Scottish Wildlife Trust

Policy


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Pesticides

Pesticide Policy

Policy headlines

1. The Scottish Wildlife Trust believes that the use of pesticides can have a deleterious effect on Scotland's wildlife and ecosystem health. Because of this, the Trust supports low-input systems which have low environmental impacts at the landscape scale, in which pesticide use and impacts are reduced through adopting an ecosystem approach to pest and disease management. This integrated pest management approach, involves knowledge of soil organisms, crop and non-crop plants, multiple herbivores, agricultural (or forestry) food webs, natural pest enemies and pest attractants and repellent.

2. The Trust believes that using pesticides in a way that reduces the negative impacts on wildlife in combination with creating the right habitat conditions at the landscape scale to encourage biological pest control can benefit agricultural ecosystems. Improving ecosystem health will enhance ecosystem services such as nutrient cycling, food production, pollination, improved water and soil quality, and the cultural and aesthetic service provided by increased biodiversity.

Scope

3. This policy sets out the Scottish Wildlife Trust's views on the use of pesticides. The policy explores the impacts of pesticides on the environment, how pesticides are regulated and what the Trust believes should be done to minimise harmful effects. As the agricultural sector is the greatest user of pesticides in Scotland, the policy is mainly aimed at this sector although the principles apply to horticulture[i] and forestry.

4. For the purposes of this policy, 'pesticide' describes commercial formulations that are used in order to change plant growth or kill: unwanted plants, animal pests or disease-causing fungi. The generic term includes: insecticides, herbicides, fungicides, nematicides, molluscicides, growth regulators and seed treatments.

Background information to inform the policy
(*The policy statement and priorities for action start on page 7)*

5. Since the 1960s, world food production has increased by c. 145%, with growth in Western Europe increasing by c. 68%.[ii] Concurrently, farming has intensified and there has been a dramatic rise in the use of chemical inputs such as pesticides which now amounts to a global application of c. 2.5 billion kg per year.[iii]

6. In Scotland the agricultural and horticulture[iv] sector uses c. 1.7 million kg[v] (which is about a third less than was used thirty years ago; although the figure regarding weight does not necessarily reflect the concentration of chemicals used, nor the type of active ingredient); use in agriculture accounts for 99% of the pesticide application. No figures are available for use in gardens/public parks or by local authorities. In forestry, data on annual use are not collected in Scotland.[vi] However total annual herbicide use has been estimated approximately 0.1 % of the total pesticide used in Britain.[vii]

Environmental impacts

7. In Europe, pesticide regulation and risk assessment have been gradually strengthened over the last 60 years, so that the effects of pesticides on non-target species such as wildlife are given greater consideration in the approval process than they were in the past. (The regulatory process is discussed in Section 14 - 28 below.) However, there is no room for complacency. The European Union's temporary moratorium (in effect from December 2013) banning the use of three types of neonicotinoids which threaten insect pollinators, illustrates that environmental effects may emerge long after a chemical has been approved, as was the case with organochlorines[viii] which were widely applied to crops 60 years ago and were then linked to a decline in wildlife such as peregrine falcon and other raptor species (see Appendix 1 for details) which eventually led to them being banned from use in agriculture.

8. Pesticides which have the greatest impact on non-target species have one or more of the following properties:

a) broad spectrum of killing ability
b) long-life in the environment or in animals or plant bodies
c) fat solubility
d) concentration up food-chains

Impacts of approved pesticides on the environment

9. Although approval of pesticides is regulated, by their nature they are designed to be toxic; they kill, reduce or repel target species of insects, weeds, fungi or other organisms. Even when used correctly, non-target species are at risk from exposure and this risk is increased if the chemical takes a long time to break down in the environment (i.e. has a long half-life)[ix,x]

10. The negative impacts of EU approved pesticides on non-target species is summarised by work conducted by Geiger et al[xi] who state *inter alia*:

Despite several decades of implementing a Europe-wide policy intended to considerably reduce the amount of chemicals applied on arable land, pesticides are still having disastrous consequences for wild plant and animal species on European farmland. This impact is manifested as a reduction of the potential of natural enemies to control pest organisms.

11. The life span of a pesticide depends on its physical and chemical properties and the characteristics of the environment. Modern pesticides are designed to break down relatively quickly in the environment. However, this does not prevent chemicals with a long half-life still being used (e.g. the reported half-life for neonicotinoids in soil typically ranges from 200 to in excess of 1000 days[xii]).

12. Routes of exposure for non-target species include: through contact during / after foliar spraying, persistence in soil, aerial drift, by seepage and surface run off into watercourses and aquifers, direct poisoning through consumption (e.g. coated seed or pesticide granules), secondary poisoning by consuming target species.

13. Research has shown approved pesticides can have negative impacts on:
a) soil biodiversity[xiii]
b) species richness in freshwater ecosystems[xiv,xv]
c) amphibians[xvi],[xvii]
d) insect pollinators through lethal or sub-lethal affects [xviii,xix,xx,xxi]
e) mammals - due to primary or secondary exposure to pesticides[xxii xxiii,xxiv]
f) agricultural biodiversity e.g. wild plant species, farmland birds, grassland butterflies and beetles[xxv,xxvi]
g) ecosystem health (e.g. by reducing species diversity; modifying food chains; changing patterns of energy flow and nutrient cycling (including nitrogen); reducing soil, water, and air quality; and changing the stability and resilience of ecosystems)[xxvii]
h) birds - due to lethal (direct poisoning) and sub lethal effects (poisoning through food chain) and less foraging opportunities because of decrease in invertebrate food abundance[xxviii, xxix]

Regulation of pesticide use[xxx]

14. There is a dual system for the approval and regulation of pesticides in the European Union (EU):
a) Under Regulation[xxxi] 1107/2009: Placing of plant protection products on the market, the EU Commission authorises the use of active substances[xxxii] contained in the products and an EU list of approved active substances is established
b) Member States may authorise plant protection products containing active substances on the EU list. The Scottish Ministers have the powers to withdraw or amend authorisations for use of plant protection products in Scotland. Currently, however, the Chemicals Regulation Directorate of the Health and Safety Executive acts on behalf of the Scottish Government under Agency Agreements between Ministers, and is the regulatory body for the authorisation of pesticide products in the UK

15. Regulation 1107/2009 places a higher emphasis on the level of health and environmental protection than was previously the case; because of this regulation, over two-thirds of a 1000 pesticides that were on the market before 1993 have been withdrawn from use. The regulation applies to all sectors using plant protection products e.g. agriculture, forestry and horticulture.

16. There are just over 500 approved active substances[xxxiii] which can be used by member states in the EU.[xxxiv] In Scotland over 200 active substances are used, with the majority being used in agriculture.[xxxv]

Risk Assessment

17. The European Food Safety Authority (ESFA)[xxxvi] carries out the risk assessment for pesticides and provides the European Commission with scientific support in the decision making processes.

18. As well as assessing the risk to human health, the risk assessment evaluates the potential impact on non-target organisms when the products are correctly used. ESFA revises guidelines on risk assessment for particular pesticides when previous risk assessments have proved to be not fit for purpose.

19. The risk assessment process is proficient at identifying pesticides that have properties which could impart undue toxicity to humans or other vertebrates. However the process can sometimes be less effective at dealing with broadness of toxicity, or sub-lethal effects[xxxvii] for invertebrate non-target species, or assessing the impacts on ecosystems at the landscape scale. An example of this limitation emerged regarding the impacts posed by neonicotinoids[xxxviii] on non-target species such as insect pollinators. Neonicotinoids have been used as crop seed dressings for nearly 20 years and a growing body of evidence showed that exposure to neonicotinoids at sub-lethal doses could have a significant negative effect on bee health and bee colonies.[xxxix,xl,xli] The ESFA was asked by the European Commission to assess the risks associated with the use of three types of neonicotinoids and after completing the review the ESFA identified that there was a risk to bees and a temporary moratorium (two years) has been placed on their use in the EU. [xlii] .

20. Other activity by the ESFA includes:
a) revising guidance for assessing the risks posed by pesticides to aquatic organisms[xliii]
b) revising guidance for assessing the potential risks to honey bees, bumble bees and solitary bees from the use of pesticides.[xliv]

21. Although the European Commission regularly reviews the risks posed by pesticides and the robustness of the risk assessment process, when new evidence emerges which shows negative effects on non-target species, by the nature of the scrutiny process this does not elicit a rapid response. This means that it can take a long time for a pesticide, which has been shown to have a negative environmental impact, to be suspended or banned from use.

The precautionary principle[xlv]

22. The precautionary principle aims at ensuring a higher level of environmental protection through preventative decision-taking in the case of risk. The precautionary principle enables rapid response in the face of a possible danger to human, animal or plant health, or to protect the environment. In particular, where scientific data does not permit a complete evaluation of the risk, recourse to this principle may be used to stop distribution or order withdrawal from the market of products likely to be hazardous.[xlvi]

23. With regard to the pesticide approval process, industry must demonstrate that substances or products produced or placed on the market do not have any harmful effect on human or animal health or any unacceptable effects on the environment.

Reducing the use of pesticides in the European Union

Sustainable use of pesticides[xlvii]

24. The EU recognises that even when correctly used, approved pesticides can have adverse effects on the environment. Under Directive[xlviii] 2009/128/EC, the EU Commission has set out rules for the sustainable use of pesticides (applicable to all types of commercial use including forestry and horticulture) to reduce the risks and impacts of pesticides on the environment.[xlix] This includes, *inter alia*, the implementation by member states of:

a) National Action Plans - to set objectives **measures** and timetables to reduce risks and impacts of pesticide use - They should also foster the **use of alternative** ecological **approaches or techniques.**
b) Integrated pest management (IPM) - Promotion of low pesticide-input management including non-chemical methods. Professional users will have to apply general principles of IPM from 1 January 2014.
c) Protection of the aquatic environment and drinking water - member states shall adopt specific measures [in the use of pesticides] to protect the aquatic environment and drinking water supplies. (This aligns the directive with the goals of the EU's Water Framework Directive[l] - which has an ultimate objective to achieve "good ecological and chemical status" for all Community waters by 2015. In Scotland the directive was transposed into law through the Scotland Water Environment and Water Services (Scotland) Act 2003 (WEWS Act); the WEWS Act has given Scottish ministers powers to introduce regulatory controls over water activities, in order to protect, improve and promote sustainable use of Scotland's water environment. This includes wetlands, rivers, lochs, transitional waters (estuaries), coastal waters and groundwater.).

25. It is important to note that although member states have to adapt their laws to meet the sustainable use of pesticide goals, because this is a directive rather than a regulation, it is up to member states to decide how to implement the directive to achieve the legislative goals.

26. The UK Government has produced a National Action Plan (NAP) for the sustainable use of pesticides, which the Scottish Government has signed up to. It is available to view from: https://www.gov.uk/government/publications/pesticides-uk-national-action-plan

27. Regarding integrated pest management, this initiative must be developed by January 2014. The Scottish Government does not intend to publish a separate NAP or develop its own IPM guidance.

28. In forestry, initiatives such as the UK Woodland Assurance Scheme[li] and the Forestry Commission's Practical Guide to Reducing Pesticide Use in Forestry[lii] promotes practices consistent with the aims of the Directive and national policy, and specifically require owners/managers to implement effective IPM strategies. Of note, this guidance was produced in 2004 and needs to be updated to reflect current EU legislation.

Article 14 of the EU Directive - Integrated Pest Management[liii]

29. The development and promotion of IPM systems is at the core of the EU's approach to decreasing the use of pesticides (See Appendix 2 for EU's underlying principles on IPM). IPM applies an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops whilst at the same time minimising the use of pesticides. A major advantage of using a combination of 'tool's rather than relying on one form of control (i.e. commercial pesticide products) is that it lessens the chance of pests becoming resistant through selection pressure.

30. IPM is not a new concept; it was pioneered over 50 years ago by four entomologists from California who described a concept of pest management[liv] that has since become the foundation for modern integrated pest management (IPM). The integrated control concept (ICC), as it was called, is '*Applied pest control that combines and integrates biological and chemical control. Chemical control is used as necessary and in a manner that is least disruptive to biological control*.

31. IPM requires understanding of agricultural ecosystems. This 'agro-ecosystem approach' involves knowledge of soil organisms, crop and non-crop plants, multiple herbivores, and agricultural food webs, natural pest enemies (e.g. predators and parasitoids).[lv] This information is used in combination with available control methods to manage pests and diseases economically and sustainably with the least possible hazard to people, property, and the environment.

32. IPM recognises that it is necessary to create conditions (e .g. by adequate plant protection measures or the utilisation of ecological infrastructures[lvi] inside and outside production sites) to protect and enhance important beneficial organisms which can provide an ecosystem services of biological pest control.[lvii, lviii] Habitat management practices relating to IPM also contributes to a range of other ecosystem services such as nutrient cycling, increase water quality and mitigation of soil erosion. [lix] To be effective, IPM needs to be implemented at the catchment scale through activities on individual farms.[lx]

33. It should be noted that the continued use of neonicotinoids (although three types have been temporarily banned for two years from December. 2013) which are applied as a seed dressings (and are taking up in plant tissue) is contrary to the principles of IMP because they are used prophylactically (i.e. as a crop protection insurance measure), are broad-spectrum and have a long persistence in the environment.

34. Further information on Integrated Pest Management, including examples, is given in Appendix 3.

Research into IPM solutions

35. Research into IPM solutions is being carried out by EU supported initiatives: ENDURE[lxi] and PURE[lxii]. ENDURE provides information, tools and services to scientists, policy and farm advisers, and trainers concerned with IPM. PURE's purpose is to research innovative solutions for crop protection in support of sustainable agriculture. With regard to local conditions, the standard approach in the EU is such that IPM is always specific to regional cropping systems, landscapes, agronomy, biodiversity and climatic conditions.

36. PURE are providing solutions using IPM to significantly reduce pesticide use on maize. Key elements of IPM in maize are: crop rotation with winter crops, legumes and cover crops, forecasting and monitoring and alternative measures against weeds and pests (e.g. biological control and pheromones).

37. Recent studies by one of the ENDURE partners (supported by EU funding) have shown that pesticide input in the soft fruit industry in Scotland can be reduced by 30% by using unique pest attractants and repellents. This biomimicry fools the specialist pest (in this case the raspberry beetle) into a trap which mimics the colour and smell of the host flower for this pest.[lxiii] On-farm trials using this IPM approach, using raspberry beetle traps as monitoring tools, gave similar levels of crop protection as the farmers' standard practice, using currently recommended synthetic insecticides.

Common Agricultural Policy and pesticide use

38. The EU's Common Agricultural Policy (CAP) is the system of subsidies and programmes under which European farmers work. In order for farmers to receive the full single payment subsidy (Pillar 1 payment) and other payments, there is a requirement for farmers to comply with a set of Statutory Management Requirements (i.e. Cross-Compliance Mechanism) to keep their land in good condition. The recent reforms to CAP which included a revision of cross-compliance, declined to include the Sustainable Use of Pesticides Directive or the Water Framework Directive. Therefore farmers are not required to comply with either of the Directives in order to receive their payments.

Policy Statement

39. The Trust supports all sustainable methods of farming which support biodiversity and through sensitive habitat management, improve ecosystem health.

40. Although there are situations in which pesticides may have to be used to support the conservation of native wildlife and habitats, the use of pesticides can have a deleterious effect on Scotland's wildlife and ecosystem health.

41. The Scottish Wildlife Trust believes that in conventional systems, pesticide application should be a last resort measure, rather than the first option. For this reason, the Trust supports integrated pest management which promotes using a combination of tools to achieve low pesticide-input systems resulting in low impacts at the landscape scale. IPM adopts an ecosystem approach to pest and disease management, works at the landscape scale, and is based on knowledge of soil organisms, crop and non-crop plants, multiple herbivores, agricultural food webs, natural pest enemies.

42. The Trust welcomes the fact that the principles of IPM are embedded within courses taught to agricultural students studying in Scotland. The Trust also believes that IPM should be part of lifelong learning for all farmers who should be encouraged to learn and apply IPM principles and practical measures to their farming practices throughout their careers.

43. The Trust believes the Curriculum for Excellence should include IPM as part of learning about food ("food literacy") and farming.

44. The Trust believes that using pesticides in a way that reduces the negative impacts on wildlife in combination with creating the right habitat conditions at the landscape scale to encourage biological pest control can benefit agricultural ecosystems. Improving ecosystem health will enhance ecosystem services such as nutrient cycling, pollination, improved water and soil quality, and the cultural and aesthetic service provided by increased biodiversity.

45. The Trust opposes prophylactic use of pesticides because this encourages pest resistance. The Trust is also opposed to the use of broad spectrum and persistent pesticides.

46. The Trust believes that where there is uncertainty regarding the environmental impacts associated with a new pesticide the Government should take a precautionary approach in assessing the risks. Short-term economic considerations should not outweigh environmental risk assessment and risk management.

47. There are some pesticides which when used turn out to be so damaging that it is appropriate for them to be banned entirely, as has been done in the past with many pesticides.

48. The Trust believes there should be complete transparency regarding research conducted by the pesticide industry to test the potential environmental effects of new pesticides. The results of field and laboratory trials should be peer reviewed and made publicly available, including those that are not statistically significant.

49. The Trust believes that the Common Agricultural Policy and cross compliance in particular should be aligned to the Sustainable Use of Pesticides Directive and the Water Framework Directive.

50. The principles of integrated pest management should be applied to the industry underpinning gardening (i.e. horticulture).

51. In controlling invasive non-native species and invasive native species, the Scottish Wildlife Trust believes that an IPM approach is an appropriate tool to assess the best way to remove unwanted species. The Trust accepts that in some instances where native wildlife is under threat there may be no other option but to use herbicides. Where this is the case, the Trust believes that control measure must be carried out at the catchment scale, where appropriate, to be most effective. Potential environmental impacts of pesticide application must be assessed at this scale, before operations commence, and mitigation measures put in place as necessary.

52. In similar situations where native wildlife is under threat in gardens, the Trust accepts that there may be no option but to use pesticides.

Priorities for action

53. The Scottish Wildlife Trust will advocate the principles outlined in this policy statement to Government, farming, forestry and horticulture sector, the wider public and other key stakeholders to promote low-input systems which have low environmental impacts at the landscape scale.

54. The Scottish Wildlife Trust will only use herbicides (to control invasive plant species) on its reserves where there is no other option available and work will be carried out by trained personnel in accordance with National Proficiency Council Standards and the manufacture's guidelines. Where feasible, the Trust will work with neighbours to ensure control is carried out strategically at the catchment/landscape scale to prevent constant re-invasion into our own reserves.

Cross-reference to other Scottish Wildlife Trust polices:

a) Policy Futures 1: Living Landscapes - towards ecosystem-based conservation in Scotland
b) Non-native invasive species

Appendix 1

The organochlorine story

DDT[lxiv]

55. In 1948 the Swiss chemist, Paul Müller, was awarded the Nobel Prize for Medicine or Physiology for his work which was first to show the insecticidal properties of dichlorodiphenyltrichloroethane (DDT), an organochlorine compound, which could be used to control vector borne diseases. His research led to DDT being used in World War II to combat insect-borne diseases and after this was seen as the solution to halt the transition of malaria. In the 1950s, DDT began to be used on a global scale, as a broad spectrum insecticide, to control agricultural pests. Organochlorine compounds such as DDT generally degrade slowly in the environment (i.e. have a long half-life) and being fat-soluble, can accumulate in humans, animals and plant tissue. The concentrations (and hence negative effects) of organochlorine compounds increases in animals higher up in the food chain. At the time, the fact that DDT persisted in the environment was viewed in a positive light (today, persistence in the environment must be avoided) and it was not until the early 1960s following the publication of Rachel Carson's *Silent Spring*[lxv] that the public began to be made aware of the damage that was being done to non-target species such as birds by the indiscriminate and largely unregulated use of such chemicals.

Dieldrin

56. During the same period in the UK, a subgroup of organochlorines – the cyclodienes such as dieldrin and aldrin were being widely applied as insecticides for crop protection, applied as seed dressings, and for use as a sheep dip. Their use coincided with an increased awareness of the decline in birds of prey such as peregrine falcon; the 1961-2 peregrine survey revealed the population had crashed down to 44% of pre-war population. Similar declines were seen in other raptor species such as barn owl, sparrowhawk and kestrel.[lxvi] Scientific research started to show the link between the persistence of organochlorines and a reduction in raptor populations. Adult peregrine mortality was caused by secondary poisoning through consumption of contaminated prey (e.g. prey that was feeding on dressed grain).

57. Egg-shell thinning (which led to low productivity) was discovered and laboratory work showed that DDT and similar compounds were the cause of thinning and the historical patterns of thinning (revealed by examining egg-collections) were shown to coincide with the introduction of DDT.

58. Although the decline in birds was seen as 'the canary in the mine' other wildlife such as bats, otters,[lxvii] badgers and small mammals were also affected by the use and persistence of organochlorines.[lxviii]

59. The UK Government's Advisory Committee on Pesticides reluctantly brought in voluntary measures to restrict the use of organochlorines, so that by the late 1960s the use of organochlorines was reduced. However it was not until 1981 when the EU brought in a ban that dieldrin ceased being used; DDT was not banned from use in European Union[lxix] until 1986, 10 years after it had been banned in the United States. Aldrin was not banned until 1991.

Appendix 2

EU's underlying principles on integrated pest management

1. The prevention and/or suppression of harmful organisms should be achieved or supported among other options especially by:
   i. crop rotation
   ii. use of adequate cultivation techniques (e.g. stale seedbed technique, sowing dates and densities, under-sowing, conservation tillage, pruning and direct sowing)
   iii. use, where appropriate, of resistant/tolerant cultivars and standard/certified seed and planting material
   iv. use of balanced fertilisation, liming and irrigation/drainage practices
   v. preventing the spreading of harmful organisms by hygiene measures (e.g. by regular cleansing of machinery and equipment)
   vi. protection and enhancement of important beneficial organisms, e.g. by adequate plant protection measures or the utilisation of ecological infrastructures inside and outside production sites.

2. Harmful organisms must be monitored by adequate methods and tools, where available. Such adequate tools should include observations in the field as well as scientifically sound warning, forecasting and early diagnosis systems, where feasible, as well as the use of advice from professionally qualified advisors.

3. Based on the results of the monitoring the professional user has to decide whether and when to apply plant protection measures. Robust and scientifically sound threshold values are essential components for decision making. For harmful organisms threshold levels defined for the region, specific areas, crops and particular climatic conditions must be taken into account before treatments, where feasible.

4. Sustainable biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control.

5. The pesticides applied shall be as specific as possible for the target and shall have the least side effects on human health, non-target organisms and the environment.

6. The professional user should keep the use of pesticides and other forms of intervention to levels that are necessary, e.g. by reduced doses, reduced application frequency or partial applications, considering that the level of risk in vegetation is acceptable and they do not increase the risk for development of resistance in populations of harmful organisms.

7. Where the risk of resistance against a plant protection measure is known and where the level of harmful organisms requires repeated application of pesticides to the crops, available anti-resistance strategies should be applied to maintain the effectiveness of the products. This may include the use of multiple pesticides with different modes of action.

8. Based on the records on the use of pesticides and on the monitoring of harmful organisms the professional user should check the success of the applied plant protection measures.

Appendix 3

Further information on applying Integrated Pest Management[lxx]

What is IPM?

1. Integrated Pest Management (IPM) is an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimise the use of pesticides. Although primarily applied to management of pests and diseases of agricultural crops, the principles of IPM can equally well be used for management of post-harvest pests and diseases and insect vectors of animal and human diseases.

2. IPM programmes are based on information on the life cycles of pests and diseases and their interaction with the environment. This information is used in combination with available control methods to manage pests and diseases economically and sustainably with the least possible hazard to people, property, and the environment.

How is IPM carried out?

3. IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions and controls.

    a) **Set action thresholds**
    Before taking any action to control pests and diseases, IPM first sets an action threshold at which pest populations or environmental conditions indicate that control action must be taken to avoid economically-significant losses.

    b) **Monitor and identify pests**
    Not all insects, weeds, and other living organisms require control. Many organisms are innocuous, and often are even beneficial. IPM programs work to monitor for pests and identify them accurately, so that appropriate control decisions can be made in conjunction with action thresholds. This monitoring and identification removes the possibility that pesticides will be used when they are not really needed or that the wrong kind of pesticide will be used.

    c) **Prevention**
    In the first instance, IPM programmes work to manage the crop to prevent pests from becoming a threat. This may mean using cultural methods such as rotating between different crops, selecting pest-resistant varieties, and planting pest-free rootstock. These control methods can be very effective and cost-efficient and present little to no risk to people or the environment.

    d) **Control**
    Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs then evaluate control methods for effectiveness and risk. Effective, less risky pest controls are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring, identifications and action thresholds indicate that less risky controls are not working, then additional pest control methods would be employed, such as targeted spraying of pesticides

Examples of IPM

a) Controlling the cabbage whitefly in UK horticulture - http://www.eucipm.org/docs/ResearchBrief-brassica2.pdf and http://www.eucipm.org/docs/EUCIPM%20Project%20page%20Brassicas2.pdf

b) Innovative IPM for maize –based cropping systems - http://www.pure-ipm.eu/sites/default/files/content/files/PURE_WP3_booklet.pdf

c) Innovative IPM for winter-wheat based cropping systems - http://www.pure-ipm.eu/sites/default/files/content/files/PURE_WP2_booklet.pdf

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[i] Both gardening and the industry that supports gardening
[ii] Pretty J (2005) Sustainability in agriculture: recent progress and emergent challenges. Sustainability in agriculture. Issues in Environmental Science and Technology **21** 1–15.
[iii] *Ibid*
[iv] Figures only available for commercial growing of bulbs
[v] Combined figures for arable crops, cereals, potatoes, vegetables, soft fruit, fodder crops and grassland and bulb growing based on SASA data available at http://www.sasa.gov.uk/pesticides/pesticide-usage/pesticide-usage-survey-reports
[vi] Ian Willoughby, Programme Group Manager, Forest Research - personal communication (Oct 2013)
[vii] Information on herbicide use in Britain is given in: Willoughby I Balandier P Bentsen N.S McCarthy N. and Claridge J. eds (2009). Forest vegetation management in Europe: current practice and future requirements. COST Office, Brussels.
[viii] Oraganocholrines are a large group of chemicals that include dichlorodiphenyltrichloroethane (DDT) and cyclodienes such as dieldrin and aldrin.
[ix] Mikhail A. Beketov, Ben J. Kefford, Ralf B. Schäfer, and Matthias Liess (2013) Pesticides reduce regional biodiversity of stream invertebrates. Proceedings of National Academy of Sciences **110** (27) 11039-11043
[x] D. Goulson (2013) An overview of the environmental risks posed by neonicotinoid insecticides. Journal of Applied Ecology **50** 977–987
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[xii] *Op cit* 16
[xiii] *Op cit* 16
[xiv] *Op cit* 15
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[xix] Mickaël Henry et al (2012) *A Common Pesticide Decreases Foraging Success and Survival in Honey bees.* Science **336** 348-350
[xx] Penelope R. Whitehorn et al (2012) *Neonicotinoid Pesticide Reduces Bumblebee Colony Growth and Queen Production.* Science **336** 351 – 352
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[xxii] Sultatos L. (1994) Mammalian toxicology of organophosphorus pesticides. Journal of Toxicology and Environmental Health. **43 (**3)
[xxiii] *Op cit* 16
[xxiv] Liu et al (2013) Linking pesticide exposure and spatial dynamics: An individual-based model of wood mouse (*Apodemus sylvaticus*) populations in agricultural landscapes. Ecological Modelling **248** 92– 102
[xxv] *Op cit* 16
[xxvi] EEA Technical report No 11/2013. The European Grassland Butterfly Indicator: 1990–2011
[xxvii] D. Pimentel and CA Edwards (1982) Pesticides and ecosystems. Bioscience. **32** (7) 595-600
[xxviii] *Op cit* 16
[xxix] P Mineau and C Palmer (2013) The Impact of the Nation's Most Widely Used Insecticides on Birds. American Bird Conservancy
[xxx] For further details see: http://www.pesticides.gov.uk/guidance/industries/pesticides/topics/pesticide-approvals/eu/european-regulation/
[xxxi] A "regulation" is a is a binding legislative act
[xxxii] A plant protection product usually contains more than one component. The active component against pests/plant diseases is called the "active substance".
[xxxiii] Three types of neonicotinoids have been banned from use for two years from 1 December 2013
[xxxiv] EU pesticide database: available at http://ec.europa.eu/sanco_pesticides/public/?event=substance.selection
[xxxv] See : http://www.sasa.gov.uk/content/scottish-pesticide-surveys-database-scopes-arable-crops
[xxxvi] See: http://www.efsa.europa.eu/en/panels/pesticides.htm
[xxxvii] Doses that are not fatal but which may have damaging effects.
[xxxviii] Neonicotinoids are a class of insecticides with a common mode of action that affects the central nervous system of insects, causing paralysis and death
[xxxix] *Op cit* 25
[xl] *Op cit* 26
[xli] *Op cit* 27
[xlii] See: http://www.efsa.europa.eu/en/press/news/130116.htm
[xliii] See: http://www.efsa.europa.eu/en/press/news/130718.htm
[xliv] See: http://www.efsa.europa.eu/en/press/news/130704.htm
[xlv] See: http://europa.eu/legislation_summaries/consumers/consumer_safety/l32042_en.htm
[xlvi] From: http://europa.eu/legislation_summaries/consumers/consumer_safety/l32042_en.htm
[xlvii] For details see: http://ec.europa.eu/environment/ppps/home.htm
[xlviii] A "directive" is a legislative act that sets out a goal that all EU countries must achieve. However, it is up to the individual countries to decide how.
[xlix] A key driver is also to reduce the risks to human health

[l] See: http://europa.eu/legislation_summaries/environment/water_protection_management/l28002b_en.htm
[li] See: http://ukwas.org.uk/
[lii] See: http://www.forestry.gov.uk/PDF/fcpg015.pdf/$FILE/fcpg015.pdf
[liii] See Annex III of 2009/128/EC
[liv] VM Stern et al. (1959) The integration of chemical and biological control of the spotted alfalfa aphid (the integrated control concept). Hilgardia **29** 81–101.
[lv] See: Birch et al (2011) How agro-ecological research helps to address food security issues under new IPM and pesticide reduction policies for global crop production systems. Journal of Experimental Botany, Vol. 62, No. 10, pp. 3251–3261, 2011
[lvi] E.g. provision of hedgerows, field margins, biodiverse buffer strips, beetle banks, field mosaics
[lvii] See for instance: Haenke et al (2010) Increasing syrphid fly diversity and density in sown flower strips within simple vs. complex landscapes. Journal of Applied Ecology **46** 1106–1114
[lviii] See: Jonsson et al 2012 Agricultural intensification drives landscape-context effects on host–parasitoid interactions in agroecosystems Journal of Applied Ecology, 49, 706–714
[lix] Jonsson et al (2008) Recent advances in conservation biological control of arthropods by arthropods. Biological Control **45** 172–175
[lx] *Op cit* 45
[lxi] See: http://www.endure-network.eu/what_is_endure
[lxii] See: http://www.pure-ipm.eu/
[lxiii] See: Birch et al (2011) How agro-ecological research helps to address food security issues under new IPM and pesticide reduction policies for global crop production systems Journal of Experimental Botany, **62** (10) 3251–3261

[lxiv] For more details, see for instance: Late lessons from early warnings: science, precaution, innovation Chapter 11 Lessons from health hazards – Bouwman et al DDT: fifty years since Silent Spring EEA publication
[lxv] Carson, R. (1962) *Silent Spring*, Houghton Mifflin, Boston.
[lxvi] Birds of prey in a changing environment. Editors: Thompson et al (2003). Joint publication by JNCC, BTO and SNH. The Stationary Office Ltd
[lxvii] Silent Fields. Roger Lovegrove. (2007) Oxford University press.
[lxviii] Jefferies DJ (1969) Causes of badger mortality in eastern counties of England. Journal of Zoology **157** 429-436
[lxix] *Op cit* 7
[lxx] The information in this section is derived from European Centre for Integrated Pest Management website: see: http://www.eucipm.org/