Embedding ecosystem services in Plant Protection Product regulation

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INTRODUCTION

Regulators at EU and Member State level face the challenge of making decisions on the registration of plant protection products (PPP) using environmental risk assessments, which do not include information on benefits and trade-offs between protection goals. In particular, evidence on how a particular PPP affects the socio-economics of farming is currently not part of the decision-making process. Regulation 1107/2009 states 'The purpose of this Regulation is to ensure a high level of protection of both human and animal health and the environment and at the same time to safeguard the competitiveness of Community agriculture'. The latter element is recognition that a regulatory decision on a PPP should not made 'in a vacuum', either if there is no evidence of harm to non-target populations in the field resulting from its use according the Good Agricultural Practice or if a potential impact could or should be offset.

Regulation 1107 provides for the protection of the environment in general terms. Specific protection goals (SPG) are recognised as a means for operationalising the legislation into measurable objectives in risk assessment and management. A first step towards the definition of SPGs for risk assessment was proposed by EFSA in 2016 and the SPGs were based on ecosystem services (ES) concept. Food and fibre production (the main purpose of agriculture) were included in the list of ES to be considered by regulatory risk managers. Additional socio-economic considerations (such as employment) and the trade-offs between relevant ES were not reflected in the EFSA guidance, yet are important for informing policy decisions and ensuring regulatory consistency. The inclusion of socio-economic assessment (SEA) would bring PPP regulation in line with corresponding legislation on industrial chemicals (REACH Regulation).

Given the SPG's regulatory nature and the important socio-economic and environmental impacts resulting from their selection, European Crop Protection Association (ECPA) initiated an Impact Assessment (IA) in line with the Better Regulation Guidelines of the European Commission to better understand the socio-economic and environmental trade-offs associated with SPGs.

OBJECTIVES

The objective is to develop a consistent impact assessment framework for addressing changes in farm and crop management using:

- a number of case studies to evaluate the use of herbicides in a range of crop production scenarios. The focus of protection is non-target terrestrial plants (NTTP)
- an ecosystem services and other socio-economics considerations to provide a holistic basis for making pragmatic and practical decisions in a transparent manner
- scenarios to emphasise trade-offs in these services when optimising agricultural land use for food production
- knowledge complementary to EFSA's Scientific Opinion on Non-Target Terrestrial Plants (2014), considering the evolution in thinking on setting SPGs since its publication.

The overall aim is to enable the Commission and Member States to take informed decisions on the future SPG for Non-Target Terrestrial Plants, and equally inform on how to safeguard the competitiveness of Community agriculture (Regulation 1107, Article 8).

METHODOLOGY

The impact assessment framework combines ecosystem services and other socio-economic methods. Ecosystem services (ES) are the goods and services provided by the natural environment that directly and indirectly affect human wellbeing, such as food and fibre, water purification, flood protection and recreation. The costs and benefits of the natural environment can be accounted for by linking them to economics.

A framework for defining ecosystem services, indicators and metrics for SPGs was developed and based on The Economics of Ecology and Biodiversity (teebweb.org). TEEB provides a clear and systematic way of considering services, that also includes soil protection, and is in line with EFSA Scientific Opinion.

Case studies were developed to road-test the framework that are representative of northern, central and southern European countries and a range of cereal, vegetable and fruit crops. The case studies account for typical environmental settings of crop production in each country, such as field size and field margin. The conceptual models for each case study were compiled with the assistance of local agronomists who provided agro-economic evidence for specific crops and their production. Four crop production scenarios were assessed in each case study (Table 1).

Table 1 Scenarios for crop production

Crops included: **Maize, France** **Winter wheat, UK** **Potatoes, Netherlands** **Oilseed rape, Sweden** **Onions, Poland** **Apple orchard, Italy**	**Scenario 1** (minimum requirements scenario)	Focus on maximising food production ecosystem service In-field herbicide application(s) in accordance with label instructions and NTTP protection in the off-field habitats, including integrated weed management
	Scenario 2	Use of an alternative weed control method as part of an integrated weed management system. Reduced yield is accepted if compensated by cost reduction; may lead to reduced income.
	Scenario 3	ES food production is maintained, and precision agriculture enables full protection of off-field habitat. In-field herbicide application(s) in accordance with the label instructions and NTTP protection in the off-field habitats (as in scenario 1).
	Scenario 4	Optimise protection of ecosystem services including all measures in scenarios 2 and 3 and compensation areas. Most conservative scenario is a combination of scenario 3, plus a greater level of protection on the off-field habitat to include vegetative and reproduction success (a net gain in NTTP).

SPGs were developed for each ecosystem service under each scenario and for both in-field and off-field areas. SPGs can differ between the two field areas. In addition, socio-economic indicators, such as farm revenues, labour, machinery, herbicides, and change in land use were valued and compared in order to derive net changes in services and socio-economics between scenarios in each case study.

Questionnaire

Agronomy experts in each country were recruited to complete a questionnaire seeking information on crop production, landscape, weed control strategy, efficacy, NTTPs and socio-economics and how these change under each scenario. The questionnaires formed the basis of the case studies.

THE FRAMEWORK

The positive and negative consequences associated with the different SPGs – measured using ecosystem services and socio-economic indicators - were valued. Trade-offs between a change in SPG and a change in farmers practices were demonstrated, which link back to the impacts on the environment. The case studies show how changes in crop management practices may be needed to accommodate a new SPG based on a farmer's agronomic needs and available tools.

Priority ecosystem services

The list of ecosystem services in TEEB were short-listed to focus the assessment on services found in agro-ecosystem service providing units (SPU), relevant to NTTP protection and likely to change through herbicide use. Prioritised ecosystem services forming the basis of the NTTP framework are in Table 2.

Table 2 Priority ecosystem services for NTTP protection

Ecosystem Service	Description in TEEB and interpretation for NTTP framework	SPU	Indicator(s)
Provisioning Services (ES that describe the material or energy outputs from ecosystems, including food, water and other resources)			
Food (in-field crop production)	Ecosystems provide the conditions for growing food. Food comes principally from managed agro-ecosystems but marine and freshwater systems or forests also provide food for human consumption. This ES includes crops for human consumption or crops grown for fodder. Food may be fresh or processed (to be defined for each case study)	Crop plants	• Yield (food security) • Quality of fresh produce (not fodder or processing) may influence price, to be reflected in SEA
Raw materials (in-field)	Ecosystems provide a great diversity of materials for construction and fuel including wood, biofuels and plant oils that are directly derived from wild and cultivated plant species. Although crops such as oilseed rape can be grown for human nutrition, for the purposes of this study we considered only industrial uses (e.g. biofuel, lubricating oil or raw material in the chemical industry). Other raw material crops include Brassica grown as raw materials for fertiliser or biocontrol pellets.	Crop plants	• Yield (fuel security) • Quality for fuel may be influenced by seed contamination, which is reflected in prices used in SEA
Wild foods (off-field)	Ecosystems provide the conditions for growing food. Wild foods in off-field include berries, nuts, wild garlic, watercress, herbs, nettles, etc, providing food for humans and wildlife.	Wild species foraged for food (or medicine)	Availability of wild foods
Freshwater (groundwater)	Ecosystems play a vital role in the global hydrological cycle, as they regulate the flow and purification of water. Vegetation and forests influence the quantity of water available locally. NTTP contribute to the infiltration of stormwater runoff and regulation of groundwater quality.	NTTPs (and soil organisms supporting them)	Groundwater quality (drinking water resource)
Freshwater (surface water)	Ecosystems play a vital role in the global hydrological cycle, as they regulate the flow and purification of water. Vegetation influences the quantity of water available locally. NTTP in regulating flow and stormwater runoff quality. Also, NTTP in off-field aquatic habitat (run-off).	NTTPs	Surface water quality and reduction of aquatic plants
Regulating Services (services that ecosystems provide by acting as regulators e.g. regulating the quality of air and soil or by providing flood and disease control)			
Erosion prevention and maintenance of soil fertility	Soil erosion is a key factor in the process of land degradation and desertification. Vegetation cover provides a vital regulating service by preventing soil erosion. Soil fertility is essential for plant growth and agriculture and well functioning ecosystems supply the soil with nutrients required to support plant growth. Role of NTTP to reduce soil erosion and impacts of herbicide and mechanical weed control practices on soil fertility	Rooted plants and soil organisms supporting them (microorganisms, macroorganisms such as earthworms)	Plant cover and rooting linked to soil erosion prevention, soil erosion vulnerability, soil loss
Habitat or supporting services (underpin almost all other services. Ecosystems provide living spaces for plants or animals; they also maintain a diversity of different breeds of plants and animals)			
Habitat for species (functioning of ecological components of the agro-ecosystem)	Habitats provide everything that an individual plant or animal needs to survive: food; water; and shelter. Each ecosystem provides different habitats that can be essential for a species' lifecycle. Migratory species including birds, fish, mammals and insects all depend upon different ecosystems during their movements. Role of NTTPs in the provision of habitat for animal and plant species	Habitats large enough to support organisms or communities of organisms. Includes ecosystem engineers (e.g. earthworms, plants) and large plants and animals that provide surfaces for periphytic organisms, and hedgerows.	• NTTPs as habitat and food for herbivores (bees), predators (spiders) and detritivores (earthworms) • Farm composition (plot/ patch type and geometry) • Indicators for species diversity and habitat diversity (Note: interpretation is contextual, for example, higher percentage of shrubs implies more biodiversity on intensive farms, but abandonment on extensive farms)

Key

In-field: material change in service provision and potential for change across scenarios

Off-field: material change in service provision and potential for change across scenarios

In-field and off-field: material change in service provision and potential for change across scenarios

SPECIFIC PROTECTION GOALS

The process for deriving specific protection goals (SPG) was as follows:

- Generic service providing units (SPU) were defined for prioritised ecosystem services, their contribution to service provision and anticipated change across scenarios were outlined (in-crop, off-crop but in-field and off-field);
- Conceptual models were developed for the off-field habitat;
- Focus on NTTP (vascular plants), but consideration was also given to indirect effects on other ecosystem components from SPGs (e.g. improvements in freshwater quality);
- For each SPU, preliminary quantitative SPGs, indicators and metrics were defined, taking account of legal frameworks, policies and relevant guidance (e.g. SPGs from EU Regulations, EC Directives, EFSA guidance, workshops, and published literature);
- Ecological characteristics of the SPUs and the receiving environment; and
- SPG dimensions from EFSA guidance (2014)

Two examples of SPGs for NTTP protection are provided in Table 3. These are presented to reflect the EFSA guidance for framing the measurement of PPP impacts against SPGs. Note, quantitative SPGs are currently being refined based on the outcome of the case study scenarios.

Table 3 Examples of specific protection goals for NTTP

Service	In-field SPG (gain or loss)	Off-field SPG (gain or loss)	Ecological entity to protect	Attribute to protect	Scale			PPP application frequency
					Magnitude of effects	Temporal scale of effects	Spatial scale of effects	
Food	• No net loss in yield (marginal contribution to food security) • No loss in quality associated with the application of herbicides	Not applicable	In-field food production (population)	Crop yield (biomass)	Negligible to small	Whole year	In crop, region or EU	Crop dependent
Habitat for species (functioning of ecological components of the agro-ecosystem)	Biodiversity net gain	Biodiversity net gain	NTTPs that provide habitat and food for species	NTTP reproduction and biomass	• Moderate-to-large effects in-field • Negligible effects on reproduction at edge of field/ field margin • Negligible-to-small effects on biomass at edge of field/ field margin	No impact on reproduction (timescale not applicable); days to weeks for biomass	Field margin to nearby off-crop	Crop dependent

CASE STUDIES

In summary, the case studies are used to road-test the socio-economic approach to the protection of NTTP using the SPGs, as follows:

- Assessment and definition of SPU and quantification of ecosystem services flows (i.e. level of service provision) in the baseline (Scenario 1);
- Assessment and quantification of changes in SPU and ecosystem services flows in the other SPG scenarios relative to the baseline; and
- Using ecosystem services assessment alongside socio-economic costs and benefits (human health, employment, farm costs and farm revenues) to show trade-offs.

The in-country agronomists provided a good understanding of weed control, crop production and NTTPs. The headlines from the case studies were as follows:

- generally, the scenarios lead to less herbicide use
- increased labour input and higher machinery costs are needed to adjust for reduced PPP weed control
- reductions of yield are anticipated under alternative scenarios (compared to baseline)
- positive effects on ecosystem services can be expected such as increased habitat for wild species and protection of surface water, however,
- in some cases, there may be a reduction in service levels, such as a reduction of soil fertility and increased erosion potential under mechanical weed control methods.

The overall findings are the impact assessment has assessed the practicability of a chosen SPG for risk assessors, risk managers and farmers and a range of potential environmental and socio-economic impacts were assessed. The socio-economic consequences of the various SPG options are revealed and explored through trade offs.

The work continues to explore the overlap between Regulation 1107 to other legislation, such as Habitat and Birds Directives and EU Common Agricultural Policy.

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