Pesticides and biodiversity

Agricultural productivity and biodiversity conservation

ELO
European Landowners' Organization

European Crop Protection

Contents

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Foreword

We all want a wide variety of high-quality and affordable foods available to us the year-round; we also want a prosperous countryside, and healthy and diverse ecosystems. A growing population and greater demands on agriculture presents society with one of the great challenges of the 21st century – to produce more agricultural goods from the same hectare while protecting biodiversity. Fortunately, the solution is at hand; productive agriculture is a key component in the protection of water, health, food, soil, and biodiversity.

To properly understand this challenge we must acknowledge the reality that whilst biodiversity offers essential contributions to agriculture such as the honey bees that assist pollination and the worms that keep soils healthy, it also threatens agriculture with insect pests, fungal infestations, and the influx of invasive alien species that can damage local ecosystems. For farmers and land managers, an invaluable part of mitigating and preventing the threats posed by biodiversity, is the safe and responsible use of plant protection products.

This report looks at the important role that the responsible use of pesticides can play in protecting the benefits of biodiversity, whilst reducing the impact of biodiversity based threats to agriculture. It explains how the research and development, approval processes, and registration requirements of the Directives and Regulations of the European Union work together to safeguard agricultural production, human health, and the environment.

The relationship between the quality of biodiversity and agricultural productivity is well understood by the majority of European farmers and is exhibited in their innate desire to maintain the farming environment; farmers are often the first to observe and experience a decline in biodiversity or other negative consequences of unprofessional pesticide use, and consequently work hard to maintain our shared European landscapes. With countryside biodiversity in sometimes steep decline, industry, policy makers, NGO's, farmers, citizens, academics and all other stakeholders must work together to find solutions to feed a growing population and ensure that a green countryside is available and enjoyable for all.

The crop protection industry, for its part, continually evolves and updates its products for safer and more efficient use. While current EU legislation demands no unacceptable side-effects from these products, it is understood that the safe use of plant protection products has acceptable consequences, but industry, farmers, and other stakeholders are continually working to minimise negative impacts.

What is vital in a time of increased public interest – and well-meaning, but sometimes misguided, scepticism – is an open and accepting spirit where innovation is concerned. However, this is not to abandon common sense; the same rigorous standards we expect from science should also be applied to the interpretation of its findings to ensure that fear, and misinterpretation of technology, is not able to guide European policy. If we are to produce more food at affordable prices, all whilst maintaining our ecosystems and the services that they provide, we must collectively embrace innovation and construct our policies accordingly.

Although there are complex and sometimes even conflicting challenges, there is no doubt that modern-day European agriculture can fulfil all these tasks; and, with the right mind-set and rules and incentives from the European Union, it will continue to do so. Together, we are committed to providing a prosperous countryside, safe and affordable food, and thriving green spaces.

Friedhelm Schmider

Thierry de l'Escaille

Introduction

With around 25% of the European landscape used for permanent crops and arable land [1], and the daily efforts of nearly 12 million European farmers and workers [2], agriculture plays an important role in shaping the Europe that we know and love, rendering the patchwork of cultural landscapes that we often refer to collectively as 'the countryside'.

The rural scenes that soften the hard edges of the suburbs and provide space for recreation and relaxation are the frontlines of agricultural production – this is where we grow our food, and where we witness the complex interactions and interdependencies of agriculture and biodiversity.

Arable and pastoral farmlands are the dominant land use in Europe, accounting for over 47% (210 million hectares) of the EU-27. With an estimated 50% of all European species reliant on agricultural habitats, it is perhaps no surprise that some critical conservation issues relate to changes in farming practices and the direct affect this has on the wildlife on farms and adjacent habitats [3].

The countryside is one of Europe's great sources of biodiversity; myriad organisms find food and shelter in the farmland that shapes the modern agricultural landscape. However, driven mainly by human activities, species are currently being lost 100 to 1,000 times faster than the natural rate; in the EU, only 17% of habitats and species and 11% of key ecosystems protected under EU legislation are in a favourable state [4].

The Food and Agriculture Organisation (FAO) warns that 60 percent of the world's ecosystems are being degraded or used unsustainably, with an estimated 85% of cultivated lands containing areas that are degraded by soil erosion, salinisation, soil compaction, nutrient depletion or unbalance, pollution and the loss of biodiversity [5].

A growing appreciation of ecosystem services, legitimate concerns about environmental degradation, and the ideal of sustainable development, have altered our expectations and increased our demands of agriculture. Today, we look beyond food, feed and fibre and expect agriculture to contribute to the protection of water, soil, biodiversity, and landscapes.

We can all agree on the need for agriculture; we must eat, therefore, we must farm. It is the parameters of agriculture over which we find contention; the location and scale of farming, its intensity, what we cultivate and the practices used for cultivation – these are the variables of an equation that is not easy to balance. Society is awakening to the significant challenge of feeding a growing population and maintaining agricultural practices which offer sustainable productivity.

Intensive use of natural resources has afforded Europe decades of economic growth and improvements in health and wellbeing. However, resources including water, fertile soils, biomass and biodiversity are all under pressure. The demand for food, feed and fibre may rise by up to 70% by the year 2050, whilst 60% of the world's major ecosystems that contribute to the production of these resources have suffered degradation, or are being used unsustainably [6]; effectively, agricultural production must double over the next 30-40 years, and this will need to be achieved using existing farmland, whilst using less water and other inputs [7]. One such input, and the focus of this report, is plant protection products (PPPs); also known as pesticides, or crop protection products.

This report outlines the valuable role that pesticides play in maintaining a productive agricultural sector and a safe, nutritious and affordable supply of food, feed and fibre. Here-in descriptions of the measures in place to enable the safe and professional use of pesticides, and insight to the continued development of plant protection products, allow for a greater understanding of how pesticides help to support sustainable and productive agriculture.

An endless number of mostly small and often inconspicuous organisms, such as bees, earthworms and soil microbes make much of our agriculture possible. Many of the organisms that live on, or move through farms help to keep soils healthy, or pollinate crops; however, insufficient management of potential pests poses risks to agricultural productivity and human health. In the event of a pest threat, and where no appropriate substitutes to the use of pesticides exist, a conventional or organic farmer may use pesticides to protect their crops.

Regulations ensure that pesticides approved for use in Europe are sufficiently effective in their protection of crops, and that they have no unacceptable effects on the environment. While the efficiency of pesticides and their safe use is continually improving (due to new and refined technologies) the acceptable side effects of pesticides are accounted for by regulations – and industry and stakeholders work together within this framework to minimise negative impacts.

Not limited to the use of pesticides alone, but no less relevant, the Common Agricultural Policy (CAP) and European Union environmental regulations oblige Europe's farmers to take biodiversity and conservation seriously, enforcing compliance with protection measures. If farmers do not take into account the protection of water, soil quality, and many other benefits to the environment, they face reduced payments and penalties [8].

Strengthened legislative measures for biodiversity protection reflect something of the increased societal awareness and acceptance of the importance of biodiversity, and so too do the rise of initiatives focused upon understanding and valuing ecosystem services.

Whilst the details remain the subject of study and debate, the message is clear; biodiversity and ecosystem services – and in the context of this report, provisioning services (food, fresh water, fibre etc.) [9] – are essential for our wellbeing and should therefore be safeguarded, and restored where reasonably possible.

How can biodiversity be conserved and enhanced at the same time as improved agricultural productivity? While this report does not offer a complete answer to this question, it does provide insight into one piece of this most complicated puzzle.

Biodiversity brings the good and the bad, benefits and challenges. Benefits to agriculture include insect pollination, the total economic value of insect pollination worldwide is estimated at €153 billion, representing 9.5% of world agricultural output in 2005[10]; however, pests, pathogens and weeds are responsible for annual losses of 26-40% of the worlds potential crop production [11].

> "Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

United Nations Conference on Environment and Development, Rio de Janeiro, June 3 to June 14, 1992

Maize is wind-pollinated, but honey bees can feed on maize pollen.

Biodiversity and agro-biodiversity – a complex relationship

Biodiversity

Biodiversity is the totality of life on earth; it is all animals, plants and microbes, and their genetic diversity; biodiversity can be regarded as the degree of variation between all life forms.

Biodiversity is more than charismatic and attractive animals and plants; it is the source of the ecosystem services that provide us notably with food, fresh water, clean air, shelter and medicine. Biodiversity contributes to the mitigation of natural disasters and the regulation of climate and pests and diseases [4]; biodiversity is the key to resilience of life, the ability of natural – and in-turn social systems – to adapt to change [12].

Biodiversity for food and agriculture is among the earth's most important resources. Crops, farm animals, aquatic organisms, forest trees, micro-organisms and invertebrates – thousands of species and their genetic variability make up the web of biodiversity in ecosystems that the world's food production depends on [13].

Agrobiodiversity

Agrobiodiversity (agricultural biodiversity) is a sub-set of biodiversity; it is biodiversity that is part of, or influences and interacts with agriculture. Agrobiodiversity includes farmed crops, livestock and all organisms that live within or pass through the agricultural environment.

Agrobiodiversity includes the life forms necessary for sustaining a healthy agricultural ecosystem; however, it also includes organisms that pose a threat to the health of crops. Organisms that assist agricultural production are often referred to as 'beneficials'; those species that complicate or prevent production, are known as 'pests'.

With regards to agrobiodiversity, European farmers and land managers have four main goals: to protect crops and livestock, control pest populations, safeguard beneficials living on or near their fields, and look after wild plants and animals that live in or near agricultural areas.

In simple terms, the influence of biodiversity on agricultural productivity can be expressed as follows:

Elements of biodiversity influence agricultural productivity

Agrobiodiversity

Beneficial organisms

Pollinators

In the European Union insects are the only animal pollinators; flies, butterflies, moths, beetles, bumblebees, solitary bees, and the honey bee *(Apis mellifera)* all make important contribution to the pollination of certain crops and wild plants.

The economic contribution to agriculture made by pollinators is crop-specific. Cereals or maize are wind-pollinated and therefore do not require insect pollination (although maize, for instance, provides pollen for honey bees). Many species of fruit absolutely depend upon pollinators for their sexual reproduction; apple and cherry, for example.

Pollinators also help us maintain variety in our diets, with many fruit and several vegetable species requiring insect pollination. There are also crops that may produce an enhanced yield when insect pollination occurs; oilseed rape is one such example.

Soil organisms

Soil is home to one of the richest, most complex biological communities on earth. The soil organisms that inhabit the world beneath our feet are vital for maintaining balanced ecosystems, healthy soils, climate control and agricultural production.

Soil organisms ensure soil fertility through humification (composting) and nitrogen fixation. Spaces created in the soil by earthworms and other organisms improve the water holding capacity of soils.

Soil is the second largest CO_2 sink on Earth, consequently, soil and soil organisms have considerable influence on the climate.

Dimensions of (soil) biodiversity under a footprint:

Taxonomic group	Number of individuals	Biomass (g/m^2)
Bacteria	10^{12} - 10^{14}	100 - 700
Funghi	10^{9} - 10^{12}	100 - 500
Algae	10^{6} - 10^{9}	6 - 30
Protozoa	10^{7} - 10^{9}	6 - 30
Nematodes	10^{4} - 10^{6}	5 - 50
Mites	$2*10^{2}$ - $4*10^{3}$	0.2 - 4
Springtails	$2*10^{2}$ - $4*10^{3}$	0.2 - 4
Insect Larvae	up to 5	< 4.5
Diplopoda	up to 7	0.5 - 12.5
Earthworms	up to 5	30 - 200

The number of microorganisms under a footprint is tremendous. Additionally, numerous higher organisms such as arthropods and various worm taxa inhabit the soil ecosystem. The absolute number of organisms under a footprint can be in the range between 10^{9} and 10^{14} individuals. From a quantitative perspective, it is reasonable to assume that the majority of the terrestrial biodiversity in Europe is to be found in the soil.

Orchards are visited by many pollinating insects

Beneficial predators, parasites and pest diseases

Organisms that prey upon, parasitise, or inflict disease upon agricultural pests are considered 'beneficials'. These organisms can improve agricultural productivity by removing, inhibiting or reducing the numbers of organisms of threat to crops. Beneficials do not belong to an ecological group of animals; they are labelled as 'beneficial' species when they are useful to agricultural productivity.

There are specific farming practices that promote beneficial species, including:

- The breeding and artificial release of beneficial species;
- Provision of habitats favoured by beneficial species;
- Field application of laboratory cultured viruses and bacteria (i.e. to promote disease in pest insect populations);
- Practicing Integrated Pest Management.

Important beneficial organisms:

Systematic Group	Example of beneficial organisms	Example of pest organism as controlled by the beneficial
Mammals	Hedgehogs, shrews	Insect larvae, slugs
Spiders	Spiders are unspecific predators	Insects
Predatory mites	*Typhlodromus pyri*	Spider mites, small insects
Roundworms	Insect-pathogenic nematodes	Insect larvae
Bugs	Predatory bugs	Spider mites, insects
Ichneumonid wasps	Most ichneumonid wasps are parasites	Caterpillars
Beetles	Ladybird beetles, carabid beetles	Aphids, slugs
Flies	Hoverflies	Aphids
Bacteria	*Bacillus thuringiensis*	Insect larvae
Viruses	Insect pathogen viruses	Insects, insect larvae

Agrobiodiversity

Pests

Pests are animals, plants and pathogens that have the potential to compete with human interests, such as inhibiting the cultivation of food and feed. There are three important categories of pest organisms:

- Animal pests – animals which feed on crops, causing physical damage and transmitting plant disease;
- Weeds – plants which compete with crops for resources like water, sunlight, or fertiliser;
- Pathogens - microbes (bacteria and viruses) which infest crops and cause plant diseases.

Animal pests

Animal pests inflict most of their damage during feeding; the canopy, roots and seeds of crops offering excellent forage. Animal pests also assist in the transmission of plant diseases; sucking insects – such as aphids – transmit pathogens to plants through the vomit expelled as part of their feeding process. Animal pests are not limited to insects, a variety of taxonomic groups qualify, including nematodes, mites, snails, birds and mammals.

According to the principles of Integrated Pest Management (IPM), an animal is considered a pest once the number of organisms per defined area exceeds a numerical threshold of acceptability; therefore, an animal is not automatically considered a pest, just because it feeds on crops. These numerical thresholds are specific to pest and crop type.

Some countries exercise legislation specifically addressing the treatment of weeds. The United Kingdom Weeds Act of 1959 (a) describes particular weed species and provides guidance for their removal. The UK Weeds Act includes the following species:

- Spear thistle *(Cirsium vulgare)*
- Creeping or field thistle *(Cirsium arvense)*
- Curled Dock *(Rumex crispus)*
- Broad leaved dock *(Rumex obtusifolius)*
- Common ragwort *(Senecio jacobaea)*

Weeds

When a plant competes with crops for resources such as soil, sunlight and water, it might be referred to as a 'weed'. Weeds might also be poisonous, or produce thorns and other defence mechanisms, that have the potential to contaminate harvests, and poison or injure livestock and humans.

Weed control is an elemental farming practice for which a diversity of techniques exist. Ploughing is a basic method of weed control, effective through the uprooting of weeds or the severing of their roots.

Weeds are often well ecologically adapted to agricultural environments. They have developed traits that increase the chances of survival in an environment without long term stability and frequent human intervention. Key weed survival traits include:

- Seed productivity: Groundsel (*Senecio*) produces around 1,000 seeds per plant, whilst the scentless mayweed can produce in excess of 30,000 per plant.
- Seed volatility: Many seeds have developed highly efficient mechanisms to enable long distance seed dispersal; dandelion (*Taraxacum*) is a well known example.
- Seed longevity: Some plants produce seeds with the trait of extreme longevity, able to survive for long period of time in the soil, only germinating on exposure to light. The poppy (family Papaveraceae) is one example, producing seeds that can survive 80 to 100 years before germination.

Agrobiodiversity

Plant Diseases

The pathogens that cause plant diseases are often fungi, but they may also be bacteria or viruses. These organisms share the characteristics of high reproductive potential and the use of mobile and robust reproductive structures – like spores – to ensure wide distribution of offspring by air, water and soil. In warm and moist weather conditions large fields can be infested within a few days.

Fungal infections in crops reduce yields as host plants are killed or damaged. Fungal infections that impact agricultural productivity include:

Powdery mildew	*Eryspihe graminis*	Wheat, barley, rye
Stripe rust	*Puccinia striiformis*	Wheat , barley
Ergot	*Claviceps purpurea*	Wheat, barley, rye
Corn smut	*Ustilago zeae*	Maize
Bakanae	*Fusarium fujikuroi*	Rice, cereals
Common bean rust	*Uromyces appendiculatus*	Beans
Potato blight	*Phytophtora infestans*	Potato
Black leg disease	*Phoma lingam*	Rape, cabbage
Black root disease	*Pleospora bjoerlingii*	Sugar beet
Apple scab disease	*Venturia inaequalis*	Apple

Fusarium molds are the cause of the most severe fungal diseases in European crops; they also produce toxic secondary metabolites (mycotoxins). More than 50 species of Fusarium are known to produce toxins including fumonisins, which affects the nervous system, and trichothecenes, which cause chronic and sometimes fatal effects on animals and humans. The relatively stable molecular structure of mycotoxins allows them to survive the transition from field to fork. [14]

Invasive Alien Species

Alien Species (AS) are species which are introduced outside their natural distribution area and succeed in surviving and subsequently reproducing. Invasive Alien Species (IAS) are alien species whose introduction and/or spread threaten local biological diversity [15].

Invasive Alien Species have affected native biodiversity in almost every type of ecosystem on Earth. As one of the greatest drivers of biodiversity loss, they pose a threat to ecosystem integrity and function and therefore, to human well-being [16]. The damage and economic impact of IAS extend to waterways, buildings, urban areas, forestry, and agriculture. The costs of preventing, controlling or eradicating invasive species and the environmental and economic damage they cause are significant; however, these costs are lower than those incurred if IAS are not managed, and damage is allowed to continue [15].

By the beginning of 2013, the European Commission funded initiative 'Delivering Alien Invasive Species Inventories for Europe' (DAISIE) had catalogued more than 12,000 species introduced to Europe and classified as 'aliens' [17].

A new legislative too to combat invasive alien species is expected from the Commission in 2013.

Several weed species have been introduced to Europe from other parts of the world:

Name	Origin	Importance
Common ragweed *(Ambrosia artemisifelia)*	North America	Allergenic plant. Grows near cultivated fields, rural sites
Horseweed *(Conyza canadensis)*	North-, Central America	Common in arable land and disturbed grounds in settlements
Gallant soldier *(Galinsago parviflora)*	Peru	Grows in arable land and waste places
Prostrate pigweed *(Amaranthuis blitoides)*	North America	Common in fields and along roadsides

Many of the most prevalent European animal pests can be classified as invasive alien species:

Name	Origin	Damaged crop	Introduction to Europe (approx.)
Grape phylloxera *(Viteus vitifoliae)*	America	Grapes	1850
Colorado beetle *(Leptinotarsa decemlineata)*	North America	Potato	1877
San Jose scale *(Quadraspidiotus perniciousus)*	China	Fruit trees	1980
Western flower thrips *(Frankliniella occidentalis)*	North America	Fruit, vegetables, ornamentals	1985
Western corn rootworm *(Diabrotica virgifera)*	North America	Corn	1990

Invasive Alien Species

Globalisation is largely responsible for IAS phenomena; the ever greater movement of people and goods has increased the unintended relocation of species; however, some IAS were intentionally introduced – at the time, the full consequences of their introduction ill-considered. The giant hogweed *(Heracleum mantegazzianum)*, the Canadian goldenrod *(Solidago canadensis)*, and the Himalayan balsam *(Impatiens glandulifera)* are species of flowering plant, purposefully introduced to Europe on account of their attractiveness. Since their introduction these plants have escaped from domestic and botanical gardens, to establish themselves 'in the wild' as alien species. Their impact on native species is difficult to assess. The relatively high nectar production and rapid growth of Himalayan balsam is good news for pollinating insects, but problematic for native plants when competing for resources.

It is realistic to assume that the influx of alien species to Europe will continue. In spite of increasing awareness about the seriousness of the problem, and improved preventative measures, the global distribution of goods, transport networks and mobility of people make it easy for animals and plants to reach and populate new areas. A few individuals, perhaps even only one plant, a seed, or a fertile female insect may be enough to start a new population and colonise a new locale, country or even continent.

Beauty gone bad – examples of ill-considered plant introductions:

Species:
Canadian goldenrod
Origin:
North America
Introduced to Europe:
1645

Species:
Himalayan balsam
Origin:
Himalaya
Introduced to Europe:
1829

Species:
Giant hogweed
Origin:
Western Caucasus
Introduced to Europe:
1817

The native Lady Bird beetle
Cocinella septempunctata

The Asian ladybird *Harmonia axyridis* was introduced to Europe in 1995 for the control of aphids in greenhouses. *Harmonia axyridis* escaped from greenhouses and successfully colonised European landscapes; their competition for prey with native ladybird species has led ecologists to consider the *Harmonia axyridis* as an ecologically critical pest species. Localised population explosions of this species have caused problems for wine growing regions; the insects are unavoidably harvested along with the grapes, their crushed bodies spoiling the flavour (and value) of the wine.

The introduced invasive ladybird beetle *Harmonia axyridis*

Protecting harvests – securing sustainable food supply

Before the intervention of agriculture the Earth's population probably never exceeded 15 million inhabitants; humans survived as scavengers and hunter-gatherers, relying on a diet of wild plants and animals.

Agricultural practices – including the domestication of species and first attempts to control pests – increased food supply and allowed populations to grow. During the Roman Empire (300-400 AD), the world hosted a population of no more than 55 million people.

At present world population numbers around 7 billion [6]. In spite of a decline in the rate of growth, predictions estimate a global population of between 7.5 and 10.5 billion by the year 2050. There are more people walking the planet today than ever before; in 2011 the population of Beijing surpassed 15 million [18], a figure that prior to the introduction of agriculture (some 10,000 years ago) would have accounted for every living human on the planet.

The demands society places upon agriculture go beyond the simple production of food. Consumer behaviour drives change within agricultural production trends; for example, increased demand for meat in developing countries [19], and growth in the provisioning of feed, fibre and fuel sees competition for agricultural land use that is potentially at odds with the need to produce more food [20]. The growing population requires more of agriculture than just more food; agricultural goods must serve a variety of functions.

Categories of agricultural goods:

Important agricultural goods	
Food	cereals, vegetables, fruits, spices, meat
Animal feed	hay, silage, legumes, alfalfa
Fibers	cotton, wool, hemp, silk, flux
Row material	bio plastic, pharmaceuticals, bamboo
Biofuels	methane, ethanol, biodiesel
Ornamental products	cut flowers, nursery plants

When weeds, pests and diseases consume or damage agricultural goods, they are in direct competition with humans. This competition would be tolerable if the result was a marginal loss of agricultural productivity; unfortunately such losses can be significant, which creates an ecological and economic need to use limited resources (land, water, soil etc.) efficiently and sustainably – this often requires crop protection solutions. A 2011 report into the potential of agriculture to produce ecological services and provide its goods for society stated *"Farmers must resolve the environmental problems to protect the resources whilst continuing to produce to satisfy the markets. The situation is complex given the committed European public requirements (Framework Directives on water, biodiversity, pesticides, etc.) and regulatory translations of specific national policies"* [21].

It is estimated that some 20-40% of the world's potential crop production is lost annually because of weeds, pests and diseases. These losses would be doubled if the use crop protection products were abandoned [8]. The 'OECD Agricultural Policy Monitoring and Evaluation 2011' concludes *"Greater global food demand, higher prices, more volatile markets and increasing resource pressures are arguments for moving beyond 'status quo' policies"* [7].

The extent of crop losses to crop pest categories for key crop types [9]:

Crop	Crop losses [%] due to			
	Pathogens	**Animal pests**	**Weeds**	**Total**
Rice	15.1	20,7	15,6	51,4
Wheat	12,4	9,9	12,3	34,0
Barley	10,1	8,8	10,6	29,4
Maize	10,8	14,5	13,1	38,3
Potatoes	16,4	16,1	8,9	41,4
Soybeans	9,0	10,4	13,0	32,4
Cotton	10,5	15,4	11,8	37,7
Coffee	14,9	14,9	10,3	40,0

Pesticides

Pesticides are biologically active compounds, formulated to affect target species. They are designed and used for the control of weeds, plant pathogens and animal pests. These products can have different biologically active origins, for example:

- Natural compounds, such as sulphur;
- Plant extracts, such as that derived from a daisy flower;
- Microbes, like insect viruses;
- Synthetic compounds, like those used in the azole class of fungicides.

Nearly all forms of agriculture, including both organic and conventional farming, require pest control, and pesticides are the most widely used and recognised tool for this job. Organic farming relies on naturally occurring inorganic molecules such as copper or microorganisms like bacteria and viruses; conventional farming uses in addition, synthetic compounds, which are formulated to be efficient and targeted in their action.

There are several classes of pesticides, the most relevant for crop protection are:

- Fungicides, for the suppression of fungal infections;
- Herbicides, used to control weeds;
- Insecticides, for the management of insect pests.

There are three key factors that determine the effectiveness of a product; the intrinsic properties of its active ingredient formulation, the characteristics of the target organism(s), and the mode of product application. Environmental variables such as local temperature and weather conditions also have influence over the effectiveness of pesticides.

Pesticides contain biologically active compounds and can therefore have direct or indirect unwanted effects on biodiversity. For example, the effective use of herbicides to remove weeds can have the secondary effect of reducing forage for pollinators if weeds that flower, are destroyed; likewise, the use of insecticide to manage aphids reduces the availability of food for ladybird beetles. Direct unintended effects of pesticides may occur for example, when a fungicide is translocated into a freshwater body, thereby exposing and potentially damaging aquatic organisms.

Society faces complex and sometimes conflicting challenges, protecting biodiversity whilst also exploiting it for the purpose of agricultural productivity is one such challenge. Pesticides play an important role here; as such, Europe has developed a policy and regulatory framework aimed at ensuring the efficacy, safety and suitability of pesticides and their use – this framework of legislation and guidance is described in the following chapters.

Protecting biodiversity, promoting agricultural productivity – pesticide assessment and regulation

There are regulations to ensure that the pesticides approved for use in Europe are sufficiently effective in their protection of agriculture, and that they have no unacceptable effects on the environment. The efficiency of products and their safe use is continually improving, as technologies and regulations are refined and innovation brings new and improved solutions.

The acceptable side effects of pesticides are recognised, notably in Regulation (EC) 1107/2009, and industry and stakeholders work together within this framework to minimise negative impacts, through the promotion of good practices, stewardship activities and the development of new technologies.

EU legislation

(EC) 1107/2009 is a robust Regulation which ensures that the use and development of plant protection products conforms to strict standards for environmental and human health.

A plant protection product is expected to meet the requirement of having 'no unacceptable effects on the environment' this includes consideration of 'its impact on biodiversity and the ecosystem'. EU processes are designed to manage and minimise potential negative impacts resulting from the application of pesticides*.

The Regulation demands no 'unacceptable' effect on the environment rather than 'no' effect. The acceptance of a degree of environmental impact, for instance short-term and indirect effects on animal or plant species, takes the potential side-effects of pesticides into consideration – recognising that, by definition, pesticides have an impact on biodiversity.

For the purposes of product authorisation, Regulation (EC) 1107/2009 divides the EU into three geographic zones (Northern, Central and Southern). The authorisation process calls for one Member State in any one zone to evaluate a product for authorisation. The authorisation of a product by one Member State within a zone, allows Member States within the same zone to implement a fast-track authorisation of the product, avoiding the need for an unnecessary replication of tests.

* *Requirements and conditions for approval – Approval criteria for active substances* [22]

3. A plant protection product, consequent on application consistent with good plant protection practice and having regard to realistic conditions of use, shall meet the following requirements:

....

(e) It shall have no unacceptable effects on the environment, having particular regard to the following considerations where the scientific methods accepted by the Authority to assess such effects are available:

...

(ii) Its impact on non-target species, including on the ongoing behaviour of those species;

(iii) Its impact on biodiversity and the ecosystem.

Regulation (EC) No 1107/2009, Art. 4

The registration of new plant protection products

A pesticide may not be placed on the market if it does not have valid registration. The registration procedure includes tests on active substances (AS), also known as active ingredient (AI), products (which may contain combinations of different AIs) and relevant metabolites. Tests, risk assessments, and risk management practices for specific elements of biodiversity are established during this period.

Active Substance approval

AS approval is granted by the European Standing Committee on the Food Chain and Animal Health (SCFCAH), a body comprised of experts nominated by EU Member States which receives expert input from bodies including the European Food Safety Authority (EFSA). The SCFCAH is empowered to grant full or conditional approval for the placing of a pesticide product on the market; it is obliged to refuse the marketing of any product which does not meet approval.

AS approval is granted for a maximum of 10 years, after this the substance must be resubmitted for approval [23]; however, an AS can be reviewed at any time if valid concerns about its safety or suitability are raised. If a review concludes that a product profile is no longer appropriate, the approval for the product is revoked.

Plant protection product approval

Once the EU has approved an Active Substance, data must be presented at Member State level justifying its use as an ingredient in a plant protection product. Data submissions at the national level must take into consideration local variations in climate, cropping patterns and human diet. Member States can grant full authorisation, restricted authorisation (based upon restricting product use to certain crops) or reject authorisation.

Toxicity, hazard and risk

Toxicity, hazard and risk are important parameters which play a fundamental role in the quantification and assessment of the side-effects pesticides may have. These three elements are carefully evaluated during the process of plant protection product registration. The terminology used in this brochure to determine what exactly constitutes toxicity, hazard, and risk is as follows:

Toxicity

Toxicity is the degree to which a substance can damage a living organism, which is an intrinsic property of any compound. If the dose is large enough, any compound can be toxic to humans or the environment. A substance with low toxicity requires high doses to have a negative effect; a substance with high toxicity requires a low dose to have a toxic effect. Arsenic, for example, requires only a small dose to be toxic, whereas water requires a very high dose before it inflicts damage on organisms that do not live in water.

The three key categories of toxicity are:

- Acute toxicity – adverse symptoms develop rapidly (often within hours or days) after brief exposure to a toxin.
- Chronic toxicity – symptoms develop over time following long-term exposure.
- Reproductive toxicity – occurs when a toxin inhibits reproductive capacity, fertility, and the normal development of offspring.

Hazard

A hazard is any source of potential damage, harm or adverse health effect to something or someone under certain conditions. Therefore all substances known to be able to cause harm or adverse health effects in humans or other organisms can be considered a hazard.

Risk

Risk is a factor of the probability that a hazardous event will take place under determined conditions of exposure to a hazard.

The following equation is often used to calculate risk:

RISK = Hazard x Exposure

An everyday example of hazard and risk

The act of driving a car generates both hazard and risk. The hazards that exist for drivers, passengers and pedestrians cannot be eliminated, but the associated risks can be managed to an acceptable level with a variety of measures; for example:

- The necessity of driving tests and licences;
- The installation of proper traffic controls (street markings, traffic lights, road signs etc.);
- Laws and campaigns to dissuade drivers, passengers and pedestrians from engaging in reckless behaviour;
- The installation of safety equipment and driving aids, such as seat belts, air bags, windscreen wipers, lights, horn and mirrors.

Risk quantification

Before pesticides are submitted for final approval, they undergo a lengthy and thorough process of toxicity, hazard and risk quantification, which in turn informs the development of risk management procedures as required by the regulatory framework.

After extensive trial periods, the risks associated with the use of a pesticide are quantified so that guidance for its safe and professional use can be published and applied by farmers.

In the production of guidance for the safe and sustainable use of pesticides, the following factors are taken into account:

- The realistic exposure of organisms to a pesticide, under realistic pesticide application conditions. Seasonal conditions, cropping systems, and pesticide application technology are all important variables when considering scenarios for realistic exposure;
- The sensitivities of different species to measured doses of pesticide;
- The specific biology of organisms, including their mobility and ecosystems which they inhabit;
- The sensitivity of the biocenosis (diverse species that live together in shared habitat) that might be exposed to pesticides.

Studies ('tests' used synonymously here) are carried out for a variety of organisms which inhabit a wide range of ecosystems. The studies are largely based upon guidelines published by international organisations such as the Organisation for Economic Co-operation and Development (OECD).

Risk is quantified through two kinds of study; studies which quantify effects on non-target organisms and studies which quantify the exposure of non-target organisms (organisms not the intended target of a particular plant protection product).

Studies are conducted in tiered stages; beginning with laboratory studies, continuing with simulated field conditions within a largely controlled environment, and finally progressing to field tests that provide realistic farming conditions.

The studies are carried out on individual active ingredients, on products that may contain more than one active ingredient and on relevant metabolites that result from the degradation of the active ingredient(s) of plant protection products.

Laboratory test

Simulated field conditions

Field tests


Aquatic plants

Laboratory studies with non-target organisms

Laboratory studies allow for substances to be tested in controlled environments; variables such as temperature and humidity are kept constant in order to assess the reactions of organisms to pesticides in defined conditions. Scientific panels select the species for which tests much be conducted; the eligibility criteria of species is based upon the likelihood and relevance of their exposure to the studied pesticide.

Organisms subject to laboratory tests include:	
Aquatic organisms	Algae, water fleas, midges, aquatic plants, fish
Soil organisms	Earthworms, insects (inc. springtails), mites
Non-target arthropods	Mites and insects like lacewings, ladybird and other beetles
Wild birds and mammals	Quails, mice, and rats
Non-target plants	A variety of regionally specific plants
Pollinators	Honey bees

The acceptable side effects of pesticides are recognised, notably in Regulation (EC) 1107/2009, and industry and stakeholders work together within this framework to minimise negative impacts, through the promotion of good practice, stewardship activities and the development of new technologies.


Honey bees tested via oral exposure


Tests on algae

Field studies and studies which mimic field conditions

In the second level (2nd tier) of testing, products are tested under more realistic field conditions. Climatic variables such as sunlight and rainfall, and a multitude of farming practices, result in diverse and complex exposure scenarios for target and non-target organisms. Field and greenhouse studies allow products to be tested under realistic (or as close to real as possible) conditions, something that cannot be achieved in a laboratory.

Non-target arthropods

A vineyard is treated to assess side-effects on predatory mites.

Field study

Soil organisms

A soil sample is taken to count the inhabiting organisms (earthworms, insects, mites etc.)

Wild birds and mammals

A mouse carries a transmitter. Herewith, the habitation and movement of the mouse can be determined.

Pollinators

In a field plot covered with gauze honey bees are exposed to a test compound which is apllied on flowers *(Phacelia)*.

A bag filled with straw is dug into the soil. This test allows quantifying the degradation rate of plant matter, an ecosystem service which is provided by the multitude of soil organisms.

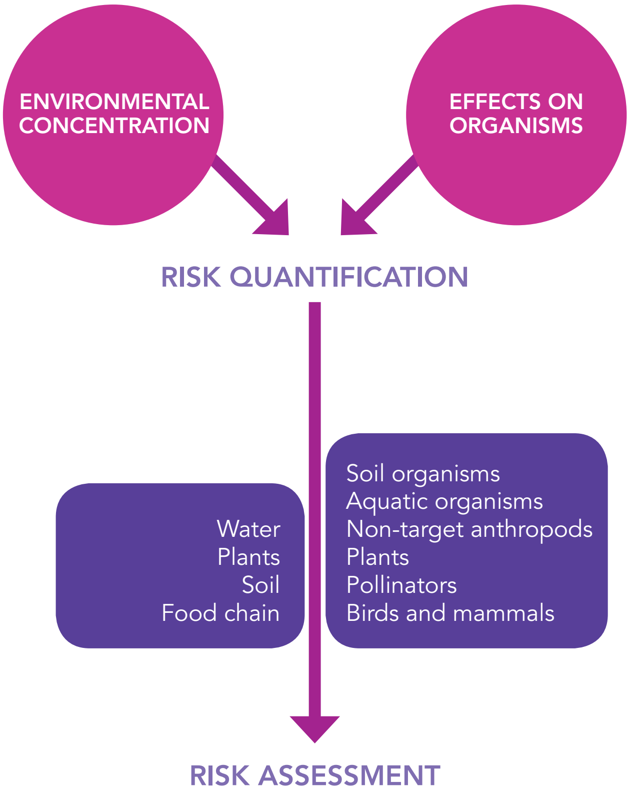
The principles of risk assessment

Following the collection of toxicity and exposure data gathered during the risk quantification stage, the process of risk assessment can begin. Risk assessment establishes the hazard and risk of a product.

Risk assessment takes the real-life environment of working farms into consideration, in order to develop a clear picture of the variables that influence hazard and risk under realistic conditions.

A key factor in any risk assessment is the stability of a compound in the environment. In general, the risk related to a compound increases with its stability. But, a compound must be found to be stable enough to safeguard the crop (as is the intended function of the product); however, it must also degrade quickly enough to minimise risks to non-target organisms which are liable to be exposed to the product.

The risk quantification and assessment procedures used for pesticide approval demonstrate that 'risk' is not an abstract term; in this context, risk is a transparent and justifiable value which is a decisive factor in the registration of a pesticide, as well as in the development of the guidance provided on pesticide product labels.



The principles of risk management

The implementation of risk management measures is obligatory for pesticide users. Guidance for the safe use of individual products is communicated by way of product use instructions (generally affixed to products as a label), that communicate to the user, where, when and under which circumstances a pesticide may be safely used. The possibility to manage the risks associated with pesticide use, means that it is possible for a pesticide to be highly toxic, but yet pose little hazard to humans and the environment. For example; if a pesticide is dug into soil in a granular form, the likelihood of exposure for above-ground organisms – such as birds – is reduced. Similarly, the use of drift-reducing nozzles can reduce exposure for organisms living near to treated fields. Reducing the dose and frequency of application of pesticides also reduces the risk of unwanted effects.

Because risk can be managed, the authorisation of pesticides should remain based upon an assessment of risk rather than hazard. A product is only granted authorisation once appropriate risk management procedures have been established.

Managing risks to non-target organisms

The good practice application of pesticides seeks to protect organisms that live within a field (like soil organisms or foraging bees) as well as those in surrounding habitats.

In the European Union there are obligatory measures in place to ensure that farming practices minimise their impact on the environment. Pesticides are labelled with explicit instructions and it is obligatory that pesticide users follow these instructions.

Off-crop area exposure routes to pesticides include:

- Drift: Occurring when wind blows spray particles outside of the area designated for treatment
- Run-off: The unintended flushing of pesticides from treated fields to areas not designated for treatment
- Drainage: Water containing pesticides can flow out of fields by way of farmland drainage

There are several risk management measures used to reduce the exposure of off-crop habitats; for example:

- The occurrence of drift from liquid spray applications can be reduced with the use of drift-reducing nozzles. These specially adapted nozzles reduce the number of spray droplets emitted by spray heads (by increasing droplet size); this reduces the potential for wind to carry particles to off-target areas.
- The accidental release of dry solid particles (particle drift) during the sowing of treated seeds is reduced using technology that minimises abrasions from treated seeds.
- Buffer zones that separate the target treatment area from non-target / off-crop territories can reduce the exposure of organisms living outside of fields.

A range of management measures which are targeted towards the protection of bees, birds, soil organisms or other elements of biodiversity, help a farmer meet the parallel challenges of farming profitably and protecting biodiversity. Product diversification helps keep this balance; for example, if a stream is found adjacent to a potential treatment site, the farmer must opt for a pesticide that is authorised for use in the proximity of water bodies. Where surface water is not present, other products may be applicable. The availability of a comprehensive selection of pesticides allows farmers to select products based upon their suitability for protecting their target crop and minimising risk to non-target organisms.

The evolution of risk assessment and risk management

Risk assessment and risk management are science driven processes (containing normative elements), so they evolve alongside developments in scientific knowledge, and to accommodate newly innovated crop protection solutions and refinements to those that are already on the market. Factors that might call for a change in the risk assessment and risk management processes include:

- The use of new molecules in a plant protection product
- The pioneering of new or improved farming practices
- The unforeseen (and often unforeseeable) arrival of new pest species in Europe

The safeguarding of biodiversity is well considered during the approval process for plant protection products; a multitude of biological and ecological groups are included in the approval process.

For those readers who want to know more about the complexity of scientific tools and regulations, a list of the most relevant documents is provided on the inside back cover of this publication.

Best Practices – resource efficient, sustainable and productive agriculture

There are many strategies that can be employed by farmers to effectively combat pests and optimise pesticide use. Some of these are outlined below.

Integrated Pest Management

Integrated Pest Management (IPM) is a crop production system that combines different management strategies in order to minimise the need for pesticide use. IPM aims to maximise the use of ecosystem deliveries for growing healthy crops.

According to the principles of IPM, an organism is considered a pest only once it exceeds a defined threshold of number of organisms per area; these thresholds are specific to pest and crop type and often consider the potential economic threat of a pest [25]. Therefore, in low population densities, 'pest' species are not actively managed in order to avert the emergence of pest resistance to crop protection products and to avoid unnecessary product applications.

Resistance management

Living organisms are not created equally; some are better equipped for survival than others. Charles Darwin's theory of evolution resulted in the popularised concept of 'survival of the fittest'; a metaphor for his theory of 'natural selection', the more favourable chance of survival of organisms better adapted for their immediate, local environment.

Natural selection drives change in evolution; the genetic variations within a group of organisms may see some individuals survive in a particular environment, whilst others die out. If the advantageous genetic characteristics of the surviving organisms are passed to the next generation, then the new generation is better equipped for survival. This process can repeat until populations have adapted themselves for particular ecological niches.

According to the FAO, the definition of Integrated Pest Management is as follows:

Integrated Pest Management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms [24].

One general consequence of IPM is apparent: namely the fact that the control of harmful organisms is based on complex decisions. A multitude of variables must be taken into account, and the integration of different control methods necessitates a well-developed strategy.

IPM and the cherry fly *(Rhagoletis cerasi)*
The maggots of the cherry fly feed on cherries and ruin the fruit for harvest. Sticky traps are placed around orchards to monitor the development of cherry fly populations. For example, the capture of more than 1.5 flies per day per trap might indicate a level of infestation that justifies the application of control methods such as pesticides.

These adaptation processes may represent threat to agricultural production. Natural selection complicates the process of crop protection, when pests and diseases adapt and successfully combat the intended effects of pesticides.

The pesticide used to treat a particular crop may not be effective on all of the organisms of one target species within a target area. When this occurs, future generations of surviving organisms are likely to share more of the genetic characteristics that protect them against the pesticide. This is known as pesticide resistance. Prolonged and repeated exposure to active ingredients with an identical mode of action can facilitate the occurrence of resistance.

Pesticide resistance can be prevented or slowed through the use of an array of pesticides (resistance management strategy) that exploit a variety of active ingredients and modes of action.

Good farming practices

Growing high yields whilst making an efficient use of natural resources requires a great deal of professionalism and knowhow. In general farmers are challenged to produce more than ever, under increasingly difficult climatic conditions, whilst maintaining standards for biodiversity as set-out by mandatory cross-compliance in the Common Agricultural Policy (CAP) and environmental legislation. Farmers must also consider the health and welfare of the final consumers of their produce.

The safe and professional use of pesticides is integral to farming practices that can deliver sufficient yield, make efficient use of natural resources, and achieve environmental protection goals. When using pesticides, good farming practice entails selection of the most appropriate crop protection product, and adherence to the instructions provided for its safe use. The financial cost of pesticides adds incentive for farmers to be sparing and efficient in their use.

Next to mandatory national and EU regulations, farmers have a strong incentive to conserve biodiversity, since biodiversity contributes to the long-term productivity of their fields. Farms are often passed-down through generations of the same family; maintaining soil health, trees and hedges (for example) help ensure that farmers can pass healthy and productive farms to their children.

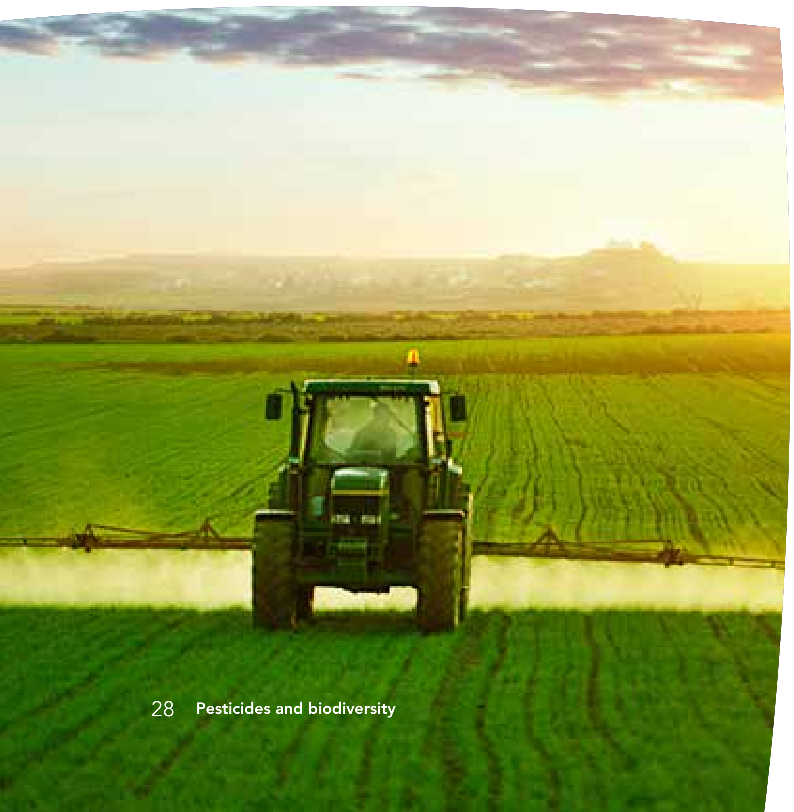
R&D and new technology – innovating the next generation of crop protection solutions

Product research and development (R&D), which results in the innovation of new crop protection solutions can offer important benefits for biodiversity; each new generation of product attempts to improve on the last, bettering previous performances in both efficiency and the minimisation of unintended effects.

Active Ingredients (AI) determine the behaviour and effectiveness of pesticides. AI's are the product of years of dedicated research and are based on particular molecular structures (so called 'lead compounds') - that have biological effects that promise an effective solution to a particular pest problem.

Active ingredients must possess suitable levels of potency, target selectivity, toxicity and ecotoxicity in order to become a marketable product. The rigorous nature of product approval combined with industry and farmers' commitment to reducing negative environmental impacts of pesticides sees a trend for products that are more efficient and targeted, and accompanying safe use restrictions and stewardship programmes that effectively manage environmental risks.

R&D promises the continued improvement of pesticide products; better crop protection coupled with reduced potential for environmental impact; however, the enormous cost, and low success rate of R&D limits the progress of discovery of new and better molecules. Globally, only a limited number of companies have the resources to conduct the R&D necessary to bring a new product to the market.

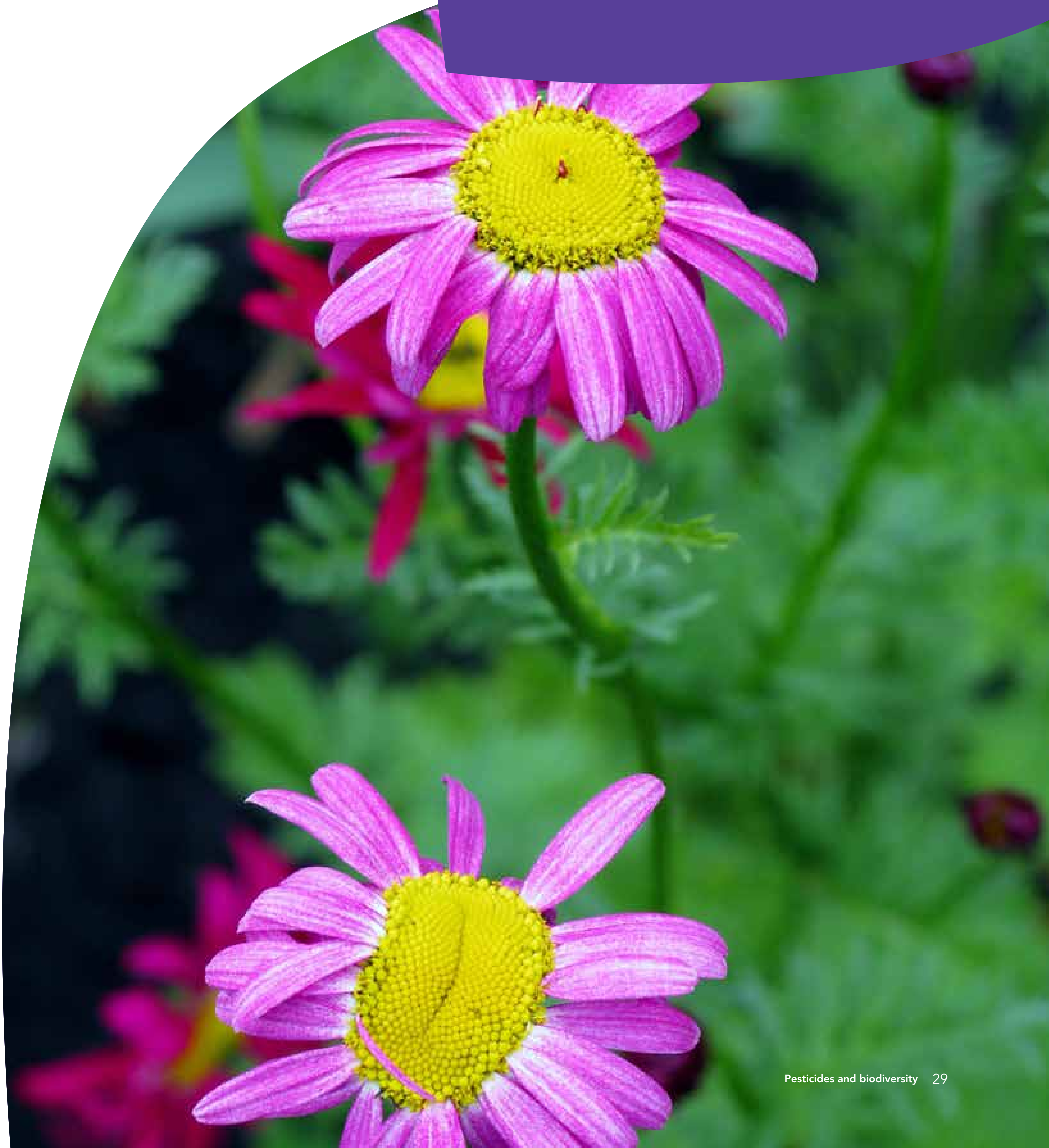


When new technologies are developed and approved, there is a real need for these new tools to be properly applied and used on the farm. Through farm advisory services, expert help, and other communication and assistance services, farmers can receive the guidance they need to safely use new products and tools.

Researching new and better molecules is a time consuming, very costly, and often frustrating business; only around 1 in 140,000 new molecules will ever reach the marketplace as a successful new product. This low rate of success is due to practical and legal constraints, which include:

- High effectiveness: the molecule should be highly effective and outperform existing products
- Production potential: it must be possible to produce the molecule at industrial level at affordable prices
- Patentability: the product must possess characteristics which allow for legal protection
- Regulatory compliance: the molecule must comply with the requirements of regulating bodies
- Suitable market potential: there must be sufficient demand for a new product to be created
- Changing conditions: On average, around 12 years will be spent doing research and development. During this time, market conditions, farming practices and pest distributions can change drastically – potentially wasting all the time, research and money spent during the development cycle of any new active ingredient.

The Pyrethrum daisy contains active compounds called 'pyrethrins' which have insecticidal properties. Pyrethrum has been widely used to control insect pests for centuries; among other uses, it forms a part of mosquito control. For the purposes of modern agriculture, however, the pyrethrum compounds are too easily broken down by exposure to sunlight. Today, synthetic derivatives of pyrethrum have overcome this weakness and form an important class of insecticides.



Conclusion

The act of increasing agricultural productivity while maintaining or even enhancing biodiversity represents an enormous challenge for humanity. The sustainable production of sufficient, safe, and high-quality agricultural goods is achievable if we make effective use of available resources, both physical and intellectual. An efficient use of natural resources is essential in any strategy that can deliver a sustainable increase of production, but we should not overlook, or indeed fear, the power and value of science and innovation, and the enormous capacity of our own species to solve complicated problems.

Science, research and development have given us sophisticated crop protection solutions, solutions that modern day agriculture has established as vital tools for productive farming. Used professionally by farmers and land managers across Europe, pesticides play a key role in delivering an abundant supply of safe, healthy and affordable food. While their use is certainly not without risk, a sensible, risk-based approach to EU legislation ensures a safe, healthy environment in addition to the reliable supply of food and other agricultural goods. Paradoxically, a significant barrier to progress is today's tendency to overlook the power and value of science and innovation.

When the global need for agricultural productivity is considered, there are currently no credible alternatives to pesticide use in either conventional or organic farming. To fulfil this need, if we wish to sustain yields, feed the planet and make efficient use of natural resources, the use of plant protection products must continue.

The biologically active characteristics of pesticides pose a risk to non-target species; this is acknowledged and accommodated in European pesticide regulation; pesticides are today one of the most regulated classes of products on the European market. None of the key drivers of biodiversity loss (such as land use change) is subject to regulation as rigorous as those applied to crop protection products. Pesticide regulations are there to ensure the safety and safe use of pesticides, so that farmers are equipped with the right tools for sustainable productivity, and so consumers can be confident of the safety, availability and affordability of food. To be certain that this remains so, farmers, industry and other stakeholders work together within the framework of EU Regulations and Directives to minimise any negative impacts.

Europe is potentially well placed to advance sustainable productivity in agriculture and thereby enhance and protect biodiversity. There is tremendous potential if decision makers recognise and add value to strong public support for biodiversity protection, a qualified and knowledgeable Europe-wide resource of farmers and land managers, and an industry active and engaged in promoting harmony between nature and agricultural productivity.

With careful management and reasoned discussion between land managers, the public, and policy makers, we can ensure a sustainable future.

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Appendix

Relevant documents for understanding the evolution of risk assessment and risk management for plant protection products

1. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Our life insurance, our natural capital: an EU biodiversity strategy to 2020 COM (2011) 24 final.*

2. *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. OJ L 206, 22.07.1992 p. 7 – 50.*

3. *Directive 98/8/EC of the European Parliament and the council of 16 February 1998 concerning the placing of biocidal products on the market. OJ l 123/1, 24.4.1998, p. 1- 63.*

4. *Directive 2000/60/EC of the European parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. OJ L 327, 22.12.2000, p. 1- 73.*

5. *EFSA Panel on Plant Protection Products and their Residues (PPR); Scientific Opinion on the development of specific protection goal options for environmental risk assessment of pesticides, in particular in relation to the revision of the Guidance Documents on Aquatic and Terrestrial Ecotoxicology (SANCO/3268/2001 and SANCO/10329/2002). EFSA Journal 2010;8(10):1821. [55 pp.] doi:10.2903/j.efsa.2010.1821. Available online: www.efsa.europa.eu/efsajournal.htm.*

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8. *Guidance Document on Terrestrial Ecotoxicology under Council Directive 91/414/EEC (SANCO/10329/2002) rev. 2 final, 17.10.2002, p. 1 – 39.*

9. *Guidance Document on Estimating Persistence and Degradation Kinetics from Environmental Fate Studies on Pesticides in EU Registration. Sanco/10058/2005, version 2.0, June 2006.*

10. *Proposal for a Directive of the European Parliament and of the Council establishing framework for Community action to achieve a sustainable use of pesticides 2006/0132 (COD).*

11. *Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EEC and 2002/21/EC. OJ 396/1, 30.12.2006, p. 1 – 849.*

12. *Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC. OJ L 309/1, 24.11.2009, p. 1 – 50.*

European
Crop Protection

The European Crop Protection Association (ECPA) represents the crop protection industry at the European level. Its members include all major crop protection companies and national associations across Europe.

ECPA promotes modern agricultural technology in the context of sustainable development; to protect the health of humans and the environment, and to contribute towards an affordable healthy diet, competitive agriculture and a high quality of life.

ECPA members support fair, science-based regulation as a guarantee to the consumer, and the crop protection user, of high standards and safe products.

ELO
European Landowners' Organization

The ELO is a European organization representing more than 54 national associations of private landowners across the EU 27. It is a non-profit organization committed to promoting a sustainable and prosperous countryside and to increase awareness relating to environmental and agricultural issues.

By engaging various stakeholders, ELO develops policy recommendations and programmes of action targeted to European policy makers.

ELO also organizes interdisciplinary meetings, gathering together key actors from the rural sector and policy makers at local, regional, national and European level.

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