SIMPLY SUSTAINABLE Integrated Pest Management

Part of the LEAF Simply Sustainable Series

LEAF
LINKING ENVIRONMENT AND FARMING

Crop Protection Association

Foreword

The global challenges of population growth, food security and climate change continue to put pressure on farmers to ensure their crops are healthy, productive, safe and resilient.

Integrated Pest Management (IPM) strategies, used as part of an ecosystem-based approach, include a combination of techniques such as biological control, rotations, selection of pest resistant crop varieties, habitat manipulation, modification of cultural practices and ensuring pesticide use is economically and ecologically justified.

IPM forms a core part of the broader Integrated Farm Management (IFM) framework, creating a pathway for farmers to plan their approach to robust, resilient, and healthy crops. LEAF and its members have been at the frontline of driving change, creating solutions, and supporting farmers in effective decision making for nearly thirty years.

Delivering more sustainable farming will require a combination of skilled practitioners, novel approaches, and innovative technology – all working together to achieve a fully integrated farming approach.

I am delighted to support this latest guidance booklet in LEAF's 'Simply Sustainable' series. It provides an essential guide offering practical tips and approaches for farmers to adopt as they look for better and more sustainable ways to protect their crops.

Dave Bench
Chief Executive, Crop Protection Association

For some 30 years LEAF has been at the forefront of developing and promoting Integrated Farm Management. A central part of this philosophy has been Integrated Pest Management, a system that brings together a range of approaches to address weeds, pests and diseases in crops. Central to this have been site specific, whole farm, logical, science based, experimental and innovative ways to create effective resilient and long-lasting programmes for crop protection through their control.

This booklet focuses on a step by step guide to delivering more sustainable crop health strategies through a range of methods, including cultural, biological, physical and chemical. All of these form part of the eight principles of IPM as defined by the 2009 EU directive on the sustainable use of pesticides and highlighted throughout this booklet using **Eight Simple Steps** which enable practical techniques to maintain or enhance productivity with reduced pesticide inputs.

Significantly, the approach is about balance with a high reliance on natural and cultural pest interactions teamed up with selective chemical use. Its origins are in the 1950s where entomologists developed IPM systems for insect control and today many of these approaches have been successfully adapted to contemporary cropping systems. While IPM was until recently considered a form of "alternative agriculture" it is no longer alternative but mainstream, especially in enclosed environments such as glass houses and polytunnels.

IPM approaches for field scale and arable crops, although more complex than in protected cropping systems, are increasingly becoming a reality well suited to modern farming and making a positive contribution to sustainable productivity across all sectors.

We hope this document will support your decision-making on farm and help drive change in the delivery of more sustainable food and farming.

Caroline Drummond MBE
Chief Executive, LEAF

Credits

This brochure has been developed by **LEAF** with particular thanks to:

"LEAF Marque has strengthened our focus on Integrated Pest Management involving sound crop monitoring methods from the use of pheromone traps to crop inspections, pest and disease thresholds."

Royalcress SA (LEAF Marque Certified Business)

Against a backdrop of uncertainty within agriculture, methods of pest management and control that utilise a range of different plant health and protection methods are needed to optimise crop performance, yield and quality.

Integrated Pest Management (IPM) aims to address these challenges facing agriculture through sustainable pest, weed and disease control strategies in ways that consider a balance of appropriate physical, biological and chemical techniques. IPM emphasises the growth of a healthy crop with the least possible disruption to agricultural ecosystems and encourages natural pest control mechanisms.

IPM is a cornerstone of Integrated Farm Management (IFM) and consists of a toolbox of techniques for sustainable crop production. IPM applies a number of principles:

- preventing and suppressing the build-up of harmful organisms
- monitoring pest populations and forecasting of impact
- use of thresholds to determine when to intervene
- considering all options for pest control (including non-chemical)
- selection of appropriate interventions considering all potential risks
- minimising chemical intervention by maximising efficiency of application
- strategising to prevent the build-up of resistance in pest populations
- reviewing the success of a chosen strategy to facilitate continuous improvement

.

Combining these principles, this approach aims to ensure management and control of pests, weeds and diseases in crop production, maintaining economically acceptable pest levels whilst optimising the use of chemical inputs.

This booklet is based on the eight principles of IPM using **Eight Simple Steps** which enable practical techniques that achieve sustainable crop production with reduced pesticide inputs.

Step 1 Prevention and Suppression

Step 2 Monitoring

Step 3 Decisions based on Monitoring and Thresholds

Step 4 Non-Chemical Methods

Step 5 Pesticide Selection

Step 6 Reduced Pesticide Use

Step 7 Anti-Resistance Strategies

Step 8 Evaluation

IPM encourages better and more targeted use of all available control measures. IPM also encourages farmers to take advantage of a wide range of practices enabling you to develop and design the best overall strategy for your circumstances which presents the lowest risk to human health and the environment, maintaining biodiversity, conservation and the sustainable use of resources.

The term "pest" can cover weeds, insects, rodents, fungi, bacteria or any other organisms which can be destructive to crops. This booklet primarily focuses on weeds, insects and diseases when referring to pests.

The term "pesticide" or "Plant Protection Product" (PPP) includes products that contain at least one active substance intended to control, disrupt, repel or kill these pests. This covers the range of PPPs used in all systems of farming, such as biopesticides and synthetic pesticides.

The most commonly used PPPs include herbicides, insecticides, fungicides and molluscicides, although other products are also used, such as nematicides, rodenticides, plant growth regulators and (PGRs)

Introduction

Integrated Pest Management (IPM) is a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimises economic, health and environmental risks.

Throughout history, humans have been developing practices to protect their food sources from pests. Some of the earliest records of pest control date as far back as 2500 BC, when the Ancient Sumerians used sulphur compounds to control insects.

Control techniques have developed significantly since then, made necessary by changes in farming practices such as block cropping, reliance on a smaller selection of varieties, travel, the growing movement of food and trade around the world and more recently, the impact of climate change. All these factors have encouraged the wider spread and more rapid colonisation of pests. Concurrently, these advancements in pest control have enabled farmers to increase yields and simplify cropping systems, contributing to the production of safe, high quality, affordable food.

Plant Protection Products (PPPs) have benefitted global food production, but in some countries and with certain crops, inappropriate use has contributed to concerns around human health and negative environmental impacts, such as water contamination and loss of biodiversity. While over the last 25 years significant improvements have been made in diagnostics, understanding of threshold levels, application accuracy and chemical formulations with reduced impact on the environment and non-target species, there is still more to do. Increased pest resistance, deauthorization of pesticide products and public concern around the use of PPPs, all mean maintaining plant health for productive cropping is a significant and ongoing challenge to the agricultural and horticultural industries. IFM and IPM aim to address this challenge through the integration of positive and diverse solutions.

Integrated Farm Management (IFM)

Decision making on farm is not based on single issues and IFM supports farmers in identifying the most appropriate decisions in an integrated way.

'Integrated Farm Management (IFM) is a whole farm business approach that delivers more sustainable farming.'

IFM is geared towards sustaining and optimising the use of all resources on farm, including soil, water, air, staff, machinery, capital, PPPs, wildlife habitats, landscape and archaeological features, addressing regulation and embracing innovation. Successful uptake requires a detailed understanding of the business and an innovative and challenging approach. The implementation of IFM is built around utilising knowledge and innovation alongside beneficial agroecological principles and traditional methods. It focuses on the development of a risk management approach to anticipate, assess, manage and develop contingency plans for any unplanned and/or natural events.

Figure 1: LEAF's Integrated Farm Management (IFM)

Getting Started

This booklet provides you with simple, practical ways to help you manage pests sustainably. It is based on the principles of IPM and uses **Eight Simple Steps** to help you improve crop protection, productivity and the long-term sustainability of your land.

You are encouraged to set a baseline by performing a self-assessment in each area and seeing how you measure up against a simple scoring system. This identifies areas where you are performing well, alongside areas on which you could improve, helping you to put together or build upon your existing IPM programme.

Eight Simple Steps for managing pests on your farm

Step 1 - Prevention and Suppression

Prevention should be the primary means of pest control in any IPM programme. Implementing preventative measures inherently reduces the risk of incidence, and suppressing harmful organisms reduces the possibility of a single species becoming dominant and significantly impacting a cropping system.

There are many ways in which you can limit and suppress pest outbreaks. There is no “one size fits all” approach to managing pests, and different approaches must be taken depending on the season, crop, field history and local conditions. Key opportunities include through crop rotation, variety selection, hygiene, cultivation practices, stale seed beds and promoting beneficial species.

Crop Rotation

Crop rotation is one of the oldest and most effective strategies for preventing pest outbreaks in annual crops. Growing different types of crop on the same area of land not only contributes to soil fertility and structure, but can also help reduce incidence of pests, weeds and diseases. In similar crops, insects can live and overwinter, diseases can persist, and weeds can continue to thrive. Rotations which involve crops from different plant families break up these lifecycles. Choosing cover crops from different plant families is also necessary to reduce the risk of pests transferring to the crop from the cover crop. Considering the lifecycle of the target pest is essential and you must also be aware of the advised gaps between crops in a rotation.

Varietal Choice

Choosing to grow pest resistant varieties informed by historical data, forecasts, research and information from trained advisors can enable you to grow a crop that will be more tolerant to pest damage. However, this must be balanced with market demand. Traits which can increase the crops resilience to pest attack can include morphologic features such as higher leaf hair densities, increased vigour or early maturity. Whilst cultivar choice does not guarantee that the crop will be completely resistant to pests, increasing host-plant resistance can contribute to prevention when used in combination with other IPM approaches.

Hygiene

It is important to try to ensure hygiene measures are implemented both within the business and by anyone (e.g. contractors) working on the land. Hygiene measures include regularly cleaning machinery, equipment and tyres, especially in known high risk areas as well as crop storage areas. It is also important to practice good field sanitation, such as disposing of diseased crop debris, for example by incorporating it back into the soil or feeding it to livestock. These measures can help to reduce pathogens, weed seeds and pests, such as potato cyst nematode, or black grass seeds from spreading between and within fields.

Cultivation Practices

Timely crop establishment helps to ensure a healthy and resilient crop that may be more able to resist pests and diseases more effectively. Cultivation practices can be chosen to disrupt pest lifecycles and it is important to consider recognised pest risks for site specific management. For example, cultivation techniques such as minimum tillage can reduce aphid infestations in the autumn through preserving natural predator populations but may also increase risk of green bridge transfer. Rotational ploughing can be used to manage weed seed populations.

Seedbed preparation can also improve crop establishment and resistance to damage alongside reducing incidence of pests. This may include rolling after sowing to help consolidate the seedbed, improve establishment, and reduce clods which can provide a habitat for slugs.

Stale Seed Beds

Use of stale or false seed beds can help to manage weeds with shorter emergence periods. An early seed bed is established to germinate the weed seeds that have been disturbed and brought to the soil surface during cultivation, so that the young weeds can then be eliminated prior to the crop being drilled. This method is particularly effective when aiming to optimise yields of crops that have limited herbicide options. Other management and establishment practices which support the prevention and suppression of pests include altering sowing dates and ensuring balanced fertilisation, liming and irrigation/drainage practices.

Beneficial Species

Encouraging beneficial species can help to manage pest populations and prevent outbreaks. Establishing and maintaining habitats such as beetle banks, strips of tussocky grass, field margins or hedgerows can provide feed, shelter and nesting sites for multiple species of birds and insects, including of the lacewing (Chrisopidae), hoverfly (Syrphidae), spider (Arachnidia) and ladybird (Coccinellidae) families.

Figure 2: Field margin providing feed and shelter for beneficial insects

Prevention and Suppression Score

Indicator	Poor (0)	Medium (1)	Good (2)
Prevention and Suppression			
Crop rotation (a)	Primarily monocropping (if not growing perennial crops e.g. apples)	Short rotation (< 3yrs)	Long rotation (> 3yrs), which is sustainable and appropriate to farm business
Varietal choice (b)	Do not consider pest risk when selecting varieties	Occasionally select varieties according to pest risk	Pest risk and resistance is a key consideration when choosing varieties
Hygiene measures (c)	Rarely clean machines, equipment or crop stores	Machines, equipment and crop stores are fully cleaned post-harvest	Machines, equipment and crop stores are regularly cleaned throughout the year
Cultivation practices (d)	Do not alter cultivation practices according to pest risk	Cultivation practices considered for potential impact on pests	Cultivation practices are used as part of our IPM strategy

Case Study – Andrew Francis, Elveden Estate, East Anglia

LEAF Demonstration Farm and LEAF Marque certified business, Elveden Estate, covers almost 10,000 hectares in the heart of East Anglia and grows a variety of root vegetable and cereal crops. Andrew Francis, Farms Director, explains how prevention and suppression are important parts of his IPM programme…

"Cereals are our break crops, whilst onions, potatoes, carrots and parsnips are our primary output. Central to our farming ethos is the balance of traditional farming practices with scientific research and innovation, which is key to a good IFM and IPM programme". Each of the eight areas of IPM are important at Elveden, and it all begins with prevention, "We grow different varieties with different traits, depending on the pest risk identified. We identify pest risk through looking at past records, current observations, soil sampling, trapping and using forecasting predictions."

Andrew also uses stale seed beds as a method which helps to control weed populations, "Stale seed beds allow weeds just below the surface to germinate. We then kill them off prior to planting, ensuring minimal soil disturbance so that more weeds don't germinate". This management practice means a reduced reliance on herbicides through beginning with less invasive practices that can work within the crop rotation. Good management of stubble can be an important tool in preventing pest outbreaks, "Stubble which has weeds or a lot of crop debris in it can provide a good host for insects and pathogens, so we manage our stubble and green bridges to prevent build-up of these pests which can lead to outbreaks later in the season."

At Elveden, careful management of irrigation also contributes to pest control, "Risk of damage from free living nematodes is increased in soil profiles that sit wet or full for long periods. Managing soil moisture levels in conjunction with good soil structure helps minimise occurrences of waterlogged soils where movement of nematodes is at its highest. More recently, we are looking at the use of trap, distractant and biofumigant control of crop pests and how best to fit them into a root vegetable rotation."

Management practices such as these are incorporated into the business, inherently reducing the risk of incidence and suppressing harmful organisms, reducing the chance of a single species significantly impacting crop production.

Step 2 – Monitoring

Regularly monitoring harmful organisms such as diseases and insect pests enables timely intervention when required to prevent outbreaks. Beneficial insect activity can also be monitored to assess the likely success or failure of a biological control strategy.

Monitoring and forecasting of pest populations should inform all decisions and the course of action to take, including as to whether to apply PPPs**.** Through locating, identifying and assessing the severity of pest infestations, monitoring informs action. Monitoring records can also help to guide predictions of future pest outbreaks and impacts.

Observation

Effective observation includes regular crop walking and scouting, recording information on the incidence of weeds, diseases and damage to crops, alongside recording the numbers of insect pests and beneficial species. Using traps can help monitor pest and beneficial insect populations, for example, yellow sticky traps can capture pollen beetles (Brassicogethes aenus) and thrips (Thysanoptera), and pheromone traps can be used in conjunction with a pest-specific pheromone to monitor pests such as vine weevils (Otiorhynchus sulcatus) or codling moths (Cydia pomonella). Spore traps can also be used for blight, by capturing fungal spores when they are arriving in the field and providing the opportunity for planning of late blight management strategies.

Keeping a record of observations can demonstrate trends and increase the understanding of pest lifecycles Specific to your farm and region, helping to implement appropriate and timely control measures. Furthermore, monitoring plant growth stages ensures optimal timing of a PPP where other non-chemical control methods prove unsuccessful.

Weather

Weather conditions can significantly impact crop productivity. Monitoring recent and forecasted weather can help to prepare for and predict the impact that conditions may have on cropping systems.

Daylight and sunlight hours and associated changes in temperature can also alter insect activity, which is important to be aware of when scouting or setting traps. There are a number of apps available to help with these predictions. Furthermore, weather not only affects pest populations, but can also impact beneficial species. Episodes of extreme weather out of season can kill beneficial species or create conducive environments for pest populations to develop and distribute, which can impact your ability to manage them.

Correct Identification

Detecting pests early helps prevent or reduce the likelihood and impact of a pest outbreak. This requires regular checking and correct identification of pests, to enable effective management and avoid the risk of causing damage to non-target organisms. Observations, traps, local warnings and professional advice from qualified agronomists all help to provide information to inform management decisions. Furthermore, training staff to observe and report potential issues or unusual in-field growth patterns can help detect pest problems early.

Figure 3: Pheromone trap in apple orchard

Monitoring Score

Indicator	Poor (0)	Medium (1)	Good (2)
Monitoring			
Regular crop walking and observation (e)	Very rarely crop walk	Crop walk occasionally	Recorded system for regular crop walking by a qualified agronomist or advisor
Use of traps (f)	Do not use traps	Occasionally use traps to monitor pest levels	Regularly use traps to monitor pest levels
Recording incidence of pests (g)	Do not or rarely record incidence of pests	Occasionally record pest numbers and outbreaks	Maintain regular, accurate records of pest numbers and outbreaks
Monitor beneficial species (h)	Do not monitor beneficial species	Occasionally and anecdotally monitor beneficial species	Regularly monitor and record beneficial species

Step 3 - Decisions Based on Monitoring and Thresholds

IPM decisions should be made based on the results of monitoring, combined with threshold information where available. Thresholds are the recorded population level or density that must be reached before intervention is required or economically beneficial. Thresholds enable growers to make decisions based on the level at which pests will impact economic crop yield. They are essential in guiding future pest control decisions, preventing the prophylactic use of unnecessary PPPs and contributing to good economic returns and sustainable crop production.

Due to the complexity of different pests, varying regions, crops and management practices, robust and scientifically sound thresholds should always be combined with observation and correct identification. Observation and monitoring for specific pests affecting the crop and consideration of weather, pest lifecycle, plant growth stage and site-specific management are essential before deciding to intervene.

Results of observations in conjunction with action thresholds, must inform decisions on appropriate next steps. Non-chemical methods should be considered where possible and where they can provide adequate pest control, ensuring that action is based on evidence of need and is targeted to the right pest.

Decisions Based on Monitoring and Thresholds Score

Indicator	Poor (0)	Medium (1)	Good (2)
Decisions Based on Monitoring and Thresholds			
Act based on the results of observations (i)	Routinely apply pest management strategies without the use of thresholds	Use thresholds as a rough guide to inform pest management strategies	Always apply pest management strategies based on monitoring and thresholds and decision support tools

Figure 4: Pollen beetle pest on oilseed rape

Case Study – Robert Kynaston, Great Wollaston, Shropshire

LEAF Demonstration Farm, Great Wollaston is a traditional, family-owned farm in Shropshire. They have approximately 120 dairy cows and grow most of the grass and crops needed to feed them on their 200-acre farm. Robert Kynaston tells us how higher weed thresholds, field margins and long rotations are part of his IPM approach…

"We grow wheat, forage peas and barley, which are all used for feeding the cows during winter months. The cows graze out in the fields from spring until autumn and housed when the ground becomes too wet. They are then fed on silage, crushed home-grown cereals and just a small amount of bought-in protein."

This system means that they can accept higher weed inclusion rates, "We follow the advice of a BASIS IFM trained agronomist who monitors specific pests in the crop. When intervention is necessary, we consider plant growth stage, usually applying at T1 and T2 on wheat and just using one spray on barley."

They have a long grass rotation which is interspersed with arable crops. "The long rotation helps control weeds such as docks, alongside improving soil health, nutrients and organic matter."

Furthermore, grass margins are around all the arable fields, "The grass margins provide overwinter cover for beneficial species that prey on the pests in the crops, particularly aphids. This helps keep our costs down from not needing to spray as much as the beneficial insects are helping to control the pests. We also have PhD and Post Graduate students conducting surveys on natural predators in the margins, such as spiders, beetles, hoverflies, ladybirds and ladybird larvae" which helps provide evidence and information for the decisions we make.'

Step 4 - Non-Chemical Methods

Pest levels can be regulated in a number of different ways. Achieving a sustainable level of pest management requires **a broad strategy that encompasses multiple non-chemical methods.**

Non-chemical methods can be **mechanical**, such as pre-emergence cultivation; **physical,** for example hand rogueing of weeds; cultural, including rotation and variety selection; **biological**, such as encouraging natural predators and beneficial species; or other non-**chemical** methods including companion cropping and biofumigation.

Beneficial insects, such as ground beetles (Carabidae), spiders, ladybirds and their larvae, naturally prey on many different crop pests. For example, ladybird larvae prey on grain aphids (Sitobion avenae). Grain aphids can carry Barley Yellow Dwarf Virus (BYDV), so their control can lead to reduced incidence of this disease. Increasing overall numbers of natural predators supports the prevention of pest outbreaks and can be encouraged through creating and maintaining beetle banks, hedges and field margins. Beneficial species can rapidly increase in these areas, over-wintering and feeding on pests found in the crop in spring or autumn, reducing the amount of insecticide required.

In some cases, natural predators can be actively introduced into indoor production, such as polytunnels and glasshouses. This form of biological control can be highly effective in covered cropping systems, which promote favourable conditions for natural enemies to reproduce. These techniques require regular monitoring, as the use of beneficials to control pests relies on managing the ecology of the farmed area, ensuring pests stay below economically acceptable thresholds.

Non-Chemical Methods Score

Indicator	Poor (0)	Medium (1)	Good (2)
Non-Chemical Methods			
Use of non-chemical methods (j)	Use chemical methods as first port of call	Occasionally use non-chemical methods before chemical	Always use non-chemical methods where possible
Monitor and encourage beneficial species (k)	Do not monitor or encourage beneficial species	Regularly monitor and have some features which encourage beneficial species	Always monitor and have many features which encourage beneficial species

Figure 5: Soldier beetle, a beneficial insect, on yarrow in a grass margin

Case Study – Mark Knight, Tangmere Airfield Nurseries Ltd, West Sussex

LEAF Demonstration Farm and LEAF Marque certified business Tangmere Airfield Nurseries is a family business based in West Sussex. They are one of Europe's largest sweet pepper nurseries growing to the LEAF Marque Standard. Mark Knight, Technical Manager at Tangmere, explains the importance of beneficial species in their IPM strategy…

"We grow our peppers hydroponically in a climate-controlled glasshouse system that covers a total area of 30 hectares. We use IPM to optimise biological control, viewing plant protection products as a final option."

Monitoring and the use of beneficials are essential in Tangmere's IPM programme, "As a grower, I need to know the pests in the crops and where they are – the earlier a pest is spotted, the less damage is done and the better the outcome. This involves having as many staff as possible aware, which is achieved through delivering training." Once a pest is found, the area is observed for the level of infestation, and this evaluation decides the action that needs to be taken. "Time of year and plant size also play an important factor in acceptable pest levels, so after checking an area we decide to either do nothing, if beneficials are present in sufficient number, or introduce beneficials to the area or crop. Spot spraying can also be used as a final option to stop further crop damage."

Mark has implemented an IPM approach that requires skill and planning, "We introduce the pest [red spider mite (Tetryanychus urticae)] and beneficial insect Phytoseiulus into the crop very early in the season, which means the pest cannot develop that fast. We then monitor the pest levels and make corrective application of beneficials, until we reach a point where there is a natural balance throughout the crop – the beneficials will not eradicate all of the pests (they need something to feed on!) and the numbers are held at an acceptable level."

Implementing this IPM practice means that the pest is regularly monitored and kept at economically viable levels, ensuring that when it does enter the crop at significant numbers, it can be effectively managed by the beneficial species already present.

Step 5 - Pesticide Selection

An IPM system aims to reduce reliance on PPPs, whilst acknowledging that careful use is still part of an effective pest management system. When the decision to apply pesticides has been made, pesticide selection is important to target the specific pest and reduce impact on non-target organisms. Pesticides must be used in conjunction with monitoring, cultural control and biological methods, and if they reduce efficacy or implementation of non-chemical methods, an alternative strategy should be sought.

Considering potential impacts includes researching product efficacy against target pests under different levels of pest pressure. Dose-response graphs for key disease targets in fungicide performance trials can be a helpful tool to provide this kind of information.

When applying a PPP, impacts of toxicity levels to pollinators and non-target organisms must be considered. For example, if a product is non-selective this could reduce the number of beneficial species, potentially resulting in a secondary pest outbreak. Or, if a product reduces pollinator numbers, this could result in reduced pollination rates – with both incidences resulting in lower yields.

Economic considerations should also be made, observing total number of applications required and price relevant to efficacy of different PPPs, including biopesticides where these are available.

Pesticide Selection Score

Indicator	Poor (0)	Medium (1)	Good (2)
Pesticide Selection			
Use of PPPs (l)	PPPs are the primary protection method	PPPs are the primary protection method for some crops	PPPs are not the primary pest protection method
Effect on non-target species (m)	Consideration is rarely given to non-target species when considering PPP selection	Some consideration is given to non-target species when considering PPP selection	Non-target species are always considered when choosing PPPs

Step 6 - Reduced Pesticide Use

Reduced pesticide use can be achieved through increased use of IPM methods. An effective IPM strategy enables reduced reliance on PPPs, resulting in environmental and economic benefits.

When PPPs are used, maximising the efficacy of each spray through good contact (achieved through training, calibration of equipment and correct nozzle selection), appropriate timings and consideration of weather, reduces the need to spray again and keeps applications to a minimum. Targeted reduction strategies do not account for the volatility of seasons, extreme weather conditions and PPP strategies should be based around an integrated and comprehensive pest management approach to avoid problems, including the risk of resistance developing in target populations.

Whilst IPM aims to reduce reliance on PPPs, this is not always possible. For example, a wet year that has a high disease pressure may require an increased use of PPPs on some crops. In this situation, it is important to focus on reducing risk from using PPPs to ensure compliance with an IPM strategy. PPP application is a highly professionalised management approach. There is a wide range of training available and users should have appropriate and up to date qualifications supported by relevant CPD opportunities.

Application Method

Consideration of application method is important when choosing to apply a pesticide, and use can be targeted through treatments such as spot spraying. Furthermore, selecting the correct nozzle and applying in good weather conditions can maximise the efficacy of PPPs, alongside reducing risk of loss through spray drift, run-off into the soil and diffuse pollution of water courses.

Alternative PPPs

Alternative options to synthetic PPPs can include biopesticides.

Biopesticides are based on micro-organisms or natural products, containing biological control agents such as pheromones or microbials. When used within an IPM programme, biopesticides may have the potential to maintain crop yields while decreasing use of synthetic PPPs. However, good management is also essential, as biopesticides can be slow to work, have a shorter residual effect, be susceptible to unfavourable environmental conditions and pose their own risks to the environment.

Reduce Pesticide Use Score

Indicator	Poor (0)	Medium (1)	Good (2)
Reduced Pesticide Use			
Reduced reliance on PPPs (n)	Are not currently focusing on reducing our reliance on PPPs through IPM	Looking at reducing our reliance on PPPs through more effective IPM	Have reduced reliance on PPPs through more effective IPM

Figure 6: Grassland weed control using drift reduction nozzle

Step 7 - Anti-Resistance Strategies

The ability of a pest to metabolise a PPP may result in the development of resistance and decrease the product's efficacy. This can lead to increased pest resistance as the genes pass onto the next generation, such as in the case of black grass (Alopecurus myosuroides) or peach-potato aphid (Myzus persicae).

Anti-resistance strategies are important for all uses and the PPP label contains relevant advice for users to follow. However, use of the same active substances year on year has contributed to the problem of resistance development and is a key driver for accelerating IPM uptake. Anti-resistance strategies are particularly important where the mechanism of resistance is known.

Preventing Resistance

Consulting a qualified agronomist or advisor is important for up to date pest control information. Most PPP labels contain advice on resistance risk and management and users should also read the latest guidance from "Resistance Action Groups". Choosing varieties with good tolerance to known pests can help to prevent resistance arising from applying products which are known to be at risk of becoming ineffective.

Resistance Potential

Considering resistance potential is essential when choosing plant protection products. Available information on product type should identify which products pose a higher risk of developing resistance in pests, and these should be avoided wherever possible. Similarly, rotating between PPPs with different modes of action that are applied at different times can contribute to a robust anti-resistance strategy. It is important to evaluate the effectiveness of a PPP soon after application, as control failures could indicate resistance.

Anti-Resistance Strategies Score

Indicator	Poor (0)	Medium (1)	Good (2)
Anti-Resistance Strategies			
Consult a qualified agronomist or advisor (o)	Do not consult a qualified agronomist or advisor	Occasionally consult a qualified agronomist or advisor	Regularly consult a qualified agronomist or advisor
Varietal choice (p)	Do not alter varietal choice based on pest risk	Consider pest risk when choosing variety, but do not always prioritise it	Choose variety based on pest risk
Resistance potential (q)	Do not research resistance potential of product	Occasionally research resistance potential of product	Consider and act based on resistance potential of product

Step 8 - Evaluation

An effective IPM programme is important for maintaining yields and for a resilient cropping system. Regular evaluation based on records of previous use, dosage and effects of PPPs is an essential element of IPM. Keeping a detailed account of pests and numbers observed, type and dosage of chemical used and environmental factors such as the weather helps study the effectiveness of plant protection measures.

Completing the LEAF Sustainable Farming Review and LEAF Management Plans provide opportunities to discuss ongoing pest management strategies with your agronomist or advisor. As part of this, your Crop Health and Protection Policy is a good document to review and update. Referring to previous years records enables you to track your progress, observe trends and the incidence of pest outbreaks. This can help you to identify approaches that performed well, alongside areas for continued improvement for future management strategies.

IPM is an essential part of IFM and is based on a systems approach. Prevention and suppression measures limit the risk of pest outbreaks. Regular monitoring ensures any outbreaks are quickly detected. This provides thresholds which enable you to intervene only when necessary. Non-chemical methods provide physical, cultural or biological control, helping to reduce reliance on PPPs. When PPPs are required, evaluating the choice of product and potential consequences enables you to target the protection as accurately as possible and limit environmental damage. Implementing each of these steps and regularly evaluating your plant protection policies contributes to reduced, targeted PPPs within a system that utilises a wide range of different management options.

IPM is knowledge rich and therefore it is essential to continue exploring new ideas to remain prepared for future changes. Visiting LEAF Demonstration Farms and technical industry events helps to challenge your current thinking and continually improve approaches to pest management.

Knowledge exchange events can also support you in integrating alternative methods of plant protection within your business allowing you to be experiment, adapt and be prepared for environmental and policy changes.

Adopting an IPM approach, set within broader agroecological considerations, ensures greater resilience for future and better environmental protection, alongside contributing to public perception and understanding of pesticides and their role in food supply and security.

Evaluation Score

Indicator	Poor (0)	Medium (1)	Good (2)
Evaluation Score			
Keep an account of pests, numbers, chemical used, weather etc (r)	Do not keep an account of pest, numbers, chemicals used, weather etc	Keep a basic account of pests, numbers, chemical used, weather etc	Keep a detailed account of pests, numbers, chemical used, weather etc for every application
Acting on evaluation (s)	Information on previous success is not used	Information of previous efficacy is used to make ad hoc changes	Full evaluation is used to review and adjust IPM strategy

How are you doing?

Now that you have carried out the Simply Sustainable Integrated Pest Management Simple Steps, how did you do?

Complete the table overleaf to get an idea of how well you are implementing IPM. Consider first targeting any areas where you score lower, which may be the biggest pest risks for your farm. Revisit your score on an annual basis. These are the first steps to developing a more sustainable IPM strategy for your business.

Overall score for your business

Poor:	0 – 5
Medium:	6 – 10
Good:	11– 16

Photocopy the sheet overleaf for each farming year to monitor your progress.

Your Integrated Pest Management Score

Indicator	Score	Value		
		Year 1	Year 2	Year 3
Step 1 – Prevention and Suppression				
Crop rotation	(a)			
Varietal choice	(b)			
Hygiene measures	(c)			
Cultivation practices	(d)			
Step 1 Total	(a+b+c+d)/4			
Step 2 – Monitoring				
Regular crop walking and observation	(e)			
Use of traps	(f)			
Recording incidence of pests	(g)			
Monitor beneficial species	(h)			
Step 2 Total	(e+f+g+h)/4			
Step 3 - Decisions Based on Monitoring and Thresholds				
Act based on the results of observations	(i)			
Step 3 Total	(i)/1			
Step 4 - Non-chemical Methods				
Use of non-chemical methods	(j)			
Encourage beneficial species	(k)			
Step 4 Total	(j+k)/2			
Step 5 - Pesticide Selection				
Use of PPPs	(l)			
Effect on non-target species	(m)			
Step 5 Total	(l+m)/2			

Step 6 - Reduced Pesticide Use				
Reduced reliance on PPPs	(n)			
Step 6 Total	(n)/1			
Step 7 - Anti-Resistance Strategies				
Consult a qualified agronomist or advisor	(o)			
Varietal choice	(p)			
Resistance potential	(q)			
Step 7 Total	(o+p+q)/3			
Step 8 - Evaluation				
Keep an account of pests, numbers, chemical used, weather etc	(r)			
Acting on evaluation	(s)			
Step 8 Total	(r+s)/2			
Overall Total				

Further Information

There is a wide range of information to support farmers in implementing IPM practices, including:

- LEAF Sustainable Farming Review (for LEAF Members only)
- LEAF Simply Sustainable Series: Soil, Water, Biodiversity and Biosecurity
- AHDB Encyclopaedia of Pests and Natural Enemies in Field Crops
- Resistance Action Groups
- Voluntary Initiative IPM Plan (English and Scottish)
- NFU Guidance on IPM
- DAERA Guidance on IPM
- IPM at the James Hutton Institute
- HSE Guidance on Pesticides
- AIC Guidance on Crop Protection
- GWCT Research on IPM
- AHDB Cereals and Oilseeds Crop Management Guidance
- AHDB Pest Monitoring
- RSPB Guidance on Arable Margins

Glossary of Terms

Pesticide: A 'pesticide' is something that prevents, destroys, or controls a harmful organism ('pest') or disease, or protects plants or plant products during production, storage and transport. The term includes, amongst others: herbicides, fungicides, insecticides, acaricides, nematicides, molluscicides, rodenticides, growth regulators, repellents, rodenticides and biocides. The term 'pesticide' is often used interchangeably with 'plant protection product', however, pesticide is a broader term that also covers non plant/crop uses such as biocides.

PPPs: are 'pesticides' that protect crops or desirable or useful plants. They are primarily used in the agricultural sector but also in forestry, horticulture, amenity areas and in gardens. They contain at least one active substance and have one of the following functions:

- Protect plants or plant products against pests/diseases, before or after harvest
- Influence the life processes of plants (such as substances influencing their growth, excluding nutrients)
- Preserve plant products
- Destroy or prevent growth of undesired plants or parts of plants

Active Substance: An active substance is any chemical, plant extract, pheromone or micro-organism (including viruses), that has action against 'pests' or on plants, parts of plants or plant products.

Biopesticide: Biopesticides are PPPs which contain biological control agents (microbials, pheromones, plant extracts etc) for use as agricultural, horticultural and home garden pesticides. These products can be based on pheromones or other semiochemicals (for mass trapping or trap cropping); they can be products containing a microorganism (e.g. bacterium, fungus, protozoa, virus, viroid); products based on plant extracts or other novel alternative products (required to be approved on a case by case basis).

Synthetic PPP: A PPP produced by the process of chemical synthesis

About LEAF

LEAF (Linking Environment And Farming)

LEAF is a leading global organisation delivering more sustainable food and farming. We work with farmers, the food industry, scientists and consumers, to inspire and enable sustainable farming that is prosperous, enriches the environment and engages local communities. LEAF promotes Integrated Farm Management (IFM), a whole farm business approach that delivers sustainable farming.

Integrated Farm Management (IFM)

IFM uses the best of modern technology and traditional methods to deliver prosperous farming that enriches the environment and engages local communities. A farm business managed to IFM principles will demonstrate site-specific and continuous improvement across the whole farm.

The LEAF Marque

The LEAF Marque is a global environmental assurance system recognising more sustainably farmed products, based on IFM principles. All LEAF Marque certified farms are independently inspected to ensure they meet stringent criteria to demonstrate that food is being produced to high environmental standards, across the whole farm.

The LEAF Network

The LEAF Network of Demonstration Farms and Innovation Centres supports the research, development and promotion of IFM. LEAF Innovation Centres represent some of the UK's leading education and research establishments which focus on specific areas of IFM. This cutting-edge research is fed back to LEAF Demonstration Farms, whose role is to show the beneficial practices of IFM to a broad range of audiences, through organised visits. This 'science into practice' approach is key to delivering IFM on the ground.

The LEAF Sustainable Farming Review

The LEAF Sustainable Farming Review is a self-assessment, online management tool for LEAF members to help them farm more sustainably. It enables them to monitor their performance, identify strengths and weaknesses and set targets for improvement across the whole farm, covering the nine sections of IFM. It is a very easy to use, practical resource to help farmers make more informed management decisions to drive their businesses forward - economically, environmentally and socially.

Education and Public Engagement

LEAF leads a collaborative approach within the industry for better education and public engagement in farming and food production, delivered through the LEAF Network of Demonstration Farms and Innovation Centres and LEAF Open Farm Sunday. **LEAF Education** works to inspire future generations about farming, food and the countryside. It manages a number of industry and educational initiatives, including Access to Farms, CEVAS (Countryside Educational Visits Accreditation Scheme), Countryside Classroom, Chef on the Farm, Farmer Time and LEAF Open Farm School Days.

Speak Out

LEAF's 'Speak Out' initiative encourages farmers to improve their communication skills through the online communications toolkit. It has some tried and tested tips for speaking with the public, helping farmers to practice techniques and sharpen their skills to become better communicators about farming.

Membership

LEAF is a charity and membership organisation. We support our members' to farm more sustainably through our membership tools and services. These include the LEAF Sustainable Farming Review, the Integrated Farm Management Guide, access to our online Information Centre as well as technical guides and events. Join LEAF at **www.leafuk.org**

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