany, Finland, Sweden and Ireland. Austria saw a small decrease in its organic farming area since 1998, after high growth figures in previous years.

More than one-quarter of the total area devoted to organic production in the EU-15 in 2000 was located in Italy. The UK is the second best organic producer, followed by Germany, Spain and France.

The countries with an increase in organic farming area in the period 1998–2000 above or close to the EU-15 average were the UK, Italy, Belgium, Greece, Denmark, France and Portugal. The high growth figures for the UK are mainly due to recent conversions of very large, very extensive holdings in Scotland.

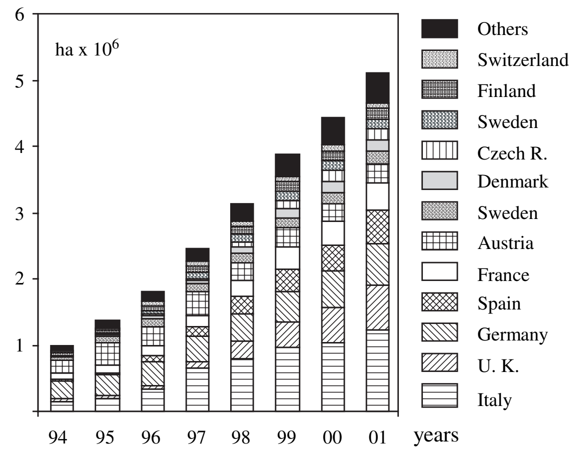


Figure 2.24.5 Trend of organic farming in EU countries during 1994–2001

2.24.3.2 Extensification and Input Reduction

Extensification by converting arable land into grassland is effective for improving soil quality (Doran *et al.*, 1996; Fauci and Dick, 1994). In the EU-15 there are about 45×10^6 ha of grassland. Under Regulation 2078/92, 0.5 % of arable land areas, corresponding to 366 000 ha, received subsides for conversion into pastures (Table 2.24.1).

The Netherlands and Denmark were the main beneficiaries of this measure. In 1997, they alone accounted for 82 % of the areas in the EU converted and assisted under this agri-environment programme. The average area converted into pasture was relatively small in Denmark (5.2 ha) and concerned almost exclusively holdings of more than 10 ha.

In Spain and Portugal, few areas and holdings received this type of aid, but the average area of arable land converted was considerably greater: 49 ha per holding in Spain and 21 ha per holding in Portugal.

The area under specific management contracts that gives more attention to maintaining biodiversity and landscape represents another indicator of environmental development of agricultural systems and of soil conservation. These contracts cover more than 22×10^6 ha (20 % of the utilised agricultural area of the EU). The extent of the contract varies between Member States: from more than 60 % of farms in Austria, Finland and Sweden to 7 % or less in Belgium, Greece, Spain and Italy. However, area alone gives no indication of the environmental performance of the agri-environment programme, as many of the programmes are not assessed in terms of effectiveness. Figure 2.24.6 shows two examples of agri-environment measures adopted in the Chianti area to conserve the soil and landscape.

With respect to the total CAP budget, expenditure on management contracts remains extremely modest (only 4 % of the European Agriculture Guidance and Guarantee Fund). It is sometimes more profitable for farmers to receive an EU payment for arable set-aside than to enter an agri-environmental programme (EEA, 2000).

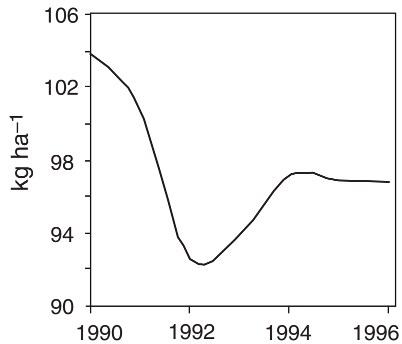
Reduction of fertiliser (Table 1) during the application of Regulation 2078/92 is another indicator of extensification and improvement of soil quality. The use of nitrogen and phosphorus fertilisers has decreased overall, but this trend has been slightly reversed since 1992.

2.24.4 DISCUSSION

An evaluation of Agri-Environment Programmes (Working Document VI/7655/98 of DG Agriculture; EU, 1998) showed that positive effects of agri-environment measures on soil quality have been achieved. These

TABLE 2.24.1 Trend of fertiliser use and area of arable converted to permanent grassland and meadow (EUROSTAT, 2001b)

Country	ha	% ha in farms $\geq$50 ha (UUA)	Total nitrogen and phosphorus fertilisers (Liechtenstein not included)
Netherlands	15220	30	
Denmark	14740	74	
Spain	28650	97	
France	12630	66	
Ireland	9200	44	
Italy	8260	55	
Portugal	7240	85	
Austria	350	3	
Belgium	300	70	
Luxembourg	150	100	
Greece	10	0	
EU-15	366	56	



beneficial effects are the consequence of the highly positive results reported for reduced inputs, organic farming, nature protection and measures to maintain landscapes.

Some difficulties arose with extensification over the past 20 years. The measure was rarely applied because farmers did not accept long-lasting periods of non- or reduced cultivation.

Measures to convert arable land to grassland, or to ensure mixed farming and rotation, performed better than segetal vegetation (row crops, small grains) in terms of soil conservation. Considerable evidence of environmental benefit resulted from erosion prevention measures, such as mulch seeding.

Nature management often requires low-intensity grazing of pastures with consequent positive impacts on soil protection. However, extensification of livestock has not been very successful in several regions; one reason may be that it is not financially rewarding. Maintenance of extensive systems essentially failed in many important zones of the EU-15.

To evaluate the effectiveness of agri-environment programmes in terms of soil quality, an effort is needed to improve data collection. In fact, existing monitoring programmes do not provide sufficient data to show the trends of physical, chemical and biological properties of soil and the effects on soil erosion, landslides and off-site impacts. Under EC Regulations, each EU-15 Member State collects highly detailed geo-referenced information on land use at the field scale to check tax declarations and compile statistics. From these databases, it is possible to track soil use and management during the years of application of agri-environment measures. Furthermore, these data can give the possibility of performing scenario analysis. However, such information is currently not accessible owing to confidentiality rules.

Figure 2.24.6 Example of agri-environment measures adopted in the Chianti area on vineyards. (A) The existing non-economic stonewall terraces (see B) were enlarged and connected (zig-zag paths) to help mechanisation. The alternate removal of a stonewall row every two terraces maintained the landscape function and reduced the slope length respect to site C, where land levelling was adopted. (C) Grass cover applied to a vineyard planted along the maximum slope, to reduce erosion (*photo* P. Bazzoffi)

The erosion literature commonly identifies acceptable rates of soil erosion that typically range from 1 t ha^{-1} yr^{-1} on shallow sandy soils to 5 t ha^{-1} yr^{-1} on deeper well-developed soils. However, with a very slow rate of soil formation, and considering that tolerability of soil erosion must be viewed with reference to off-site socio-environmental costs and benefits, any soil loss of more than 1 t yr^{-1} can be considered to cause irreversible damage within a time span of 50–100 years (EEA, 1998). Although soil is a vital and largely non-renewable resource, it has not been the subject of comprehensive EU action so far. A thematic strategy for soil protection, which recognises soil erosion as one of the major threats, has currently been placed high on Europe's political agenda.

Assessing and monitoring soil erosion are needed to evaluate the impact of, *inter alia*, agricultural and land use policies such as the agri-environment measures in Europe (Gobin *et al.*, 2004). Europe's agri-environment policies are increasingly focusing on gains in environmental functions, by decreasing negative and increasing positive externalities from agriculture (Regulation EU 1782/2003). These externalities, which include soil erosion, need to be quantified and compared against environmental standards of sustainability (Regulations EEC No. 2078/1992 and EEC No. 1782/03). In 2004, as part of the environmental standards of sustainability (Regulation EEC No. 1782/03), the Italian Ministry of Agriculture tried to solve the problem of identifying where soil erosion occurred above tolerable limits. Erosion is considered tolerable on condition that rills do not appear on the field surface. This indicator addresses the need of providing a sure and certifiable reference point to the 'on-site' controls randomly made by the paying organisms. This definition of tolerable soil erosion represents a valid compromise, to be considered by other EU countries, because it is almost impossible to measure soil erosion that occurred in the absence of control devices previously installed in the field.

Since erosion is patchy in both time and space, there is a need for a revised and comprehensive framework to analyse the complexity of the problem. Gobin *et al.* (2003, 2004) proposed a revised driving force–pressure–state–impact–response (DPSIR) framework and a set of soil erosion indicators that can be objectively calculated, validated against measurements or observations and evaluated by experts. The soil erosion indicators have to be evaluated against the physical background of topography, climate, soil characteristics and vegetation cover.

2.24.5 CONCLUSIONS

At the beginning of the CAP, the major issue was to support product prices through compensatory payments, with agri-environment programmes receiving only a relatively small share of the budget. This policy determined the intensification of inputs with potential harmful effects on soil conservation. Various reforms of the CAP have aimed at resolving some of the environmental problems introduced by agriculture.

Quantitative values of change in physical and chemical properties of European soils under the effects of agri-environment measures are lacking. Nevertheless, it is possible to provide a judgment in terms of extent of utilised agricultural area (UAA) where certain agri-environment measures have been applied that influence soil protection. Percentage uptake of organic farming, integrated farming, input reduction, extensification and crop rotation are specific agri-environment measures that reduce soil erosion and, at the same time, are cross-nationally comparable. Other agri-environment measures such as those related to preservation of nature and landscape have a positive influence on soil protection but are site-specific and therefore more difficult to compare across Member States.

Since many of the agri-environment measures have a positive impact on soil protection and combating soil erosion, there is an urgent need for a scheme to monitor soil erosion under different agro-ecosystems in order to evaluate numerically the effectiveness of agri-environment measures. This requires a revised DPSIR framework, a set of soil erosion indicators and measurements/observations for full analysis of the soil erosion problem in different agro-ecological zones and agri-environments (Gobin *et al.*, 2004).

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