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RESOURCE EFFICIENCY

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European Network for Rural Development

The European Network for Rural Development (ENRD) is the hub that connects rural development stakeholders throughout the European Union (EU). The ENRD contributes to the effective implementation of Member States' Rural Development Programmes (RDPs) by generating and sharing knowledge, as well as through facilitating information exchange and cooperation across rural Europe.

Each Member State has established a National Rural Network (NRN) that brings together the organisations and administrations involved in rural development. At EU level, the ENRD supports the networking of these NRNs, national administrations and European organisations.

Find out more on the ENRD website (https://enrd.ec.europa.eu)

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Introduction

This edition of the EU Rural Review focuses on the resource efficiency challenge and examines what the concept of 'doing more with less' means for rural development in this regard.

The Earth's natural resources are fundamental to health, well-being and quality of life on the planet. As the global population approaches 9 billion, these resources are under mounting strain.

Transitioning to a green economy implies a societal transformation in production and consumption habits. New technologies, renewable energy and recycling are all part of the mix of solutions. However, the move to a green economy is founded on the widely applicable concept of resource efficiency.

Resource efficiency means using the planet's limited resources in a sustainable manner and seeking to minimise impacts on the environment. 'Doing more with less' is an especially pertinent concept for rural development practitioners.

The natural environment – notably soil and water – powers the rural economy. Sustainable land-management practices support valuable ecosystem services and help in the fight against the effects of climate change. A healthy environment implies a healthy rural economy.

The sustainable management of soils and water is a strategic priority for Europe, and is also a key contributor to the achievement of the UN Sustainable Development Goals. Rural Development policy has an important role to play in delivering resource efficiency through the Rural Development Programmes (RDPs).

For the rural economy, the RDPs offer numerous pathways to creating greater value from fewer inputs. While the business case for resource-efficient behaviour gets stronger as pressure on natural resources increases, practical steps are required to encourage an even greater rate of change.

The ENRD's Thematic Group on 'Resource-Efficient Rural Economy' has provided valuable insight into how resource efficiency is practised in rural areas and how wider take-up can be promoted. In framing, the problem of how to improve soil and water management, the work identified the three gaps – motivation, knowledge and policy – that can impede resource efficiency. More importantly, the group has identified how the RDPs can be shaped to deliver more and help make change happen. This edition of the EU Rural Review highlights how rural areas can become more resource-efficient and is focused exclusively on water and soil management.

STRUCTURE OF THE PUBLICATION

1. The resource efficiency challenge

The introductory article to this edition of the EU Rural Review outlines the international and European policy contexts behind the vision of economic activity based on efficient use of natural resources. It then examines what this vision means for Europe's rural areas and the gaps that need to be bridged before pathways to making change happen are identified.

2. Water-efficient rural activities

Rural activities are dependent on water. As Europe adapts to the effects of climate change, this article considers the rural impact on water use and what can be done to tackle water scarcity. It examines the potential of new irrigation techniques and alternative water sources to increase efficient use of water at farm level, considers the role of other rural users of water, and highlights the need for river basin-scale management of water sources.

3. Soil and carbon conservation

Soils can contribute to increased greenhouse gas emissions and multiply the impacts of climate change, or they can support carbon storage and climate change mitigation. This article examines how to sustain the ecosystem services soil provides to society. Coordinated management by several stakeholder groups can be essential for effective long-term management of soil across a territory.

4. The LIFE programme and rural development

The article profiles the EU's LIFE programme. LIFE supports activities which can strongly contribute to rural development and resource efficiency objectives. LIFE demonstration and pilot projects provide many examples of inspiring and sustainable practices that can be replicated by the agricultural and other rural business sectors.

5. Integrated approaches

Continuing to increase production while using fewer natural resources in the rural economy requires a coherent approach. The article looks at the role of EU Rural Development policy in supporting resource efficiency and how it can best encourage the more widespread use of sustainable practices for soil and water management in particular.

6. Improving resource efficiency through the RDPs

How can the Rural Development Programmes (RDPs) be best used to support improved management of natural resources? The article shows examples of how the RDPs are playing a vital role in supporting resource efficiency, offering flexible approaches adapted to the different contexts and needs across rural areas in the EU.

The ENRD Contact Point

1. The resource efficiency challenge

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At the most basic level, resource efficiency is the notion of ‘doing more with less’ and is essential to sustain socio-economic progress in a world of finite resources and ecosystem capacity.

In addition to being key for climate mitigation and adaptation, resource efficiency is especially pertinent for the long-term sustainability of agriculture and forestry. This point has been articulated internationally through the UN's Sustainable Development Goals (SDGs) and again more recently at the European level and specifically in the context of rural development, through the Cork 2.0 Declaration.

The sustainable management of natural resources is an EU policy objective for rural development. This article outlines the significance of the resource efficiency concept in an international and European policy setting. It considers the implications in the specific context of rural development, by building on the work carried out by the ENRD Thematic Group on 'Resource-Efficient Rural Economy' which has analysed how soils and water can be managed more sustainably.

A VISION OF RESOURCE EFFICIENCY

MIND THE GAP

MAKING CHANGE HAPPEN

A VISION OF RESOURCE EFFICIENCY

Natural resources underpin the functioning of the global economy and have a special relevance for the rural economy. Resources such as soils and water are an inherent part of the ecosystems upon which the agriculture and forestry sectors depend. Despite their importance, pressure on these natural resources remains a central challenge in achieving sustainable development.

Adding to this pressure are the impacts of climate change, which is altering production patterns, water cycles and ecosystem functions. The **State and Outlook of the Environment Report** [1] from the European Environment Agency highlights that despite progress in reducing environmental pressures, there is much that still needs to be done to achieve a low-carbon society, a green economy and resilient ecosystems.

The importance of improving the efficient use of resources is explicitly recognised at the global scale in the **United Nations' Sustainable Development Goals (SDGs)**. Five of these SDGs have specific relevance for the use and management of soils and water in rural sectors in relation to food production, the availability and quality of fresh water, protection of terrestrial ecosystems and oceans, and combatting climate change (see page 6). Governments have the primary responsibility for follow-up and review of progress in meeting the 2030 target of sustainable management and efficient use of natural resources.

The **Paris Agreement**, which entered into force on 4 November 2016, was a notable landmark in the international commitment to tackle climate change and establishes a new ambition for climate mitigation efforts globally. The EU and over 170 other parties have ratified to date. The agriculture sector is set to play a significant role in reaching the targets set.

Europe has long championed sustainable development. This is reflected in the mainstreaming of sustainability in a number of high-profile initiatives such as **Europe 2020**, the growth strategy that aims to make the EU a smart, sustainable and inclusive economy. The **resource-efficient Europe flagship initiative** [2] is part of the Europe 2020 strategy. The initiative supports the shift towards sustainable growth via a resource-efficient, low-carbon economy. It includes a roadmap to a resource-efficient Europe [3]. The roadmap outlines the structural and technological changes needed by 2050, including milestones to be reached by 2020. It proposes ways to increase resource productivity and decouple economic growth from resource use and its environmental impact. Key resources are analysed from a lifecycle and value-chain perspective. The roadmap also illustrates how the various resource-focused policies interrelate and build on one another.

The **EU's Circular Economy Action Plan** [4] further promotes a fundamental transition away from a linear economy, towards one where resources are not simply extracted, used and thrown away, but are recycled so they can stay in use for longer. It sets out measures driving a more efficient use of resources and waste minimisation.

The abovementioned policy goals and commitments only scratch the surface of the many initiatives underway at

THREE RESOURCE EFFICIENCY CHALLENGES

The ENRD Thematic Group on 'Resource-Efficient Rural Economy' focused on three key challenges for rural areas.

Soils and nutrients

To encourage the resource-efficient use of nutrients, reduce water pollution, prevent soil compaction and erosion and promote approaches to increase ecosystem resilience and improve productivity.

Soils and carbon

To improve the carbon conservation and sequestration potential of soils, to improve soil health and contribute towards climate mitigation and adaptation.

Water availability

To improve the efficient use of water in rural areas, reduce water demand and stress and address floods and extreme events.

(1) European Environment Agency, 'The European Environment - state and outlook', 2015: https://www.eea.europa.eu/soer

(2) European Commission, 'Resource-efficient Europe flagship initiative': http://ec.europa.eu/environment/resource_efficiency/index_en.htm

(3) European Commission Communication, 'Roadmap to a Resource-Efficient Europe', 2011: http://ec.europa.eu/environment/resource_efficiency/about/roadmap/index_en.htm; http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0571

(4) European Commission, '2018 Circular Economy Package': http://ec.europa.eu/environment/circular-economy/index_en.htm

United Nations' Sustainable Development Goals (SDGs) relating to the resource-efficient use of soils and water

SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

2.4 - By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.

SDG 6: Ensure access to water and sanitation for all

6.3 - By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

6.4 - By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

6.5 - By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

6.6 - By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.

SDG 12: Ensure sustainable consumption and production patterns

12.2 - By 2030, achieve the sustainable management and efficient use of natural resources.

SDG 13: Take urgent action to combat climate change and its impacts

13.1 - Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.

SDG 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss

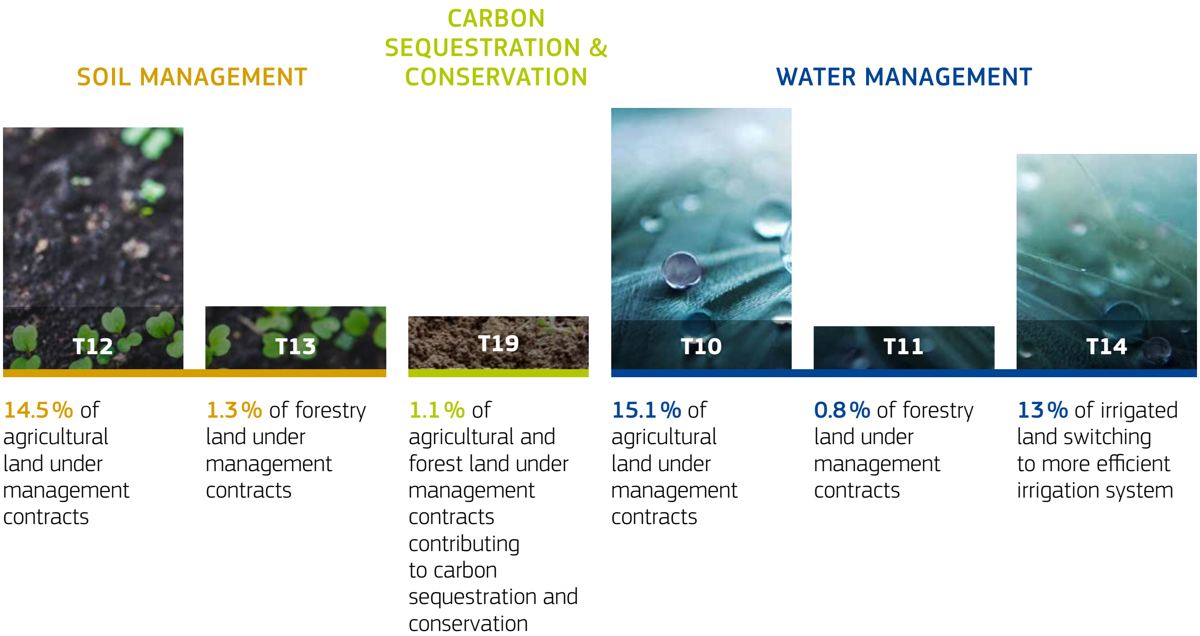
15.1 - By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.

15.2 - By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.

15.3 - By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.

Source: United Nations, 2015

Figure 1. RDP targets – soils and water



Source: European Commission's Directorate-General for Agriculture and Rural Development

the global and EU levels. While each initiative has its specific goals, taken together they are delivering a coherent message: resource efficiency is a priority for all sectors of the economy.

Rural development practitioners are considering how they can best realise this vision of economic activity based on efficient use of natural resources. What can be done to make sure policy, financing, investment, research and innovation are all pulling in the same direction?

Today's Rural Development Programmes (RDPs) are already investing in activities that support resource efficiency. At least 30 % of the European Agricultural Fund for Rural Development (EAFRD) funding component of the RDPs must be reserved for Measures[5] contributing to the environment and climate, though in practice, the actual share is considerably higher at 52 %, according to recent figures. Specific RDP Focus Areas (FAs) relate to resource efficiency in relation to soils and water.

Priority 4: Restoring, Preserving and Enhancing Ecosystems includes FA 4B: Improving water management and FA 4C: Preventing soil erosion and improving soil management. Priority 5: Promoting resource efficiency and supporting the shift towards a low-carbon and climate-resilient economy in agriculture, food and forestry sectors, includes FA 5A: Increasing efficiency in water use by agriculture and FA 5E: Fostering carbon conservation and sequestration in agriculture and forestry. These Focus Areas can draw on a wide range of RDP Measures and tools.

In addition, Pillar 1 of the Common Agricultural Policy (CAP) supports the use of climate- and environment-friendly farming practices such as crop diversification, maintaining permanent grassland or 'ecological focus areas' (which include hedges, trees, fallow land, biotopes, buffer strips or nitrogen-fixing crops), through greening requirements for receipt of direct aids. EU Member States are required to use 30 % of their national funding allocations for this greening payment.

(5) These comprise the following seven Measures: M4 for environmental and climate investments; M8 for investments in forest area development and improvement of the viability of forests; M10 for Agri-environment-climate payments; M11 for organic farming; M12 Natura 2000 (except payments related to the Water Framework Directive); M13 payments for areas facing natural and specific constraints; and M15 for forest-environmental and climate services and forest conservation.

MIND THE GAP

While the advantages of resource efficiency are clear, the challenge from a rural perspective is getting the productive sectors to move at the required pace. Improving efficiency and reducing the pressure on natural resources is not only about updating current practices, it is also about seizing business opportunities. Greater efficiency reduces costs, enables production systems to become resilient to climate change, and can stimulate growth and jobs in the rural sector.

Changes in approach to waste management also have positive implications for rural economies, such as the creation of new bioeconomy industries exploiting residues, by-products and waste to produce energy. New technologies and processes are creating new markets and policy-makers and stakeholders are working closely to increase competitiveness in European bioeconomy sectors, including via the LIFE programme (see chapter 4).

It is clear that resource efficiency is a core objective of the CAP and that agriculture is expected to play its part in attaining Europe's SDG and climate commitments. So what more could rural development practitioners be doing to make sure that rural areas become champions for resource efficiency?

'Greening the Rural Economy' is one of the broad themes being explored by the ENRD Contact Point in the 2014-2020 programming period. The **ENRD Thematic Group on 'Resource-efficient Rural Economy'** has identified three gaps[6] that need to be addressed if Europe's rural areas are to be successful in the drive towards resource-efficient management of soil and water.

The motivation gap

Despite the potential benefits, some rural actors are reluctant to improve the management of soils and water in a way that benefits both their farms and the environment. The main reasons for this are linked to the perceived risks of adopting new or different approaches and the time it can take to see a return on investment; a lack of understanding about the economic impacts on farm businesses; and a potential need to invest time to become familiar with new practices compared to those with which they are familiar. So, how can farmers and Managing Authorities be encouraged to invest in the resource-efficient management of water and soils? In most cases, being more resource-efficient will lead to economic and environmental benefits over time. This may be in terms of reduced costs for fuels or machinery and increased productivity through better functioning of soils.

The knowledge gap

Understanding of how to encourage the resource-efficient management of soils and water varies considerably across the EU and between different rural actors. In the farming sector, resource efficiency is generally viewed from a production perspective and with a primary focus on short-term savings. Yet, farmers may take less account of aspects whose implications for productivity are longer-term in nature, for example impacts of land

THEMATIC GROUP ON 'RESOURCE-EFFICIENT RURAL ECONOMY'

The ENRD Thematic Group (TG) on 'Resource-efficient rural economy'[7] ran from July 2016 to July 2017. Part of the broader ENRD thematic work on 'Greening the Rural Economy', it sought to identify how RDPs could help to improve the efficient use and management of resources fundamental to agricultural production.

The TG, composed of rural experts and practitioners, undertook case studies in selected EU Member States and identified good practice examples and approaches. It decided to focus on improving soil and water quality through efficient land and nutrient management; improving water-use efficiency to reduce the pressure on water systems and improve water availability; managing carbon conservation and sequestration in soils.

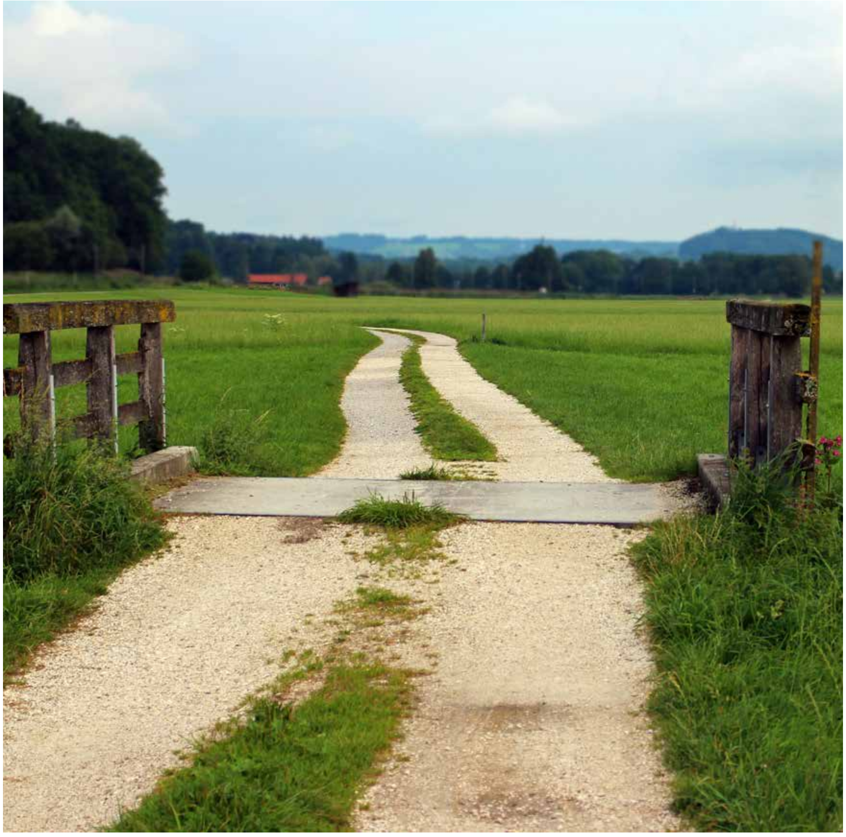
The TG highlighted how strategic combinations of RDP Measures can provide the tools and opportunities for resource efficiency and offer approaches that can be adapted to the different contexts and needs across rural areas in the EU. The TG also emphasised the need for coherence with other policies and interventions, as well as the use of schemes promoting sustainable resource management, including new results-based approaches.

The work of the TG emphasised that building a truly sustainable and resource-efficient rural economy requires multi-stakeholder engagement involving actors along the agri-food supply chain from farmers to consumers and policy-makers.

(6) For more about the three gaps: https://enrd.ec.europa.eu/sites/enrd/files/tg_reseff_factsheet-low-res_fin_0.pdf

(7) https://enrd.ec.europa.eu/thematic-work/greening-rural-economy/resource-efficiency_en

management on delivering ecosystem services, such as building soil organic matter or natural flood management. Knowledge of how to improve resource efficiency is geographically dispersed, such as good understanding of irrigation practices in the Mediterranean region or flood management in northern parts of Europe. Transferring this existing knowledge to areas that are experiencing new soil and water problems as a result of climate change is as important as developing new approaches or reviving traditional techniques.



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The policy gap

In addition to resource efficiency being an objective of EU Rural Development policy in its own right, improving use of soils and water is an objective of a range of other policy instruments, such as the Water Framework Directive and the Sustainable Use of Pesticides Directive. RDPs are a key tool to support the delivery of some of these related policies. Yet, due to a variety of reasons such as implementation timing and inter-institutional factors, these policy instruments do not always work well together. Enhanced coordination between environment and agriculture ministries should be actively encouraged. In the design of other policies, consideration should be given as to how the RDPs can best be used to support implementation. Likewise, the design and implementation of RDPs could be improved, such as ensuring that Measures, support and compliance rules are enabling, not constraining good practice.

MAKING CHANGE HAPPEN

Deterioration of natural resources undermines the future basis of rural productivity. The protection and careful management of water and soil resources should be understood as an investment in the quality of environmental services and thus, the long-term productivity of rural businesses.

Today's reality is that agriculture remains a significant source of soil degradation, water pollution and over-abstraction. Trends in soil characteristics set out in various pan-European reports indicate that the pressures on soils are increasing and the overall condition of soils continues to decline. Diffuse water pollution affects 90 % of Water Framework Directive (WFD) river-basin districts and agricultural production is a primary source of harm. Significant nutrient loads (nitrogen and phosphates) from agriculture run-off remain an issue in some areas.

The case studies undertaken by the ENRD Thematic Group found that farmers' decisions often seem to be governed by short-term considerations related to economic and policy factors (e.g. the profitability of crops, an immediate return on resource-efficiency investment, the effect of other regulatory mechanisms, and the level of subsidy for any given intervention). Decisions are to a lesser extent motivated by the longer-term benefits to the environment and resource base. In all case study territories, the knowledge, motivation and policy gaps are intertwined.

For these reasons, the TG made the following recommendations for an improved use of the RDPs to support resource efficiency:

- Engaging farmers and stakeholders from the outset of the process of RDP Measure design and implementation is important to ensure buy-in across the farming and rural sectors. Willingness to adopt resource-efficient practices is generally higher in *younger farmers* and those who have had the latest training and education. So, it is important to target them effectively.
- Farmers' commitment to a more sustainable use of natural resources could be enhanced by improved *advisory services*. The ratio of scheme advisors to farmers should also increase. Targeted educational packages for farm contractors and other actors should be developed in parallel to those of farmers.
- To improve motivation, *schemes should be flexible* so work can be tailored to the context of specific geographic areas and at farm level.
- Greater use of the Cooperation Measure (M16) can improve interaction between crop and livestock producers and with the wider supply chain. For example, to improve flexibility for farmers to adapt to new and changing priorities as they arise, M16.1 (EIP-AGRI Operational Groups) working in synergy with M16.2 (pilot projects), and LIFE funding could be used to test results-based approaches for resource efficiency objectives before being mainstreamed.
- To engage those farmers who are more willing to make changes, RDPs should target support towards *lifelong-learning*, encouraging all farmers willing to be more resource-efficient.
- Where a significant shift in the way land is managed is required, consideration should be given to the *type of financial support and advice required* during the transition period.
- More generally, to help farmers access EAFRD support, Managing Authorities should work with farmers to develop *easier ways of applying for schemes* and projects.
- To help build knowledge at farm level, *long-term monitoring* should be developed to demonstrate the impacts of resource efficiency actions on productivity and the environment over time. To support this idea, RDPs should be used to test and develop reliable indicators – specifically, better reporting of soil and water conditions at local and regional levels.
- To ensure that resource efficiency is addressed *in areas that are most vulnerable to water and soil degradation issues, stringent sustainability criteria need to be applied* – building on the example of rules regarding investment in irrigation as set out under the Rural Development Regulation[8].

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(8) See article 46 of Regulation (EU) No 1305/2013: https://ec.europa.eu/agriculture/rural-development-2014-2020/legislation_en

2. Water-efficient rural activities

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Increasing water scarcity and rising energy prices are accelerating the need for governments and farm businesses to re-assess rural water management policies and practices. In 10% of Europe's surface water bodies (rivers, lakes and reservoirs), water is being withdrawn at such a rate that downstream water users are deprived of water or habitats that depend on water are becoming degraded. At the same time, in 20% of Europe's groundwater bodies, water use exceeds the rate of recharge, leading to long-term depletion and to saltwater intrusion into freshwater resources in coastal areas.

This article considers the rural impact on water use and what can be done to tackle water scarcity. It examines the potential of new irrigation techniques and alternative water sources to increase efficient use of water at farm level, looks at the other rural users of water, and highlights the need for river-basin scale management of water sources.

WATER SCARCITY IN THE EU

WATER SAVING AND AGRICULTURE

USING ALTERNATIVE WATER SOURCES

BASIN-SCALE WATER EFFICIENCY

WATER SCARCITY IN THE EU

Much of the EU, particularly the Mediterranean region, is exposed to increasingly frequent and severe droughts during summer. For example, 2017 saw significant droughts in Spain, Italy and Portugal. But droughts are also a problem in more temperate countries, such as Denmark, the UK, Belgium and Bulgaria, and in all, around 20 river basin districts in the EU have been identified as at risk from summer water stress[1].

A growing European population will increase demand for food (which will require more water to produce) and increase demand for water for domestic (household) and industrial use. Bringing surface and groundwaters back to a good environmental condition inevitably implies leaving more water in ecosystems to maintain environmental flows and, therefore, a reduced allocation for competing water uses.

Climate change is also projected to lead to an increase in the area under supplemental irrigation[2] and the total irrigation water demand, as well as to reduce river flows in many basins. These impacts are expected to be more acute in southern Europe, where water shortages are likely to be more common. Despite some potential climate-related positive impacts on agriculture in northern Europe, a greater reliance on supplemental irrigation (particularly for high-value vegetable cropping) to cope with increased year-to-year variability in rainfall may nonetheless increase water demand in dry years.

WATER SAVING AND AGRICULTURE

Although water demand for domestic and industrial use is lower in rural areas, agriculture is an important contributor to the problems of chronic water scarcity ,and short-term drought and its effect on the whole river basin need to be considered. Across the EU, 44 % of all freshwater withdrawal is used for agriculture[3] – mostly for irrigation – but this ranges from very little in some countries in northern Europe to approximately 80 % in the more arid parts of southern Europe (notably Spain, Greece and Portugal).

Even where agriculture accounts for a smaller proportion of water withdrawals, it often requires most water at the driest times of year and in the driest locations. For example, in the UK, where water withdrawals for agriculture account for less than 2 % of total withdrawals, in some catchments and at some times of the year, agriculture can be the largest water user.

The impact of agricultural water use can also be greater than for other uses, such as industry and public water supply, as water used for irrigation is to a large extent 'consumptive'. That is, in the short term, water used for plant growth is lost through transpiration and does not return directly to the river

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(1) http://data.consilium.europa.eu/doc/document/ST-8705-2017-INIT/en/pdf

(2) Supplemental irrigation is the addition of small amounts of water to crops when rainfall fails to provide sufficient moisture for normal plant growth.

(3) https://ec.europa.eu/agriculture/envir/water_en

basin. As a result, there is now a policy expectation on farmers to consume less water whilst maintaining, or even increasing economic output – that is to produce more from less, sometimes referred to as 'more crop per drop'. Fortunately, there is considerable scope in many rural areas to reduce water use by careful consideration of return flows and selection of water-efficient equipment and technology, and particularly through improved management and operation.

ENERGY EFFICIENCY TRADE-OFFs

The modernisation of the irrigation system of the Flumen Canal[4] in Huesca (Spain) has replaced traditional surface-irrigation systems with a new pressurised irrigation network allowing the use of sprinklers. Over 1 000 ha have been modernised with water savings of 30 % and higher crop yields.

However, switching to pressurised irrigation systems results in increased demand for energy, so, for example, although the national demand for irrigation water in Spain[5] fell by 21 % between 1950 and 2007, energy demand increased by 657 %. The trade-off between water and energy efficiency therefore needs to be carefully considered.

Crops

In cropping systems, although small amounts of water are used for spraying and washing machinery and produce, by far, the greatest volumes of water are used for irrigation.

Agriculture tends to use three application methods, namely, surface irrigation, sprinkler irrigation, and drip (also known as trickle or micro) irrigation. With surface irrigation, water is distributed by gravity-fed open channels and directed into furrows, basins or border strips. Since water flows by gravity, no energy or other structures (pumps, filters) are required and thus, surface irrigation is the cheapest method. It is widely used in Bulgaria, Croatia, Italy and Portugal (as well as in parts of Greece and Spain). Although well suited to large-scale extensive cropping, surface irrigation is often inefficient, requiring up to three times as much water to be withdrawn from the water source than is actually required by the crop as water is lost in deep drainage and run-off.

Delivering water under pressure through piped systems to sprinklers increases the energy requirement, but can increase water application efficiency. Water losses in piped systems are minimal and well-designed fixed or mobile sprinkler systems are capable of providing uniform water applications across a wide range of crop types and soil conditions, minimising run-off and deep percolation. However, they are susceptible to wind drift and evaporation losses. Typically, sprinkler systems achieve efficiencies of 60-90 %.

Exposure to rising energy costs has highlighted the risk of switching to pressurised 'on-demand' irrigation systems as they can constrain opportunities for maximising crop productivity and water efficiency. With drip irrigation, only part of the soil profile around the roots is wetted and this direct connection between the irrigation system and the plant (and the fact that fertiliser can be delivered with the water) offers potential advantages of water saving and improved yields and crop quality.

Lower operating pressures mean lower energy costs and automation offers scope for savings in labour costs, therefore it is particularly attractive in regions where water is scarce and/or expensive. While measuring and objectively comparing water efficiencies between different irrigation systems is notoriously difficult, estimates for drip irrigation suggest efficiencies up to 95 % are potentially achievable.

In Europe, there has been an interest in promoting drip irrigation to save water. In many cases, drip irrigation has led to improved yields and crop quality, but water savings have not been significant, probably reflecting the low marginal cost of water for irrigation and farmer priorities to use drip irrigation to maximise nutrient uptake, rather than save water *per se*[6].

The water required is determined by the crop and evaporating conditions, not the irrigation method. Potential water savings can be derived from reducing water losses normally associated with sprinklers – spray evaporation, wind drift, over-irrigation to compensate for poor uniformity, and evaporation from foliage and soil. However, the agronomic demand for water remains the same irrespective of the method of application.

Largely in response to rising energy and labour costs, there has been a significant modernisation across Europe over the last few decades involving the conversion of gravity-fed surface irrigation to pressurised sprinkler systems, and more recently, the switch from sprinkler to drip irrigation.

(4) http://enrd.ec.europa.eu/enrd-static/policy-in-action/rdp_view/en/view_project_8240_en.html
(5) Corominas, J., 'Agua y energía en el riego en la época de la sostenibilidad', 2010: https://polipapers.upv.es/index.php/IA/article/view/2977
(6) Knox, J.W. and Weatherhead, E.K., 'The growth of trickle irrigation in England and Wales', 2005: http://79.170.40.182/iukdirectory.com/iuk/journals/34/KnoxAndWeatherhead.pdf

Irrigation management

To a large degree, inefficiency in irrigation is due to management – applying water at the wrong time or applying more than the crop needs leads to water wastage. There are many examples of poorly managed modern drip irrigation systems that are less efficient than well-managed traditional surface irrigation. Guidance on how much water to give to a crop and when (irrigation scheduling) can be supported by monitoring the soil-water conditions with electronic sensors and estimating plant water demand through automatic weather stations and satellite imagery.

CUTTING-EDGE IRRIGATION PRACTICE

A better understanding of the effect of water stress on plants at different growth stages is allowing irrigation of crops to be managed more precisely in response to actual water need. Techniques such as deficit irrigation and partial root drying are being adopted by some farmers to reduce the amount of water used whilst maintaining yield. In the Mediterranean region, for example, the APMed project(7) has been researching how water restriction can be managed in apple and peach orchards. It has shown how the water use can be significantly reduced without affecting yield or quality by deficit irrigation and crop shading.

Precision irrigation

Irrigation systems are constrained by their ability to vary water application spatially in order to better match the inherent variation in soil or topography, or due to sequential crop production patterns. Inspired by precision agriculture, precision irrigation aims to deliberately apply water differentially in response to variations in soil type, soil moisture, crop growth, topography and any in-field obstructions (e.g. hedges, roads, electricity pylons). By matching water application precisely to crop water requirements, very high rates of efficiency should be achievable.

Most research is being undertaken in countries such as Australia and New Zealand where variable rate irrigation is being implemented on high-value horticultural crops or grassland (to support dairy farming).

In Europe, the uptake of precision irrigation technologies has been slow(8), with low levels of investment, reflecting the relatively low cost of irrigating. However, as competition for water drives up water costs and if labour and energy costs increase, the economic feasibility will change, leading to greater adoption of both technology and management interventions to support improved water-use efficiency.

Other sectors

Apart from irrigation and livestock drinking water, many water uses in rural areas are largely non-consumptive. That is, the water is withdrawn from the source, used for a particular purpose, and the wastewater (effluent) is returned in a short time. Most of the water used in homes is returned to the environment via sewers and water-treatment facilities, or discharged to land. As long as the water is returned in a good condition, it can be re-used elsewhere in the basin.

During periods of low flows, many watercourses are augmented by discharged waste water from non-consumptive uses. However, these uses can also contribute to water scarcity if the water is withdrawn at a time of shortage and returned to a different water body or at a time when it is not needed. For example, the water stored in a reservoir may be the only water available during the summer. Excess water withdrawals during the summer will deplete the reservoir during the critical time of year and the effluent may be discharged downstream, where it is not required, or to land, where it may take a long

(7) https://ec.europa.eu/eip/agriculture/en/find-connect/projects/apmed-managing-water-scarcity-apple-and-peach

(8) Monaghan, JM et al., 'More 'crop per drop': constraints and opportunities for precision irrigation in European agriculture', 2013: https://www.ncbi.nlm.nih.gov/pubmed/23436218 and
European Parliament, 'Precision agriculture and the future of farming in Europe', 2016: http://www.europarl.europa.eu/RegData/etudes/STUD/2016/581892/EPRS_STU(2016)581892_EN.pdf

time to recharge the groundwater. By using water more efficiently, the same activities can be carried out with less withdrawal and therefore, less pressure on water resources.

Across Europe, 20 % of water abstraction supplies public water systems for household use, industry, services (e.g. schools, hospitals) tourism and recreation (e.g. swimming pools). As with agriculture, efficiencies of water use result from improvements in technology and management. Water losses between source and user arise from leakages in the public water infrastructure. Where the infrastructure or conditions are unfavourable, leakage can account for up to half the water supply [9]. Upgrading infrastructure to reduce the leakage rate can reduce withdrawals and the energy required to distribute water, but can be expensive and cause considerable disruption.

For instance, under the Romanian RDP, investment in some 2 600 km of water and water-treatment infrastructure in rural communes is planned, with one objective being the upgrading of outdated systems to reduce water losses.

The LIFE programme project PALM[10] has trialled a decision support system to allow water companies to balance leakage reduction and economic sustainability. In a case study in Perugia in central Italy (with 120 000 customers), it showed how even reducing the leakage rate to around 26 % would save 2.3 million m^3 of water and € 1.5 million each year.

USING ALTERNATIVE WATER SOURCES

Where water from traditional surface and groundwater sources is scarce, there may be alternative sources. While not strictly saving water, they can reduce the pressure on water bodies and the public water supply at critical times. This may be important for protecting high-value water uses (e.g. industry, tourism) and sensitive habitats. It can also save the farmer money and may be more reliable than traditional water sources during droughts. Although water quality is very important for livestock and human consumption, with the right treatment, recycled, reclaimed or harvested water can be used for many rural operations. For example, lower grade water can be used for cleaning and crop, and landscape irrigation.

The use of on-farm water storage, such as small reservoirs, provides security of supply by allowing water storing to take place during periods of water excess and supplements water use during periods of scarcity, provided that the storage volume is large enough. They may also provide resources for wildlife and recreation (e.g. angling).

Water that is not consumed can be saved after first use and recycled for another process. For example, in dairy parlours, milk-cooling water can be re-used for animal drinking or washing. However, the opportunities for recycling depend on the quality of the water after the first use and water used for animal hygiene or yard cleaning may require solid-separation and treatment before re-use.

Increasingly, treated wastewater is providing a reliable soure for rural areas, particularly those located close to large centres of population. For example, in Cyprus, over 20 million m^3 per year of tertiary treated effluent is re-used, mostly for irrigation. However, strict rules apply for the uses that may be made of the recycled water and they are dependent on the treatment level.

The EAFRD has supported a modernisation programme at a seedling nursery in Cyprus [11] with co-financing for the installation of a 'smart' irrigation system, including automated desalinisation of underground water, collection of rainwater, and wastewater collection and treatment. As a result, costs and water use have decreased and product quality has been improved.

(9) https://www.eea.europa.eu/data-and-maps/indicators/water-use-efficiency-in-cities-leakage/water-use-efficiency-in-cities-leakage
(10) http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3738
(11) http://enrd.ec.europa.eu/enrd-static/policy-in-action/rdp_view/en/view_project_841_en.html

BASIN-SCALE WATER EFFICIENCY

Many EU Member States have opted for a twin-track approach to improving water efficiency in both urban and rural settings, combining a range of supply-side interventions (including investment in new sources of supply and increased reservoir storage) with demand-management options (such as improved technology, smart metering, leakage reduction, recycling). Although investment in water-efficient technologies costs money, using less water reduces costs – especially the cost of energy to move, pressurise, heat or cool water. In addition, a lot of inefficient water use is due to poor management, which may cost little to correct.

An essential starting point is to understand how much water is being used, where and when. This requires regular reading and recording of water meters and an audit of water flows. Usage can then be benchmarked and anomalies – where water use is greater than expected – can be identified. Businesses can prepare a water management plan that combines investment in water-efficient technology and/or changes in management practices and behaviours to make best use of water. Re-using water, recycling, or using alternative sources can then be considered where the water quality is appropriate for the intended use.

It is important to note that increasing farm-level water efficiency may not necessarily make more water available for other uses. If water availability is the limiting factor for growth, then being more water-efficient means that less water needs to be withdrawn to support the same level of activity. However, if water generally has a low cost to the user, there is a business advantage in using the water that has been 'saved' to increase output.

Irrigation modernisation can increase water productivity at the farm level, but there is little evidence that it has resulted in basin-scale water savings [12]. Consequently, in water-stressed basins, good governance is necessary to ensure that water saving at the level of individual businesses is translated into sustainable resource management. This requires: an understanding of the needs of the whole river basin for agriculture, households, industry and environment; allocation of water-withdrawal rights across sectors in a way that reflects social, economic and environmental sustainability; and monitoring and control of water use to ensure that rights are not abused. This starts at the political level by setting goals for water management, but has to be implemented locally by basin authorities with the active engagement of the public water utilities, businesses and the local population.

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(12) http://www.fao.org/policy-support/resources/resources-details/en/c/897549/

3. Soil and carbon conservation

Soil is generally defined as the top layer of the Earth's crust, formed by mineral particles, organic matter, water, air and living organisms. It is the interface between land, air and water and represents a vital resource enabling the production of food, the preservation of biodiversity, facilitating the natural management of water systems and acting as a carbon store. As such, soil health is an indicator of wider environmental quality and resilience. As its formation is an extremely slow process, soil can be considered a non-renewable resource.

Soil management choices can either compound existing challenges of loss of fertility and questions around food security, or facilitate a more robust and climate-resilient future. In the context of climate change, soils can contribute to increased greenhouse gas emissions and multiply the impacts of climate change, or support carbon storage and climate mitigation. This article examines the management approach needed to protect and maximise the ecosystem services soil provides to society.

UNDERSTANDING SOILS AND RURAL LAND

IMPROVING SOIL CARBON CONSERVATION

BOOSTING SOIL HEALTH

UNDERSTANDING SOILS AND RURAL LAND

"Soils are fundamental to life on Earth but human pressures on soil resources are reaching critical limits. Careful soil management is one essential element of sustainable agriculture and also provides a valuable lever for climate regulation and a pathway for safeguarding ecosystem services and biodiversity."
FAO, World Soil Charter, 2015 [1]

Soil forms over very long periods of time and once destroyed ,it is effectively lost to present and future generations. Soil formation and its quality are a result of environmental processes, including the effects of weather and climate on the degradation of organic matter and bedrock, alongside man-made interventions to manage and make use of the soil and land for agriculture, forestry or nature. The extent and type of soil degradation relates to the pressures on the soil, including through its management, combined with its natural character and resilience [2].

Soil degradation continues to undermine the functions soils provide and the delivery of ecosystem services. Approximately 22 % of all European land is affected by water and wind erosion. Around 45 % of the mineral soils in Europe have low or very low organic carbon content and an estimated 32-36 % of European sub-soils are classified as having high or very high susceptibility to compaction [3].

Soils across the European Union are extremely diverse. The European Environment Agency (EEA) has identified over 20 major soil types across four climatic zones [4]. There is a range of threats facing Europe's rural soils. These include local and diffuse contamination, soil sealing, soil erosion by wind and water, soil salinisation, decline in organic matter (and loss of associated soil carbon component), soil compaction and soil biodiversity loss [5].

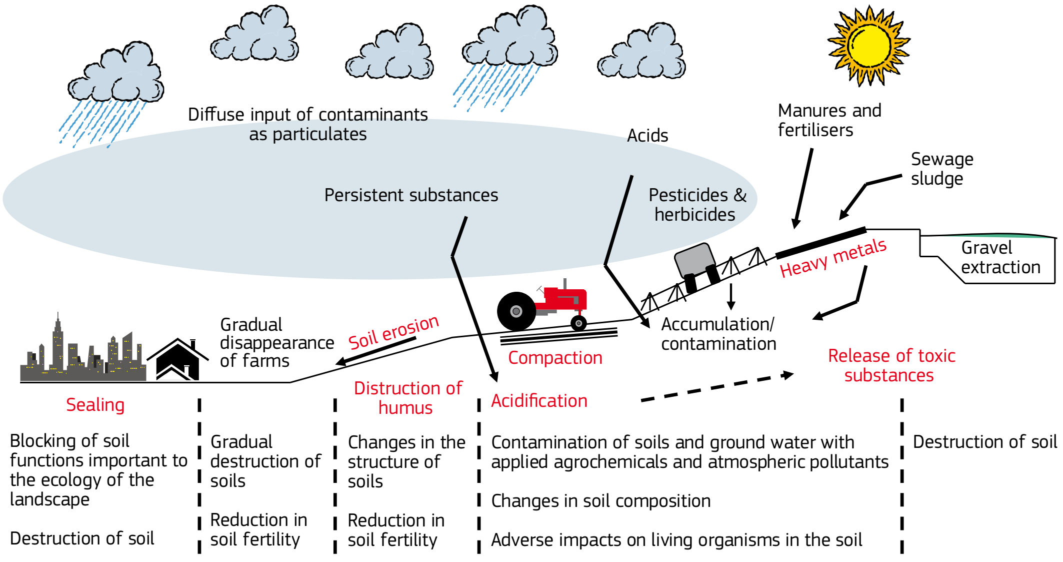
While all the threats will impact soil quality, the type of changes required to combat them and the actors involved varies. For example, soil sealing, i.e. the loss of soil to development, is often cited as a major threat to agricultural soils, but this threat is commonly controlled by spatial planning laws in EU Member States [6]. In comparison, combatting loss of soil organic matter or soil erosion is largely down to the management choices of farmers or foresters for a given parcel of land.

Although soil degradation processes and their visible consequences are often identified and classified separately, this can misrepresent how degradation occurs. Commonly, a range of changes to soil condition will arise at the same time or will mutually reinforce one another. For example, soil erosion is more likely to occur and its intensity to be greater when soil organic matter has declined; soil organic matter loss is closely linked to declines in soil biodiversity; reduced soil biodiversity results in less stable soils, more prone to erosion; soil structure is improved with the addition of soil organic matter; however, soil structure can be lost or decline due to compaction, which in turn will increase the severity of soil erosion.

Solutions adopted by farmers and foresters must reflect the interconnected nature of the factors causing soil degradation if they are to deliver improved soil health. This offers significant insight for those seeking to improve soils since success can be achieved through many different types of intervention and by employing different management tools. Solutions can be tailored to local situations to meet both the needs of the farmers and foresters, and the soil.

(1) Food and Agriculture Organization of the United Nations, 'Revised World Soil Charter', 2015: www.fao.org/3/a-i4965e.pdf
(2) European Parliament, Policy Department Economic and Scientific Policy, 'Land Degradation and Desertification', 2009: http://www.europarl.europa.eu/RegData/etudes/etudes/join/2009/416203/IPOL-ENVI_ET%282009%29416203_EN.pdf
(3) European Environment Agency, 'The European environment - state and outlook 2015': https://www.eea.europa.eu/soer
(4) For further details on European soils, their classification and distribution, see: https://www.eea.europa.eu/data-and-maps/figures/the-major-soil-types-of-europe
(5) This is the list identified in the EU's Soil Thematic Strategy for more information see: http://ec.europa.eu/environment/soil/three_en.htm
(6) Blum, W.E.H., 'Soil and Land Resources for Agricultural Production: General Trends and Future Scenarios - A Worldwide Perspective', 2013: http://www.sciencedirect.com/science/article/pii/S2095633915300265#bb0370

Figure 2. Impact of human activities on soil – demonstrating how different pressures and human-induced threats interact, resulting in the degradation of rural soils[7]



Source: European Commission, Joint Research Centre

UNDERSTANDING SOIL ORGANIC MATTER DECLINE

Soil organic matter consists of a range of materials from the intact original tissues of plants and animals to the substantially decomposed mixture of materials known as humus[8]. Soil organic carbon content (the amount of carbon stored in the soil) is commonly used in indicators to represent soil organic matter and the two are inherently linked in terms of their impact on soil quality, wider environmental benefits and soil fertility.

Organic matter is an important component of soil because of its influence on soil structure and stability, water retention, cation exchange capacity[9], soil ecology and biodiversity, and as a source of plant nutrients. A decline in organic matter content is accompanied by a decrease in fertility and loss of structure, which together exacerbate overall soil degradation and are strongly linked to susceptibility of soils to erosion, compaction and to the level of soil biodiversity.

Human-induced pressures causing losses in soil organic matter are combined with environmental characteristics that are more likely to lead to a more rapid or negative change.

Human activity inducing decline in soil organic matter

- Conversion of grassland, forests and natural vegetation to arable land;
- Deep ploughing of arable soils causing rapid mineralisation of those components of organic matter that are easily broken down;
- Overgrazing with high stocking rates;
- Leaching, i.e. the loss of nutrients from the soil in water;
- Forest fires and deforestation;
- Extraction of peat from mires and peatlands;
- Drainage of wetlands;
- Poor crop rotation and plant residue management, such as burning crop residues.

Environmental factors influencing soil degradation

- Clay content (influences the capacity of soils to protect organic matter from mineralisation and therefore influences rates of change in organic matter content);
- Vegetation pattern;
- Soil biodiversity;
- Climatic conditions;
- Soil erosion by water and wind.

(7) European Commission, Joint Research Centre, 'Threats to Soil Quality in Europe', 2008: http://eusoils.jrc.ec.europa.eu/ESDB_Archive/eusoils_docs/other/EUR23438.pdf

(8) For further details, see FAO, 'The importance of soil organic matter', 2005: http://www.fao.org/docrep/009/a0100e/a0100e00.htm#Contents

(9) A cation is a positively-charged ion. Cation Exchange Capacity (CEC) is the total capacity of soils to hold exchangeable cations. It is an inherent soil characteristic and influences the soil's ability to hold onto essential nutrients and provides a buffer against soil acidification.

IMPROVING SOIL CARBON CONSERVATION

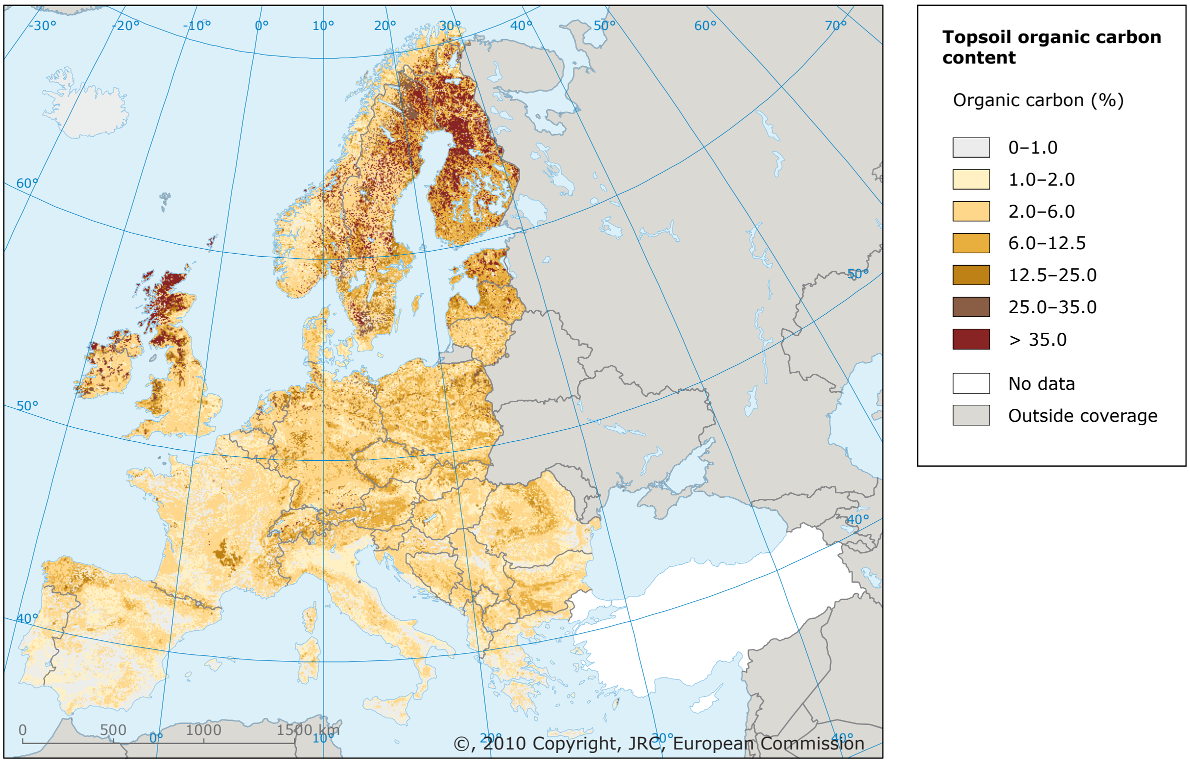
Improved carbon conservation and sequestration in soils provides an important and necessary contribution to healthy soil function. Carbon conservation – as part of Europe's low-carbon transition – is also a key priority for all sectors in society to help with the mitigation of climate change.

Rural sectors can contribute to carbon sequestration through the capture and storage of carbon in soils and biomass. This crucial role is increasingly acknowledged by a growing emphasis on land use and land management in climate discussions. Soil is estimated to be the largest terrestrial store of carbon. From a climate mitigation and adaptation perspective, it is the carbon component in soil organic matter that is the key focus [10]. Research has, however, shown that the global carbon distribution is uneven. Generally, in temperate, cooler parts of the world (including Europe) more carbon is stored in soil than in plants, compared to tropical areas where more carbon is stored in plants than in soils [11]. This means that comparatively, soil organic carbon is even more important to protect in the EU.

Soil carbon levels vary between EU Member States and according to land use. It is generally poor on arable land. It is, however, on arable land that the most significant opportunity for additional carbon sequestration arises [13]. It relates to both changes in land use (i.e. conversion of arable land)

Figure 3. Soil organic carbon content across Europe [12]

Source: European Soil Database, 2003



(10) Inorganic soil carbon is also present in soils as various minerals and salts from weathered bedrock and its role remains under discussion in terms of soil dynamics and fertility. For further details, see: https://www.nature.com/articles/srep36105

(11) Scharlemann, J. P.W., et al., 'Global soil carbon: understanding and managing the largest terrestrial carbon pool', 2014: https://www.tandfonline.com/doi/abs/10.4155/cmt.13.77

(12) For more details, see: https://www.eea.europa.eu/data-and-maps/indicators/soil-organic-carbon-1/assessment

(13) Budiman, M., et al., 'Soil carbon 4 per mille', 2017: https://www.sciencedirect.com/science/article/pii/S0016706117300095

or land management (i.e. applying different agricultural management practices) that result in an increased level of soil organic matter and its retention.

According to the European Environment Agency (EEA), on average, Europe's soils are accumulating organic carbon. Soils under grassland and forests are a carbon sink (estimated as up to 80 million tonnes of carbon per year) while soils under arable land are a carbon source (estimated as between 10 and 40 million tonnes of carbon per year)[14]. These figures highlight the need for a two-pronged approach to simultaneously protect and improve soil organic carbon in rural soils.

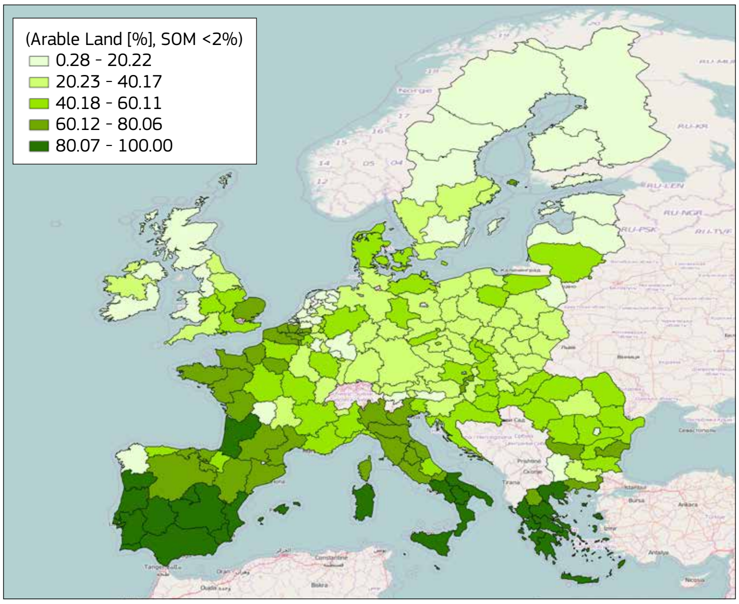
Firstly, existing stores need to be protected, especially the large stocks in peat and other soils with high organic carbon content, as the emission of the stored carbon from these soils could have major potential impacts on carbon balances globally and climate change. Secondly, carbon sequestration in soils needs to increase in order to reduce carbon emissions from arable land caused by land management practices and land use change.

Protecting existing soil organic carbon reserves requires the conservation of existing permanent grassland, forest and the carbon-rich soils that remain. Peat soils are also highly productive farmland in several EU Member States. The area of permanent grassland has seen a downward trend across the EU, although this has slowed in the last decade[15].

Demand for meat from livestock that are grazed, rather than housed, is predicted to decline over the coming decades[16]. In the future, a key challenge will be to prevent the loss of permanent grassland (which is also

Figure 4. Soil organic matter on arable land is generally low – proportion of arable land with less than 2 % soil organic matter[17]

Source: Report for European Commission, Directorate-General Climate Action



often of high biodiversity value and delivers other environmental benefits) either as a result of land abandonment, agricultural intensification, forestry or use as building land.

The management practices that promote soil carbon retention include those that require changes in land use, those that involve changes in crop production patterns, and those that involve managing soil nutrients and the soil resource itself.

- Land use changes include the conversion of arable land to grassland, rewetting of peatland or wetlands and woodland planting. These represent quite significant shifts in land use that may not be compatible with farmers' aspirations or demand from the market. However, actions that do not involve substantive change, yet still increase soil organic carbon include agroforestry, the management of existing hedgerows, buffer strips and trees on agricultural land.
- Actions relating to crop production include:
  - **a.** reducing, minimising or zero tillage systems; and
  - **b.** reducing levels of bare earth and enhancing crop cover.
- Soil and nutrient management aim to change the way nutrients are returned to the soil – this includes management practices involving use of increased crop residue incorporation and the use of manure in a targeted way to replace man-made fertilisers. Alongside this are approaches to better understand and manage nutrients on farms, such as nutrient management plans.

(14) European Environment Agency, 'State of the Environment Report 2015': https://www.eea.europa.eu/soer-2015/europe/soil

(15) Eurostat data.

(16) Report prepared for DG Environment, 'Land as an Environmental Resource', 2013: http://ec.europa.eu/environment/agriculture/pdf/LER%20-%20Final%20Report.pdf

(17) https://ec.europa.eu/clima/sites/clima/files/forests/lulucf/docs/cap_mainstreaming_en.pdf

Actions relating to crop production and nutrient management are best carried out in combination. For example, cover crops, retaining crop residues, soil compaction avoidance and reduced tillage activities, when operated together, can enhance the benefits achieved [18]. These include reducing the speed of soil organic matter decomposition leading to its increase in soil, an enhanced nutrient cycle, enhanced soil structure and increased water infiltration.

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PRESERVING ORGANIC SOILS IN COMBINATION WITH BIODIVERSITY AND WATER

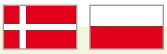
The mountain area of Northern Cantal, France, is part of the Regional National Park 'Volcans d'Auvergne'. It is an area with a wet mountain climate, with significant snowfall, heavy rain and severe winds – conditions that favour peatland formation. In the Rural Development Programme of Auvergne, a dedicated scheme was established in 2015 for 'common mountain pastures', i.e. areas used for grazing of sheep and cows.

The objective of the agri-environment-climate scheme is to preserve the peatland and wet meadows in two Natura 2000 areas. In its initial two-year campaign in 2015-2016, the scheme aimed to include at least 45 % of the sites in northern Cantal, implying contracts covering at least 738 ha to maintain habitat and species diversity, improve water quality, avoid eutrophication of the wetlands and maintain the carbon-sequestration capacity of the peatland and natural meadows. The campaign quickly achieved this goal and the number of contracts is constantly growing. The scheme integrates different forms of EAFRD support, including tailor-made support and advisory services for farmers, consultations between farmers and the local chamber of agriculture, and investment support linked to sustainable farming practices, or investments to improve Natura 2000 sites.

See pp.19-20: https://enrd.ec.europa.eu/publications/eafrd-projects-brochure-resource-efficient-rural-economies_en

Project duration: 2015-2016
Total budget: € 558 688
EAFRD contribution: € 420 066
National/regional contribution: € 138 622
RDP Measure: M10.1 payment for Agri-environment-climate commitments

(18) Frelih-Larsen, A., et al., 'Mainstreaming climate change into Rural Development policy post 2013', 2014: https://www.ecologic.eu/sites/files/publication/2015/mainstreaming_climatechange_rdps_post2013_final.pdf



COMBINATIONS OF SOIL MANAGEMENT PRACTICES

Within the EU research project SmartSOIL[19], real-life stories of farmers who had adopted management practices beneficial to soil organic carbon management were recorded in six countries. The farmers interviewed tended to use more than one management practice to improve soil carbon in positive, reinforcing combinations.

Bjarne Hansen farms 279 ha in Denmark, including clover/grass seed and cereals. He combined minimum-till, crop rotations and residue incorporation. He started using minimum tillage practices due to the difficulty in ploughing soils with high silt content, he then moved to residue incorporation to improve nutrients, soil fertility and soil structure. He noted benefits both in the impact on soil organic carbon levels and in terms of enhanced germination of grass and clover seeds, better precipitation infiltration and growth of mycorrhizae, thus improving soil quality and so reducing pest and disease incidence. He also noted savings associated with the practices due to reduced fertiliser, crop protection and fuel usage.

Jan Rykalski farms a 220 ha arable farm (maize, wheat, rape and lupins) in Poland. The soils on the farm are mainly light, sandy with low carbon content. He used a combination of residue management (which is done across the whole farm), manure application (on approximately 50 ha per year) and reduced tillage or no-tillage (on approximately 60 ha per year). He had always used organic fertilisation and reduced tillage to avoid bringing sand to the surface of the soil. He considered organic fertilisation and residue management to have improved the structure and organic matter of the soil and found that reduced tillage increased resistance to drought and helped retain moisture in the soil. He has also seen benefits in terms of yield increases and reduced costs linked primarily to reduced fertiliser costs.

BOOSTING SOIL HEALTH

The protection of soil resources and improvement in soil health has global consequences for climate change, food security and sustainable development, but requires actions that are locally tailored and knowledge driven to take account of local soil conditions.This in turn requires robust data to understand soil condition and how best to improve or protect the soil in a given situation. For example, how the quality of a particular soil type compares to its natural condition and what management practices could deliver positive change. This requires networks that can support both land managers' decisions on soil management, as well as develop the data to provide systematic and reliable soil knowledge. To date, a key challenge has been a lack of coherent, harmonised and continuous monitoring of Europe's soils. Moreover, where geographically located data exists, this can be highly sensitive given that soil quality may

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(19) http://smartsoil.eu/

be linked to the land's economic value. This limits data sharing and crowd-sourced data.

In Europe there are also policy gaps that inhibit the prioritisation and delivery of soil protection. This is important when considering the need to emphasise the prevention of further soil degradation and the loss of remaining soil carbon. Analysis for the European Commission [20] identifiedthat the lack of a strategic policy framework for soil at the EU level and in many Member States makes it difficult to identify clearly the soil challenges, priorities and solutions. This hinders effective integration of soil considerations into sectoral and environmental policies.

Many of the management practices that can benefit soils generally, and soil organic carbon specifically, are known. Achieving effective protection requires improvements to the policy framework, the data resources, knowledge sharing, advice and financial support to enable on-farm innovation. It also implies a stronger appreciation by all in society of the importance of soil.

© Jukka Rajala, OSMO Project Manager

A COLLABORATIVE NETWORK FOR RESOURCE-EFFICIENT SOIL HEALTH MANAGEMENT

Soil and knowledge are the most important resources of agriculture, according to the OSMO project, a collaborative network that transforms new research findings into practical action and on-farm learning.

OSMO helps farmers who are interested in improving soil health and soil management. The project focuses on four regions, which are top-priorities for managing the Baltic Sea nutrient emissions. Each area has its own typical soils and crop production mixes, ranging from heavy clays to sand and peatlands. It is a joint project between the University of Helsinki Ruralia Institute and Rural Advisory Services ProAgria (Southwestern Finland and South Bothnia regions). It is part funded by the RDP for mainland Finland 2014-2020.

OSMO aims to improve soil-testing methods and farmer know-how in soil health management, to develop practical tools for soil management and to inform the public on soil health and its management. Farmers are involved at three levels: on-farm trials demonstrating the impact of management on soil quality and productivity; farmer study groups (of around 20 farmers) help farmers to make a holistic soil management plan for their farm and get peer support; workshops, field days and demonstrations for regional farmers to observe and share experiences in different aspects of soil management.

https://tuhat.helsinki.fi/portal/en/projects/knowhow-and-tools-f%28bd6c2d08-4090-4433-b955-4993d2c7b4a6%29.html

Project duration: 2015-2018
Total budget: € 700 000
EAFRD contribution: € 235 200
National/regional contribution: € 324 800
Private/own funds: € 140 000

Measure: M16.5 support for joint action undertaken with a view to mitigating or adapting to climate change and for joint approaches to environmental projects and ongoing environmental practices.

(20) Ecologic Institute, Berlin, 'Updated Inventory and Assessment of Soil Protection Policy Instruments in EU Member States', 2017: http://ec.europa.eu/environment/soil/pdf/Soil_inventory_report.pdf

4. The LIFE programme and rural development

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Many of the best practices and innovative methods for moving towards a resource-efficient economy have been pioneered under the EU's LIFE programme. The actions implemented by LIFE projects have proven that the efficient use of resources is not only of great environmental benefit, it can also provide new revenue streams and help put rural areas on a sustainable economic footing.

LIFE supports a wide range of resource-efficient initiatives. This article focuses on those pertaining to the smarter use of soils and water.

SUPPORTING RESOURCE EFFICIENCY INNOVATION

AGRICULTURAL PRACTICES THAT SAVE WATER

TACKLING WATER SCARCITY

IMPROVING SOIL QUALITY FOR SUSTAINABLE GROWTH

CONCLUSION

SUPPORTING RESOURCE EFFICIENCY INNOVATION

The LIFE programme [1] is the EU's dedicated funding initiative for nature conservation, environmental protection and climate action. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental and climate policy and legislation by co-financing projects with European added value.

LIFE was established in 1992, in the same year that the EU's flagship nature legislation – the Habitats Directive – came into being. Under the sub-programme for Environment, the priority area 'Nature and Biodiversity' supports the implementation of the Directive, along with the Birds Directive and the implementation of the EU's Biodiversity Strategy to 2020. The priority area 'Environment and Resource Efficiency' supports, amongst others, a wide array of projects that make industrial processes less polluting or harmful. The sub-programme for Climate Action supports both climate change mitigation and climate change adaptation projects, thus both reducing Europe's greenhouse gas emissions and addressing the impacts of climate change.

THE LIFE PROGRAMME

LIFE is the EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU. LIFE has co-financed more than 4 500 projects which have been directly selected at the European level. During the 2014-2020 funding period, LIFE is to contribute approximately € 3.4 billion to the protection of the environment and climate.

Over the past 25 years, LIFE has led the way in generating innovative solutions to environmental problems and the challenges of climate change. Actions pioneered by LIFE projects demonstrate what can be achieved at a local and regional level, and the programme proactively shares the insights gained.

To facilitate this exchange of best practice and replication of results around Europe, LIFE projects disseminate their outcomes through national and international conferences, the publication of scientific papers and by networking with organisations and government bodies operating in similar fields.

Sustainable farming practices that are resilient to climate pressures have received much attention by the LIFE programme. It has supported initiatives across Europe to encourage a more efficient use of water, among other scarce natural resources, in order to foster the sustainable development of rural areas.

One of the benefits of LIFE is that it adopts a collaborative approach, engaging stakeholders in efforts to improve common practice. Pilot projects demonstrate what can be achieved, whether on a small or large scale, the wider uptake of LIFE-supported technologies and practices is actively encouraged through knowledge-sharing activities.

Moreover, beneficiaries are requested to draw up a plan for continuing the positive impact of the project following its conclusion. In some cases, this may include a follow-up LIFE project, but it can also mean applying for funding from private or public sources, both EU and national or regional. Given that the targets of projects frequently align with rural development goals, there is a clear opportunity here for Rural Development Programme (RDP) funding to deepen the beneficial impacts of LIFE projects, and for LIFE to help introduce new ideas and approaches into mainstream RDP Measures.

(1) The LIFE programme: http://ec.europa.eu/environment/life/

AGRICULTURAL PRACTICES THAT SAVE WATER

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The more efficient use of water in agriculture implies a reduction of the amount consumed and a more targeted use. These are the principles behind precision agriculture which uses the latest monitoring tools, such as satellite observation, to accurately assess the amount of natural resources that are required for a specific piece of farming land. Precision agriculture thus maximises crop yields while minimising the use of inputs, such as irrigation water and fertiliser.

A good example of a LIFE-supported initiative to increase the efficiency of irrigation and the fertility of soil is the Greek **HydroSense project**. Launched in 2008 in the Thessaly Plain, the project is located in one of the country's main agricultural regions. Irrigation is mainly based on pumping water from groundwater aquifers, using private boreholes and pumping units, practices that have lowered aquifer levels to the point where water scarcity is a serious concern.

The project applied precision agriculture methods in three pilot cotton fields in the Pinios watershed area of the plain. In these fields, each covering 3 ha, the use of irrigation water is targeted and controlled in accordance with the data received from infrared thermocouple sensors that measure canopy temperatures(2). Furthermore, multispectral proximal sensors that measure chlorophyll content allow the amount of fertiliser applied to be limited, and a device for detecting weeds restricts and targets the use of herbicides.

In this way, the project was able to demonstrate that the use of irrigation water and agri-chemicals can be greatly reduced. On average, precision farming reduced the use of irrigation water by 18 %, nitrogen fertilisers by 35 % and total herbicides by 62 %, in comparison to conventional farming practice. These figures translate to an increase in water, nitrogen and herbicide use efficiency of 26 %, 60 % and 168 %, respectively, while in turn, less irrigation and spraying lowers energy requirements and thus energy use was estimated to be 20 % more efficient.

Moreover, the cotton yield was 10 % higher using the new techniques. Clearly, higher yields must be weighed against the cost of purchasing and installing the sensors, but the project calculated that a partial adoption of its practice would be economically feasible as most farmers already possess some of the equipment required. For full adoption, it recommended subsidies for equipment purchase and lower water tariffs for those farmers practicing reduced irrigation methods. The application of Rural Development funds, such as under Focus Area (FA) 2A: 'Improving the economic performance of all farms and facilitating farm restructuring and modernisation' would also potentially offer a return on investment and encourage a step towards the adoption of sustainable practice, especially through measure Measure 4: 'Investments in physical assets'.

Many LIFE projects have addressed the problem of inefficient irrigation. In Spain, for example, one project developed an **Irrigation Expert Simulator**, a web platform for training and supporting farmers in the drawing up of their own personalised irrigation

(2) Canopy sensors measure biophysical plant traits rapidly and make assessments about plant status.

schedules. Via the platform farmers receive expert advice for optimising their irrigation practice with the desired effect of rendering water use more efficient.

Furthermore, in Malta, LIFE-supported actions have shown the value of recycling wastewater for irrigation. The **WINEC project** constructed a wastewater treatment plant for the Tsiakkas winery, which removes toxic and harmful substances in the wastewater ahead of its re-use. The project is promoting its replication in other wineries via its best practice guide.

TACKLING WATER SCARCITY

Water scarcity is one of the main drivers behind initiatives to tackle water loss, particularly as a means of adapting to climate change. Improving storage systems to cope with periods of drought has been investigated by the LIFE programme.

In Spain, as in other Mediterranean countries, environmental action has focused on managed aquifer recharge, i.e. intentionally storing water in an aquifer for subsequent recovery, as a way of buffering the impact of seasonal variations in rainfall.

The **ENSAT project**, for example, aimed to better manage the Llobregat river delta aquifer. Though aquifer remediation is a well-established technique, the project's main innovation was to introduce a reactive organic layer at the bottom of an infiltration pond for the aquifer. The layer was shown to be effective in promoting micro biological activity to break down pollutants, and thus reduce the need for reagent and energy use in treating the water. The project's natural solution to reducing the presence of water contaminants demonstrated clear economic and environmental benefits.

In Italy, the **TRUST project** demonstrated the importance of engaging stakeholders in river basin management. In the Upper Plain of Veneto and Friuli, stakeholders agreed to provide monitoring data of water flows, which formed the basis for modelling the impact of climate change and making regional risk assessments. The models showed that managed aquifer recharge for an area of 100 hectares could add around 50 million cubic meters of water, thus rendering the area suitable for cultivating fast-growing plants.

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Given the necessity of sustainable water supplies for the economic future of the region and elsewhere, these projects highlight the need for rural development policy-makers to be part of the conversation as to how water-scarcity challenges can be addressed.

At the opposite end of the scale from water scarcity, increased frequency of flooding is another outcome of climate change. The German project **FLOODSCAN** developed a new technology that combines laser scanning with remote sensing data to model the risk of flooding on a large territorial scale. The technology is intended to help reduce negative impacts of flood incidents by providing reliable and accurate information for regional planning authorities to formulate regulations and manage land use.

IMPROVING SOIL QUALITY FOR SUSTAINABLE GROWTH

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The fundamental importance of good-quality soil to the socio-economic well-being of rural communities is difficult to overstate. The EU's **Soil Thematic Strategy** recognises the factors that are leading to the steady degradation of soil quality in many areas: the overuse of agri-chemicals in intensive farming; sealing and compaction; floods and landslides; and contamination and erosion.

The LIFE programme has proved to be an adept instrument for tackling many of these problems, while emphasising that soil-friendly land-use practices can deliver both environmental and economic gains. As such, these LIFE initiatives are relevant to Focus Area 4C: 'Preventing soil erosion and improving soil management of rural development' under Priority 4: 'Restoring, Preserving and Enhancing Ecosystems'.

The **Soil Sustainability (SoS) project** showed how the EU's strategy could be implemented specifically in the Anthemountas river basin, but also in the wider central Macedonia area, and Greece in general. The project, which was approved by farming associations and municipal authorities, developed decision-support tools for identifying and combatting the risks of soil erosion, organic matter decline, salinisation, contamination and sealing. A comprehensive soil map was produced – the first such extensive soil map in Greece – which is a valuable resource for agricultural practice in the area.

Soil fertility, which is directly related to crop yields and amount of fertiliser/herbicide needed to achieve desired yields, has been the focus of a range of LIFE projects. Actions to increase the organic content of soil, which enhances fertility and the soil's ability to absorb nutrients, make it less susceptible to compaction and erosion, better able to filter out pollutants and more likely to produce crops that are resistant to environmental stresses.

The Italian project **LIFE HelpSoil** carried out in the Po river plain demonstrated how to achieve more efficient irrigation and fertiliser use. The project team from the Lombardy region targeted an increase in organic carbon content of soil of 0.2-0.7 tonnes per hectare per year. For the farmers, the competitive advantages are clear: cost savings related to reduced fertiliser and water use; fuel savings related to less need for soil excavation work; and higher yields.

The innovative use of pig waste was pioneered in Spain under the **ES-WAMAR** project. It sought to match the need of arable farmers for fertilisers with the need of pig farmers to dispose of their slurry. Its solution was to set up three pig slurry management companies comprising interested farmers responsible for collecting manure, distribute it to where it is needed and apply it in fields. Such a collective approach allowed for logistic costs to be shared with the effect of increasing energy efficiency. The value of pig manure as an organic fertiliser was thus widely accepted by farmers.

Further initiatives have demonstrated the feasibility of using other natural wastes – such as straw, wool, cotton and sawdust – to improve soil quality. Such fibrous materials were used as bio-activators in the greenhouse cultivation of vegetables in Poland, under the **BIOREWIT project**. Utilising agricultural and textile waste in this way has a natural commercial incentive for industry. Valorising waste material cuts down on the cost of its disposal for manufacturers, while for vegetable producers, the use of organic recycled material eliminates the need for nitrogen-based fertiliser.

Moreover, the project itself created new commercially viable products – for example, Ekofert K, an organic fertiliser produced from dried biomass of red clover, and Ekofert L, a fertiliser produced from dried lucerne (alfalfa) – that have been cleared for use in agricultural production and can be sold on the EU market. The project beneficiary is Poland's Research Institute for Vegetable Crops, so the way forward is for a partner organisation to cooperate with the institute, perhaps with the assistance of Rural Development funding in order to exploit the commercial opportunities opening up by the technological advances of the project.

Furthermore, examples of LIFE paving the way to the circular economy have also included cases of farmers re-using their waste products – particularly olive oil producers. The Greek project **PRODOSOL** is one of many LIFE actions that have addressed the problem of Olive Mill Wastes (OMW) disposal. The polyphenolic content of such waste, which is typically disposed of on agricultural land, poses a serious threat to the environment, but the LIFE project developed a low-cost way of pre-treating OMW and then applying bioremediation technology on affected soil.

In common with most LIFE-supported innovations, the project's technique was first piloted on a small scale before trials continued on a larger area.

© LIFE HelpSoil

Full-scale roll-out of new technologies often requires further investments by the project partners or additional financial back-up and funding.

PRODOSOL maintained its established stakeholder network of experts, business leaders, government officials and olive growers following the end of the project with a view to encouraging further application of its procedures and guidelines. However, the project team acknowledges that the financial incentive for wider uptake among farmers needs to be stimulated. EAFRD investment could be one such way to promote the take-up of proven ideas that encourage resource efficiency in the rural economy.

CONCLUSION

The lessons to be learnt from the LIFE programme are far-reaching and their application ongoing. As demonstration projects, many have highlighted the clear economic case for the adoption of a resource-efficient approach to the use of natural resources, including soil and water.

The effect of climate change on the supply of natural resources makes efficient use more necessary than ever before. LIFE is demonstrating that solutions are available to meet current and future challenges and to move towards a resource-efficient economy in rural areas.

Rural Development funds can breathe more life into these ideas by helping to offset the installation costs of new technology or by bringing rural stakeholders together to turn promising designs into commercial solutions. Replicating LIFE-tested ideas has the additional strength of being both good for the environment and the sustainability of rural economies.

5. Integrated approaches

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Continuing to increase production while using fewer natural resources in the rural economy requires coherent action across the EU and its Member States, ensuring that policies share the same objectives and provide complementary tools to encourage action by rural stakeholders.

Developing effective governance systems and empowering farmers and land managers are important ways of achieving a more joined-up policy design and more effective and long-lasting action. While the Rural Development Programmes (RDPs) are already providing vital support, more is expected if Europe is to accelerate its transition to a resource-efficient rural economy.

The dedicated ENRD Thematic Group and an ENRD seminar on this topic in Brussels in June 2017 have looked at the role of EU Rural Development policy in supporting resource efficiency and how it can best encourage the more widespread use of sustainable practices for soil and water management in particular.

JOINED-UP POLICY DESIGN AND IMPLEMENTATION

STRENGTHENING RURAL GOVERNANCE

IMPROVING KNOWLEDGE EXCHANGE AND MOTIVATING ACTION

CONCLUSIONS

JOINED-UP POLICY DESIGN AND IMPLEMENTATION

Using soil and water resources more efficiently in rural areas, particularly in the way land is managed, requires the use of a coherent set of policy levers at regional, national, EU and global levels. These policy instruments need to be put into practice in a joined-up way in order to create a coherent plan of action and, ultimately, deliver the action required on the ground.

From a global perspective, the Paris Climate Agreement and the Sustainable Development Goals provide high-level targets which require a shift towards greater resource efficiency if they are to be met.

At the EU level, initiatives such as Europe 2020[1], the growth strategy to make the EU a smart, sustainable and inclusive economy, support the shift to viable growth via a resource-efficient, low-carbon economy. The strategy includes a roadmap to a resource-efficient Europe.

A range of more detailed policy commitments and initiatives are now in place to promote action that requires a more efficient use of soil and water resources. These relate to: climate mitigation in agriculture; the re-use of agricultural and forestry residues in the circular economy; reduction in the use of fertilisers and promotion of those based on agricultural residues or waste; and improving the quality of watercourses as well as ensuring that water resources are not over-abstracted.

National policy also plays an important role in promoting a shift towards a more sustainable and efficient use of natural resources. This is particularly true in the case of soil protection which lacks an EU-wide strategic framework. Member States have put in place a series of instruments that support action on soil protection. For example, soil protection legislation (Soil chart in Austria[2]), wider environmental and agricultural strategies (the Ordinance on Environmental Protection[3] in Romania), Research and Innovation programmes (the GESSOL research programme[4] in France) or monitoring systems (the Wallonian soil status database[5]).

At the European level, the CAP, and Rural Development policy in particular, provides a valuable source of funding that can be used to encourage farmers, foresters and other rural actors to take appropriate action on the ground.

The RDPs contain a wide range of Measures that can be used to improve the sustainable and efficient use of soil and water resources. These can be used to support investments in machinery or other types of infrastructure on farm and along the supply chain, provide incentives to encourage different types of land management, as well as encourage cooperation between land managers across wider areas, and support advice and knowledge exchange.

EU INITIATIVES RELEVANT TO RESOURCE EFFICIENCY

Climate & Energy

- 2030 Climate and Energy Framework;
- Effort Sharing Regulation;
- Land Use, Land Use Change & Forestry (LULUCF) Decision;
- Emissions Trading System;
- Recast Renewable Energy Directive (RED II);
- Climate Adaptation Strategy.

Circular / Green Economy

- Circular Economy Strategy;
- Bioeconomy Strategy.

Soil & Agriculture

There is no overarching and integrated policy framework on soil. However, some levers come from:

- CAP Cross-compliance and Greening;
- National policy instruments – among others, waste, forestry, planning.

Water & Agriculture

- EU Communication on Agriculture and Sustainable Water Management;
- Water Framework Directive (WFD);
- Nitrates Directive.

(1) http://ec.europa.eu/info/strategy/european-semester/framework/europe-2020-strategy_en
(2) https://www.bmlfuw.gv.at/land/produktion-maerkte/pflanzliche-produktion/boden-duengung/bodencharta.html
(3) http://legislatie.just.ro/Public/DetaliiDocument/67634
(4) http://www.gessol.fr/articles-et-documents-de-synthese
(5) http://environnement.wallonie.be/legis/solsoussol/sol003.htm

For example, in Flanders (Belgium), funding under the Agri-Environment-Climate Measure (AECM) is provided to encourage farmers to tackle soil erosion by supporting the establishment of grass buffer strips on erosion-sensitive slopes (€ 1 047 / ha), the conversion of arable land to grassland on slopes (€ 619 / ha), or the construction of erosion walls made of straw bales (€ 12.86 / m).

In Emilia Romagna (Italy), farmers are being encouraged to embrace conservation agriculture techniques to tackle erosion and improve soil carbon, which entails no or minimum tillage.

In Greece, funding is provided to farmers to build more efficient irrigation infrastructure (for example, closed networks combined with drip irrigation), in compliance with actions set out in the River Basin Management Plans (RBMPs), stemming from the Water Framework Directive (WFD). Additional pilot activities for monitoring meteorological, water and soil data are supported under the same Measure.

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A shift towards a more resource-efficient rural economy requires joined-up plans for particular rural areas. This requires government bodies to work together with relevant environmental and farming stakeholders, including the land

WATER AND INTEGRATED LOCAL DELIVERY PROJECT (WILD)

The 'Water and Integrated Local Delivery' (WILD) project in the UK uses a facilitation-based approach to meet Water Framework Directive objectives. The project has built a lasting multi-stakeholder partnership bringing farmers and local communities together to provide economic and social benefits, as well as improve water quality.

The central objective of WILD is the improvement of the water environment, with a focus on finding solutions to minimise the impacts of floods in the area, achieving good ecological status of surface water and good chemical status of groundwater.

Coordinated by the Farming and Wildlife Advisory Group (FWAG)[(6)], the initiative covers an area of 26 000 ha of the higher and central parts of the Upper Thames catchment within the Thames river basin in central and southern England. It brings together farmers and landowners, local NGOs, regional wildlife groups, water trusts and partnerships, 18 local communities, local councils, the University of Gloucestershire and the Thames Water company.

Through carrying out events with the local communities as well as hundreds of farm visits to provide advice on how to remain productive while sustainably managing natural resources, the various actors have come to understand how their actions impact flooding and water quality.

The partnership has been able to facilitate implementation of EU Regulations at the local level. Involvement of both the private sector (Thames Water) and public bodies working alongside local advisors and facilitators has strengthened the project and enhanced communication and trust. In particular, the setting up of a 'Farmer Guardian network' – key point of contact for discussions between farmers and the water regulators – has improved accountability and dialogue.

The project has led to changes in farming practices, including the adoption of sustainable pesticide management techniques by 461 farmers over 25 000 ha, 1 500 hectares of land entered into the agri-environment-climate scheme, 3 000 metres of fencing put in place to protect the water course, as well as the development of water management plans for local communities.

For more information, see: http://pegasus.ieep.eu/case-studies/list-of-case-studies#united-kingdom and http://www.fwagsw.org.uk/projects/wild-project

(6) WILD involves a partnership between the Environment Agency, Farming and Wildlife Advisory Group, Gloucestershire Rural Community Council, Cotswolds Water Park Trust and the Countryside and Community Research Institute at the University of Gloucestershire.

managers themselves, to elaborate these plans based on clear evidence. The available funding, of which Rural Development funding is the most significant, should then be targeted in ways that respond to the identified needs and priorities.

Strengthening rural governance

Making and taking decisions is part of people's daily life. However, when it comes to collective well-being, bringing all relevant actors together and making informed decisions as a community becomes more complex. This brings into play questions around effective governance.

There are multiple stakeholders involved in decisions about the way in which soil and water resources are managed and all should be engaged in the discussions and decisions on the actions that are required for rural areas. This involves interaction between agricultural and environmental government departments, between policy-makers, researchers and environmental and farming stakeholders, as well as land managers who are those ultimately responsible for the management of the resources in question. One way is to engage stakeholders in open consultation on the RDPs.

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At national and regional levels, bringing all actors within the rural economy together from the start of the design of RDP Measures and during the implementation process can help improve internal RDP coherence and buy-in to its aims and objectives and the Measures used.

Bringing together such expertise, for example via formal stakeholder groups or other engagement activities organised by national ministries or regional authorities, can help ensure that the activities promoted within the RDP to support resource efficiency of soil and water are coherent both with the other parts of the CAP, as well as with other relevant EU and national-level policies, such as the River Basin Management Plans (RBMPs) under the Water Framework Directive.

With regard to RDP design, one important step is to make sure that the National Rural Network (NRN) includes as wide a range of stakeholders as possible to enable stakeholders' views to be taken into account considering the design or revisions to the use of RDP Measures. Also, active communication between the NRN and other partners such as the EIP-AGRI Operational Groups and LEADER Local Action Groups (LAGs), as well as between researchers and farmers, ensures a wider exchanges of views. Involving land managers is important to enable knowledge exchange and to provide them with fora in which to input their experiences and expertise into revisions to the RDPs.

IMPROVING KNOWLEDGE EXCHANGE AND MOTIVATING ACTION

A key challenge is to encourage widespread action across the EU, engaging the 12 million farmers and land managers in 28 Member States. This requires up-to-date information on the practices that work and the exchange of these practices that can be applied to other areas, not just between land managers, but amongst stakeholders and administrations.

Building on LEADER and the European Innovation Partnership (EIP-AGRI), bottom-up and locally led initiatives can be used to engage rural stakeholders and improve their understanding of the requirements of certain RDP Measures or associated policies. For example, in Gotland (Sweden), a LEADER project was used to help raise awareness among landowners on the issue of water protection, as well as to increase water availability for agriculture within the area.

Participatory processes can lead to greater understanding of what is needed in practice to deliver the outcomes required and enable farmers to utilise their knowledge and determine what the best practices might be to deliver these over the long term.

Equally, understanding the needs and concerns of farmers and land managers is important for national implementation agencies when designing schemes supporting resource efficiency to work in the local and regional contexts, as well as to increase the engagement of farmers in delivering resource efficiency objectives.

In Emilia Romagna (Italy), 20 demonstration farmers took part in the **LIFE project HelpSoil** with the aim of testing the effects of conservation agriculture on soil quality and climate resilience, and feeding into the design of the regional RDP. One farm involved in the project, the Ruozzi farm, stressed the value of EAFRD funding during the transition phase from traditional to conservation agriculture, which helped recover income losses from lower yields during the first few years.

On the other hand, the long-term commitments required under RDP Measures such as agri-environment-climate contracts (AECM) for instance, were identified as potential barrier to the uptake of conservation agriculture by a wider pool of farmers within the region. Conservation agriculture is currently supported under the Emilia Romagna RDP, under the AECM.

In some instances, traditional practices, knowledge and approaches to soil and water management that have been developed by farmers and land managers over time need updating in order to align them with modern technology and new thinking. Despite sometimes being willing to embrace new challenges, farmers and land owners need sufficient support to develop and apply the right set of skills or techniques.

RAISING AWARENESS OF WATER PROTECTION THROUGH LEADER

Since the 1990's, access to groundwater has been declining in the island of Gotland, Sweden. Privately dug wells have been drying out which has proven particularly challenging for livestock farmers. Drilling new wells was not seen as an easy solution because of the potential environmental impacts as well as the associated costs.

RDP funding under LEADER was used to develop the Aquabrava project that supported the creation of eight wetlands and ponds over a total area of 10 ha. Within this area, a water system based on wetlands was tested to understand both the factors that had an impact on water availability and new approaches to the creation of water reservoirs.

In addition, a series of meetings and workshops were organised to raise awareness and promote the construction or restoration of wetlands on land owned by the arable and livestock farmers involved in the project.

The project proved the wetland system to be effective and cost-efficient in capturing rainwater for use in agriculture. It also showed increased water availability in wells located further way from the wetland system. All stakeholders were better informed about the advantages of the new wetland system in the area and, linked to that, of the importance of protecting water resources.

https://enrd.ec.europa.eu/projects-practice/water-preservation-project-%E2%80%98aquabrava%E2%80%99_en

Project duration: 2011-2013
Total budget: € 154 554
EAFRD contribution: € 88 096

RDP support – such as that through advice and training (M1), knowledge sharing (M2) or Cooperation (M16) – can help land managers increase their own knowledge, as well as support peer-to-peer exchanges. In Belgium, the Cooperation Measure (M16) was used to co-fund a three-year project SOCROSense (2016-2018). The project, an EIP-AGRI Operational Group, gathers pioneer farmers and other actors who have experience in the use of GPS sensors for monitoring soil and crop quality. Because of the cross-cutting nature of resource efficiency, these opportunities for discussion and exchange of data and information have not only included farmers and other land managers, but also research institutions and businesses. This should also have a positive effect of mainstreaming resource efficiency thinking and understanding of how it can make farming more resilient to future pressures.

The private sector can also play an important role in furthering resource efficiency through technological development. For instance, it could support capacity building, share expertise or implement solutions when public authorities cannot deliver, while linking private entities with public administrations at all levels could accelerate the diffusion of technologies and new practices. The LIFE-funded **AQUAVAL project** shows how joined up cooperation between municipalities and private companies was successful in introducing the use of a new approach to managing urban water in the city of Xativa and the municipality of Benaguasil, in the province of Valencia, Spain. The Sustainable Urban Drainage System (SUDS) reduced the energy consumed for treating and pumping wastewater by reducing water inflow into the drainage system.

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Result-based schemes for resource efficiency

In the context of empowering farmers to take active decisions supporting resource efficiency on their farm, an interesting emerging development in Europe is the creation of approaches to land management that are based upon results.

Result-based schemes re-focus the payment to the farmer away from carrying out a specific farming practice (for instance, no or minimum tillage) to the achievement of environmental results. Depending on the specific design, result-based schemes can offer a much clearer link between the

EXCHANGING BEST PRACTICES

Intensive arable farming in the Czech Republic has contributed to the decline of wildlife and biodiversity, as well as to the deterioration of soil quality. A seven-year agri-environment-climate scheme (AECM – M10) was set up in the surroundings of the village of Šardice, in south Moravia, to finance the planting of fodder strips alongside crops to maintain and enhance biodiversity and improve soil quality.

In the previous programming period, the lack of direct communication with beneficiaries resulted in only a handful of applications. In this case, local hunters' societies proved influential by meeting with farmers and persuading them to join the project, illustrating the potential benefits for farmers, hunters and the wider community alike, as well as the expected results on local environment.

By 2011, a total of 1 100 ha of fodders strips were planted in the region. This increased wildlife and improved the quality of soils within the region.

http://enrd.ec.europa.eu/enrd-static/policy-in-action/rdp_view/en/view_project_9980_en.html

Project duration: 2007-2013
Total budget: € 1.14 million
EAFRD contribution: € 910 000
National/regional co-financing: € 230 000

payment and the outcome required. In addition, farmers are encouraged to take direct responsibility for the results by using their skills and knowledge.

Currently these approaches have been developed mainly with biodiversity results in mind. But their potential for other environmental issues, such as soil health or water, is being explored.[7] In Sweden, the Board of Agriculture is investigating the possibility of setting up a result-based agri-environment payment scheme for nutrient management. However, more work is needed on how to design payment schemes linked to results for soil and water – especially on identifying appropriate, realistic and measurable indicators, and ensuring reliable data are available.

PILOTING RESULT-BASED PAYMENT SCHEMES FOR NUTRIENT MANAGEMENT IN SWEDEN

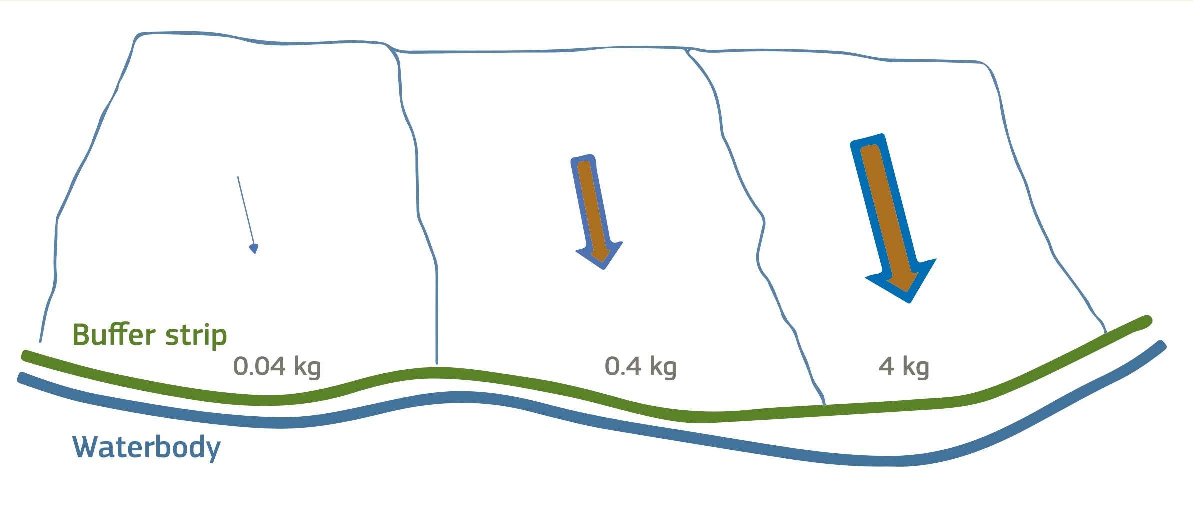
A pilot initiative, set up by the Swedish Board of Agriculture in the spring of 2017, aims to explore the feasibility of designing a result-based payment scheme in view of the next programming period. The project brings together a number of partners – including the Federation of Swedish Farmers and WWF, which are providing financial support (10%) alongside EAFRD funding via Measure 16.5 (90 %).

The main objective of the pilot is to reduce loss of nutrients from farming practices on arable land while avoiding additional administrative burdens for farmers. While the first phase of the project involves the identification of activities with a proven impact that farmers can choose from, the second phase will involve the actual design of the payment scheme and its testing in a pilot area.

A major challenge facing the Managing Authority is the development of a model calculating the nutrient load at different geographical scales and identifying activities for prevention of nutrient loss. Other issues, such as defining appropriate indicators and the geographical scale of examination for the payments, as well as setting up monitoring systems and appropriate controls of the value-based components, are being explored in the design phase.

The aim is for the first phase of the project to be finalised in the first half of 2018.

https://enrd.ec.europa.eu/sites/enrd/files/tg1_water-soil_result-based-aecm_svensson.pdf



A wall of buffer strips (green line) is being used to reduce the nutrient load from farming activities in the downstream waterbody (blue line).

(7) https://enrd.ec.europa.eu/sites/enrd/files/s5_resource-efficiency_keenleyside.pdf

CONCLUSIONS

The transition to a resource-efficient rural economy requires action on many fronts: from more joined-up strategic planning involving multiple stakeholders; putting in place appropriate incentives for farmers and land managers to take action on the ground; to accompanying this with the necessary support, advice and capacity building.

Rural Development policy already includes the tools required to bring about the more sustainable use of soil and water resources. However, more must be done to ensure that these are incorporated within the RDPs in a way that addresses the needs and priorities in particular areas, working alongside existing action plans, such as River Basin Management Plans, and that the necessary knowledge exchange and co-learning are encouraged.

Beyond the initiatives that are already happening across EU's rural areas, to achieve the transformative shift necessary to get to a resource-efficient rural economy in Europe, the adoption of current good practice needs to happen on a much larger scale. This requires thinking about ways of making stronger links between the local, scientific and policy communities, opening up further the process of RDP design and delivery by involving local populations and farmers, or creating the conditions for peer-to-peer exchanges among farmers and scientists. This will contribute to more joined-up planning, decision-making and, ultimately, implementation on the ground.

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6. Improving resource efficiency through the RDPs

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Natural resources underpin the functioning of the European economy and have a special relevance for the rural economy. Pressure on these resources is increasing and remains a central challenge to achieving sustainable development.

The challenge for agriculture lies in securing a sufficient food supply for future generations while reducing resource use and increasing resource recycling. The Rural Development Programmes (RDPs) are investing in activities that can support resource efficiency in agriculture. At least 30 % of the EAFRD funding of the RDPs must be reserved for Measures contributing to the environment and climate, though in practice the allocated amount is significantly higher (52 %).

The ENRD Thematic Group (TG) on 'Resource-Efficient Rural Economy', which concluded its work in July 2017, concentrated on how to support the integration of resource-efficient activities and thinking relating to soils and water into RDP implementation.

This article draws on the results produced by the TG to explore the RDPs' potential to improve the management of natural resources in European farming, taking into account the bottlenecks highlighted by some key case studies.

CURRENT PROGRAMMING PRACTICE

USING RDPs TO IMPROVE RESOURCE EFFICIENCY

REAL-LIFE RDP USE

BOTTLENECKS AND SOLUTIONS

CONCLUSIONS

CURRENT PROGRAMMING PRACTICE

Resource efficiency or 'doing more with less' is essential to sustain socioeconomic progress in a world of finite resources and ecosystem capacity. It is linked with a reduction in the overall use of resources through demand reduction and alternative supply patterns. This concept is at the heart of the green economy [1].

Improving resource efficiency means adopting more sustainable methods for farming and may mean reducing use of inputs such as synthetically produced fertilisers. Organic farming is a pioneer in the efficient use and recycling of soil nutrients. There are also business opportunities to be had when looking at how such farming systems can work.

Using soil and water resources more efficiently will help achieve a number of the EU's strategic objectives. For land-using sectors, resource efficiency brings with it greater resilience and adaptation potential. From a rural perspective, lightening the load on freshwater systems and reducing pressures on soils will provide ecosystems greater scope to adapt to changing climate and weather patterns. In turn, these actions will support the economic sectors that rely on the effective functioning of these systems, in both urban and rural areas.

Despite improvements in land management, rural natural resources are under pressure. Currently, nitrogen pollution is costing the EU € 70-320 bn a year, or € 150-750 per EU citizen. More than 50 % of nitrogen discharged to water bodies can be attributed to agriculture, while 15 % of soils in the EU-25 were shown to have in excess of 40 kg N per ha.

Since 2005, a key feature of the first Pillar of the CAP has been a compulsory cross-compliance scheme that makes direct payments to farmers contingent on compliance with basic environmental requirements regarding: water and soil management, plant and animal health, and land maintenance. It was further reinforced by the greening of the CAP, introduced with the last reform in 2013. Cross-compliance establishes a baseline for agri-environment Measures and encourages farmers to use natural resources more wisely.

A further push for the sustainable use of water and soil resources in agriculture comes with the RDPs funded by the EAFRD, as the second Pillar of the CAP. These multi-annual programmes, currently covering the 2014-2020 period, are agreed between the European Commission and the Member States or regions which implement them.

SUSTAINABLE IRRIGATION MANAGEMENT

The Italian project IRRINET-IRRIFRAME shows how the EAFRD can drive behavioural change and dramatically improve resource efficiency. Emilia-Romagna is a leading region in Italian agriculture with more than 84 000 farms and about 1 million hectares under production. About 33 % of farms in the region include irrigated land.

The IRRINET-IRRIFRAME project uses a web-based platform that provides information on the availability and balance of water resources across the region. It is used to help farmers and agricultural operators plan their water use and its application to crops by providing up-to-date information on: the necessary irrigation volume; the best timing for irrigation; and the estimated economic advantages of more effective irrigation. The information supplied is adapted to different crops.

The service has undergone a series of upgrades and farmers applying for support under the agri-environment-climate or organic farming Measures of the region's RDP are eligible for an additional support of € 15 per hectare if they use the approved 'IRRINET-IRRIFRAME' tool.

In 2007-2013, it resulted in water savings of more than 50 million m^3 in the region. The service covered more than 40 000 farms, or almost 40 % of the irrigated area in the region. By 2013, irrigated land managed by IRRINET-IRRIFRAME was saving around 100 million m^3 of water per year.

See pp. 9-10: https://enrd.ec.europa.eu/publications/eafrd-projects-brochure-transition-greener-rural-economies_en

(1) European Commission Communication, 'A policy framework for climate and energy in the period from 2020 to 2030', 2014: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2014%3A15%3AFIN

USING RDPs TO IMPROVE RESOURCE EFFICIENCY

The RDPs are implemented using a wide array of distinct Measures addressing six different Priorities, of which at least two are highly pertinent in the context of promoting resource efficiency.

For example, in the case of Priority 4, quantified targets for EU-28 in the 2014-2020 programming period foresee: 15.1 % of agricultural land and 0.8 % of forestry land under management contracts aiming at better water management; and 14.5 % of agricultural land and 1.3 % of forestry land under management contracts aiming at better soil management.

In the case of Priority 5, quantified targets for 2014-2020 RDPs in EU-28 foresee: 13 % of irrigated land switching to more efficient irrigation systems; and 1.1 % of agricultural and forest land under management contracts contributing to carbon sequestration/conservation.

To achieve these impacts, EU Member States and regions can choose between a series of seven core Measures aiming to improve resource efficiency:

- M4: investments in physical assets (for environmental and climate-related investments);
- M8: investments in forest area development and improvement of forest viability;
- M10: agri-environment-climate payments;
- M11: supporting organic farming methods;
- M12: Natura 2000 areas and Water Framework Directive payments;
- M13: payments for areas facing natural and specific constraints;
- M15: forest-environmental and climate services and forest conservation.

RDPs AND RESOURCE EFFICIENCY

Relevant Priorities and Focus Areas

Priority 4: Restoring, preserving and enhancing ecosystems

- Focus Area 4B: Improving water management, including fertiliser and pesticide management;
- Focus Area 4C: Preventing soil erosion and improving soil management.

Priority 5: Resource-efficient, climate-resilient economy

- Focus Area 5A: Increasing efficiency in water use by agriculture;
- Focus Area 5E: Fostering carbon conservation and sequestration in agriculture and forestry.

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In addition, some other RDP Measures can actively contribute to the goal of achieving a greater efficiency in managing natural resources like water and soil. These include: M1 (knowledge transfer and information actions); M2 (advisory services, farm management and farm relief services); M7 (basic service and village renewal in rural areas); M16 (Cooperation). Last but not least, M19 (LEADER/CLLD) can often foresee the promotion of activities leading to the ultimate outcome of an improved efficiency in the use of natural resources in rural areas.

The Measures can be put into practice in various ways, according to the specific needs and choice of the Member State or region. For example, M4 may support investments in new farm infrastructures and assets such as covered storage facilities for organic manure, slurry and silage, to help reduce emissions, prevent run-off of silage effluent or in more efficient and/or precision irrigation systems for farming.

M7 can support investment in infrastructure to capture and store water in times of high rainfall and to prevent flooding and inundation of rural and urban areas. M8, M10 and M11 support sustainable land management practices. These may include: the optimisation of the application of fertilisers, matching them to crop requirements as closely as possible; the use of cover crops following the cereal harvest to reduce the risk of soil erosion; the cultivation of crops requiring fewer nutrient inputs; and avoidance of overgrazing and unsuitable supplementary feeding.

M8 appears to play a major role in addressing soil carbon emissions, for example by increasing forest cover (under Focus Area 5E, 70 % of EU-28 public expenditure is allocated to M8).

The use of M16 can be particularly important for addressing water and soil management in river catchments that extend beyond single farms and administrative boundaries. This can be of fundamental importance at the landscape scale, especially when dealing with high-value, traditional landscapes and farmland.

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REAL-LIFE RDP USE

One can best appreciate how different RDP Measures are being used for promoting resource efficiency in farming patterns by looking at examples and data from the EU. The ENRD Thematic Group (TG) analysed a selection of EU Member States and regions: Italy (Emilia Romagna), Belgium (Flanders), Finland, Greece, Hungary, Germany (Lower Saxony).

The TG found that the total allocation of budget to Priority 4 in percentage of the total public expenditure programmed in the six RDPs[2] ranges from 25 % in Flanders to almost 70 % in Finland, compared to an EU average value of 45.6 %.

The RDPs analysed typically apply a combination of Measures to achieve the objectives of the Focus Areas that relate to resource efficiency. M1, M2 and M16 featured in most RDPs as Measures indirectly contributing to resource efficiency objectives.

The most frequently applied Measures in the six case studies and at EU scale, having a direct contribution to resource efficiency, include: M10: Agri-environment-climate (18.8 % of RDP expenditure in Flanders); M13: payments to areas facing natural or other specific constraints (45.6 % in Finland); M11: organic farming (9.1 % in Greece); and M4: investments in physical assets (12 % in Greece).

BOTTLENECKS AND SOLUTIONS

The ENRD TG analysis unearthed some interesting findings and made recommendations as to how resource efficiency objectives can be better targeted by the RDPs.

In the Emilia Romagna region, information exchange between the various decision levels is limited. Therefore, synthesis and integration of such data to support policy choices and bridge motivation gaps is missing. There is still a strong administrative burden associated with the RDP implementation (e.g. lengthy application forms, poor online tools, payment times). The *ex ante* conditionality regarding water pricing

(2) Priority 4 & Priority 5 - Focus area 5A, Focus Area 5E

in agriculture is not implemented at the regional scale, and initially this delayed the activation of the relevant Measures addressing water-related issues and problems.

To counter the above-mentioned bottlenecks, policy design could make use of best practice examples not only at a regional, but also inter-regional level. The Cooperation Measure (M16) can be an effective tool in facilitating the integrated use of Measures and other tools in achieving resource efficiency objectives. In Emilia Romagna, such cooperation projects have been already funded, and these projects build on the **IRRINET-IRRIFRAME project** (see page 40) to improve irrigation practices and enhance towards 'ferti-irrigation' using data on soil nutrient demand.

In the Flanders region, some farmers do not perceive degrading soil quality as a key problem. They are afraid of permanent grassland status if arable land is converted to it. Moreover, the Flemish RDP has many distinct Measures, resulting in many small impacts on resource efficiency. An RDP focusing more on certain areas of interest would strengthen the impact at a territorial scale. The issue of soil organic matter could also be further considered in the context of the RDP and the existing manure policy of Flanders.

In Hungary, the case study found that environmental monitoring systems were not fully suited to measuring the impact of CAP payments on the provision of public goods. Moreover, soil samples are not always properly taken by farmers, nor are nutrient management plans used for investment planning. Farmers appeared motivated more by income support rather than by awareness about environmental benefits; traditional land uses tend to prevail, partially due to the high average age of farmers. More generally, applications and interventions are farm-based and delinked from a more territorial, community-based approach. There is a difficulty in defining controllable and quantifiable criteria for soil protection and carbon sequestration.

FARMING WITHOUT AGRI-ENVIRONMENTAL PAYMENTS

In 2014, the majority of commitments under the agri-environmental Measure under the 2007-2013 Hungarian RDP came to an end and the new RDP was adopted in 2015. This resulted in a one-year gap for a large number of farmers when no agri-environmental payments were made.

In the autumn of 2015, two researchers (from the Hungarian National Academy of Sciences and Cambridge University) surveyed farmers with land in high-nature-value areas. This provided an interesting 'rural reality check' of the internal workings of the Measure and insight into the motivations of the farmers.

In total, 300 farmers were interviewed and questionnaires were completed. The size of farms ranged from 3 hectares to 1 600 hectares (with most farms being in the 11-50 hectares or 101-300 hectares categories).

Farmers were asked about how the gap year in payments affected their farms, farming practices, and their future plans. The main results of the survey were:

- The two main reasons for entering the scheme were the financial incentives and the fact that the support provided made farming possible even on lower quality farmland, where few alternatives are feasible.
- AEC payments represented between 25-38 % of the total farm income.
- 58 % of farmers overall gave up on fulfilling all of the AEC criteria after the end of payments. The 42 % who continued did so for reasons related to the characteristics of the territory (low fertility), existing plans to continue after the resumption of payments, and the proximity of protected areas (more controls usually involved on farm activities).
- 57 % of farmers used more herbicides and pesticides, 28 % used more artificial fertiliser.
- Between 23 % and 33 % of farmers cancelled or postponed their farm-related investments due to the suspension of AEC payments.
- Overall, more than 80 % of farmers (will) re-enter the scheme. However, 16 % of the farmers decided to start the next round of AEC obligations with a smaller territory.

CONCLUSIONS

The three gaps framework – as detailed in the article entitled 'The resource efficiency challenge' (see page 4) – is a helpful way to understand the barriers to resource efficiency. The motivation gap, the knowledge gap and the policy gap can be useful in detecting bottlenecks and outlining potential improvements to the design and implementation of the RDPs and of their Measures from a resource efficiency perspective. It is clear that, in most cases, the gaps are intertwined, therefore the challenge for Managing Authorities is to find solutions that tackle all three gaps.

The effectiveness of RDPs can become very diffuse if Measures are not sufficiently targeted and tailored to the needs and priorities of the local area in terms of resource efficiency. Effective targeting can also help to increase coherence between related policies and objectives, such as spatial targeting of resource efficiency activities in areas that require action under the Water Framework Directive. In seeking to accelerate the move to a resource-efficient economy, the RDPs will need to address some recurring challenges.

Resource efficiency awareness is still limited among farmers, even if it is of strategic importance for the future profitability of farms. Boosting high-quality and/or tailored advice to farmers and their organisations would make improved resource efficiency more attainable. It would also boost the appetite for innovation at farm level.

Take-up rates can be improved by adopting a more user-focused approach to RDP implementation. Well-functioning application methods and timely payment will encourage farmers who are willing to change their land-use practices.

The indications are that there is a need to improve monitoring and assessment efforts for RDP implementation at various stages. This includes the provision of tailored information to help farmers choose the most appropriate Measures so as to combine improved resource efficiency with the goal of long-term profitability; or the mandatory use of easy-to-handle nutrient balance tools when applying for some RDP Measures.

Ultimately, Managing Authorities are seeking to increase the impact of their efforts in order to boost resource efficiency. It is possible via improved targeting of measures based on a better knowledge of the environmental problem at stake (e.g. via better benchmarking) and via an increased use of packages of interventions combining distinct RDP Measures.

The latter pathway can be divided in collective actions arranged according to a territorial focus (e.g. a specific, large-scale water-related challenge) or a value chain approach can be used involving producers, processors and distributors.

A packaged adoption of Measures according to a territorial focus may help tackle more urgent and concentrated environmental problems. Collective adoption of distinct Measures by different actors of the same value chain is likely to facilitate the adoption of innovations and can prove of vital importance in creating new market opportunities that, in turn, can ease further adoption of resource efficiency Measures. That is why, as a first step, a wider use of M16 is generally advocated (it currently absorbs only 1 % of the average RDP budget).

Looking beyond the RDPs alone, greater resource efficiency can be targeted via the multi-fund approach that can be applied to Community-led Local Development (CLLD) initiatives. By combining the use of distinct European Structural and Investment funds, Managing Authorities can improve the targeting of money for different types of expenditures and beneficiaries in the rural sector, all leading to enhanced resource efficiency.

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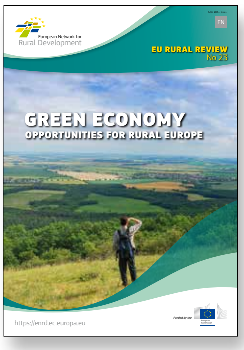

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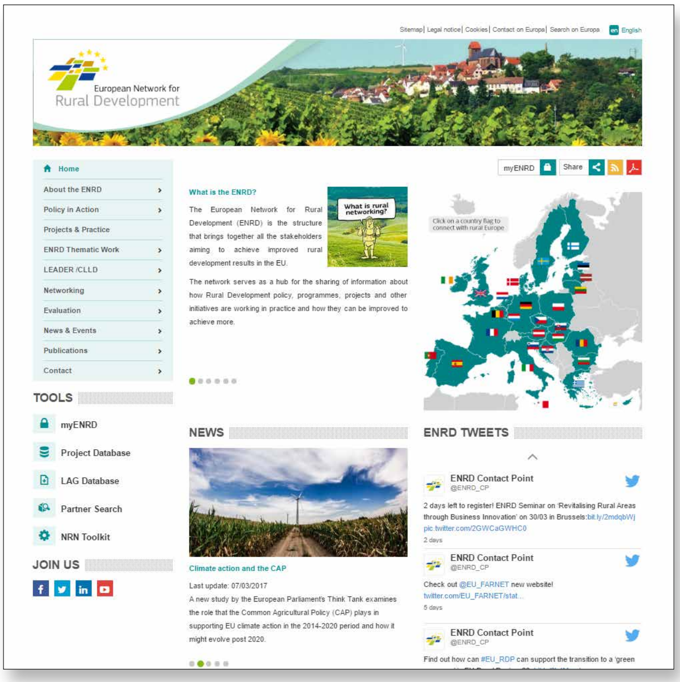

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