Module 5
Integrated pest management

Definition

- A co-ordinated and planned strategy for the prevention, detection and control of pests, weeds, and diseases
- Cultural
- Biological
- Chemical

Definition:

- A systems approach that combines different crop protection practices with careful monitoring and the use of natural enemies.

Sustainable Use Directive: legal requirement as of 1st January 2014

Integrated Pest Management

- Cultural: general hygiene, ground cover materials, weed control, plant movement, change cultivar, monitoring, sticky traps.
- Biological: parasitoids, predators and pathogens.
- Environmental: disease control for plant and insect pathogens.
- Pesticide backup with selective chemicals.
- Crop rotation,
- Cultivation techniques,
- Use of resistant/tolerant cultivars and standard/certified seed/planting material,
- Use of balanced fertilisation, liming and irrigation/drainage practices,
- Hygiene measures (e.g. cleansing of machinery)
- Protection and enhancement of important beneficial organisms,
- Monitoring of Harmful organisms
- Application of plant protection based on monitoring data
- Use of biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control.
- Application of pesticide should be as targeted as possible.
- The professional user should keep the use of pesticides and other forms of intervention to levels that are necessary and that do not increase the risk for development of resistance in populations of harmful organisms.
- Anti-resistance strategies applied to maintain the effectiveness of the products.
- Review the success of plant protection measures.

LEAF IPM 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 chosen strategy to facilitate continuous improvement

Principles of Integrated Pest Management

- Uses site selection and information such as cropping history mapping and soil test, sampling to identify suitable sites
- Uses forecasting tools and visual assessments to make decisions based on risk
- Use technology such as precision applications, mapping and equipment to improve efficiency of pesticides
- Choose products carefully
- Use cultural methods such as seed choice, rotation, seed rates and companion crops

IPM Examples used in arable farming

1. Satellite imagery can help with all aspects of IPM on farm such as mapping, variable rate inputs and crop density
2. Use of cultivation techniques to reduce weed, pest and disease return in the following crop and so minimise plant protection product (PPP) inputs
3. Yield and soil mapping used to identify less productive areas of the farm which can be used for environmental gains
4. Wildflower margins and strips provide habitats for beneficial insects which improve pollination and control insect pests
5. Regular crop inspections monitor pest pressure, and the effectiveness of any pest control measures used
6. Cover crop used to improve soil structure, nutrient retention and prevention of soil erosion
7. Use of varieties with disease and pest resistance or tolerance to minimise PPP use where market demand allows
8. Crop rotation used to reduce weed, pest and disease carry over
9. Application technology - nozzles and boom switch off. Variable rate application for nutrients
10. Insect trap used to monitor if pest present and if numbers at threshold
11. By improving crop health, bio-stimulants enable plants to better withstand pests and diseases
12. Adjuvants are recommended to improve PPP efficacy and min. PPP use. Drift retardants, water conditioners and pH buffers can also help maintain pesticide performance
13. Weather forecasting services used to plan ideal planting, harvest times and predicting pest and disease pressure and if or when any action is required
14. PPPs used with different modes of action to minimise development of resistance
15. Monitoring stored grain to ensure kept at correct temperature and moisture to prevent spoilage

Integrated Pest Management (IPM)

Importance:

- Completing an **IPM plan** annually will help ensure that opportunities to improve productivity are not missed
- Help meet the market demand to see more sustainable practices and reduced reliance on pesticides.
- It may also be necessary for compliance with farm assurance schemes.
- Funding opportunity under **SFI**

Completing an IPM Plan

Soil Type
Structure
Nutrient
Infrastructure – hedgerows –
Rotations –
Variety selection
Site history – Weeds – P & D
Cultivation
Hot spots

Variety Choice

Watkins Wheat 788 - March 2023

- Bofin **(British On-Farm Innovation Network)** has successfully supported a group of farmers in delivering an on-farm trial to explore the properties of a wheat variety believed to be resistant to slugs.
- **Watkins 788,** a wheat variety identified as one spurned by slugs, was sown on control plots with the aim of helping farmers move away from a reliance on chemical control measures.

Managing Pest, Disease & Weeds

- Hedgerows, beetle banks, buffer strips habitat for beneficials
- Ladybirds – Lacewings – Hover flies – Ground beetles
- Seed treatment
- Hot spots – digital mapping - GIS
- Topography
- Site climate
- Drainage

Establishing Action Thresholds

- Number of pests or level of damage beyond which management action should be taken is known as the action threshold, a fundamental concept in IPM
- When management action should be taken is determined by the total cost of the action (including monitoring), the value of the crop, and the impact on the environment.
- Specific thresholds or management action guidelines may be developed over the long term by growers who regularly monitor crops, keep good records, and evaluate and summarize outcomes for comparison over time.

Why Use Thresholds

- PPP sometimes applied on a calendar schedule, when pest presence is only suspected, or when pest numbers are already high and difficult to control.
- Using thresholds can maintain or improve crop quality while reducing the cost and frequency of control measures.

- Less frequent applications help maintain pesticide efficacy by reducing the development of pesticide resistance.
- Fewer applications reduce the disruptions to cultural practices that occur during applications and the subsequent restricted entry interval (REI).
- In addition, fewer applications may improve plant growth and quality by minimizing phytotoxicity and increase profit by reducing costs of pesticide purchases, application labour, and regulatory compliance.

When to Take Management Action

- Action thresholds based largely on economics.
- Action warranted when the revenue expected from improved crop quality or yield will exceed the cost and adverse impacts harvest disruption of the action.
- Amount of pest damage or presence that can be economically tolerated is determined by many factors, including the type of pest and damage, crop species & cultivar, stage of plant development, time until harvest or sale, and market conditions.
- Tolerance to pests can be higher if infested plant parts are not marketed, such as older leaves on seed crops or cut flowers.
- Thresholds can be higher if highly effective or quick-acting methods are available for controlling the problem.
- Conversely, if controls are slow-acting or only partially effective, or crops are of an exceptionally high value, thresholds may be relatively low.
- In certain situations, regulations such as quarantines may impose zero tolerance for exotic organisms even when numbers are low or an organism does not directly damage the marketed crop.
- Mother stock and new plants should have virtually no pests.
- Action thresholds may be higher for mature plants of certain crops.
- More mature plants are often better able to tolerate some level of certain types of pests or their damage.
- If monitoring reveals very low pest abundance or damage near the end of production, it may not be necessary to take management actions.

How to Establish Thresholds

- Establish by regularly monitoring plants in a consistent and systematic manner.
- Keep good records and judge the acceptability of the finished crop
- Experiment developes thresholds appropriate for situation and market conditions.
- Flexible adjusting thresholds adapt monitoring & management methods as appropriate.
- Quantitative or numerical to be useful. example, thresholds could be based on the
- Average number of pests per trap each week
- Percent of leaves or plants found to be damaged or infested during visual inspection
- Number of pests dislodged per beat or shake sample
- Quantitative thresholds can be developed for most pest monitoring methods,

Pests & Beneficials
Monitoring Technique for Assessing Beneficial Insect Population

- Crop Walking
- Indicator plants
- Sticky traps

Pests & Beneficials
Measure To Protect and Increase Non-Target Organism's on farm

- Increase biodiversity
- Increase natural landscapes
- Hedgerows – Meadows – Beetle banks – Trees
- Cover crops
- Stubble left
- Minimise the use of PPP
- Favored plants

Pests & Beneficials
Habitat Provision and Management on Population

- Beneficials:
- SAFE Approach – see next slides
- Effective use of conservation biological control

S is for 'shelter'

- Hedgerows, margins & shrubby areas protected from insecticides and intensive tillage.
- Such habitats enable beneficial insects to repopulate nearby crops.
- Strips of tussocky grasses & flower-rich grassland support high densities of some species.
- Natural enemies that live for part of year within a crop need other habitats to forage, breed or survive dormant periods.

Provide shelter for natural enemies by:

- Managing hedges to create different structures with varied plant species
- Re-sowing any degraded hedge bases covered in noxious weeds (such as ragwort or thistles) with a flower-rich grass mix
- Protecting natural vegetation along hedge bases & fence lines from insecticide & herbicide drift
- Ploughing two furrows together to form a raised 'beetle bank' to create drier conditions favoured by insects and divide larger fields – sow with tussock-forming grasses

A is for 'alternative prey'

Pests occur sporadically during growing season, with shorter life cycles than natural enemies.
Other food sources within & outside fields are needed to maintain natural enemy populations.
Food sources include:

- Other crops
- Uncropped areas, field margins, woodland & less intensively managed grassland
- Under sowing
- Weeds (uncompetitive)
- Minimum tillage
- Organic manures
- Min tillage & application of organic manures are valuable for providing suitable conditions for detritus-feeding invertebrates that serve as alternative prey for predators.

F is for ‘flower-rich habitat’

- Pollen and nectar are essential for some groups of natural enemies, especially parasitic wasps and hoverflies.
- They are important foods for many other natural enemies.
- Woodlands, hedges, margins, crops and agri-environment habitats containing wildflowers, annual arable plants or flowering wild bird seed plants can supply pollen and nectar.
- These flower-rich areas also support alternative prey.
- Flower-rich areas can be created using a mix of wildflowers and grasses or legumes.
- Mixes that provide both complex and simple flowers are the most beneficial because these support both short- and long-tongued insects.

E is for ‘environment’

- Insect natural enemies thrive in diverse vegetation that has not been treated with insecticides, such as field margins.
- All insecticides affect them to some degree, so it is important to minimise usage by adopting IPM practices.
- Other pesticides may adversely affect natural enemies, directly or indirectly, for example, removal of weedy habitats.
- Correct management will help to create a habitat structure that provides natural enemies with cover and a suitable microclimate.

Ensure habitats are:

- Spread across the farm – some natural enemies
- tend to remain close to margins
- Diverse – to encourage a variety of natural enemies

Hoverflies Natural Enemies

- Adults are pollinators feeding on pollen and nectar
- Typically have 3 – 5 life cycles per year
- Eggs are laid close to aphid colonies and hatch within 2 – 3 days
- Larvae go through 2 moults
- Pupation occurs on the plant or soil surface
- Adults emerge after pupation period between 9 – 21 days
- Encouraged by planting flower rich habitat but they need aphid population to feed on
- Specific flowers would be coriander and phacelia

Ladybirds Natural Enemies

- Obligate aphid predator feeds on aphids for most of its life
- Life cycle usually last for one year
- Eggs laid in spring / early summer in large batches close to prey
- Hatch after 2 – 3 days with larvae feeding on shells and unhatched eggs
- Larvae undergo 3 molts with larval stage lasting 1 – 4 weeks
- Pupation in mid-summer and adult emerge mid – late Sept.
- Adults are attracted to open flowers such as wild carrot & jarrow to feed on nectar & pollen
- Use of wildflowers mixes in buffer strips
- Avoid broad spectrum insecticides

Lacewing Adult & Larvae Natural enemies

- Bright green or brown bodies.
- Adults & larvae eat aphids
- Often hide under the bodies
- Female lay single egg on a thread that hardens in air
- Some hibernate some die overwinter
- Aphids, Scale, Caterpillars, Mites and pest eggs

Carabids
Natural Enemies

- Ground beetles
- Mainly nocturnal hunters
- Flightless – fast runners
- Powerful jaws
- Eat wide range including slugs, worms
- Hibernate coldest months

Phytoseiulus persimilis Natural Enemies

- Feeding on aphid
- Normally RSM
- 5 adults / 25 larvae or eggs per day
- Quick mover
- Prefers cool moist conditions

Predatory Midge Natural Enemies

- Aphidoletes – gall midge is an example
- Feed mainly Aphids 4 – 65 / day can eat much larger aphids
- Depending on food Orange, red, brown or grey
- 7 – 14-day larvae – pupates in the ground

Biological Control
Key Crop Pests in Cereals

- Insecticide cannot prevent BYDV transmission but may decelerate the spread.
- Use resistant cultivars (e.g. 'Rapier') to lessen chemical inputs.
- Provide flowering borders (e.g. *Phacelia* spp.) and increase non-crop structural complexity for natural enemies (e.g. parasitoid wasps).
- Encourage springtails (as alternative food source) [conflicts with OSR point: 25], and hoverflies, lacewings, ladybirds, spiders, carabids, and parasitoid wasps as natural enemies.
- Reduce spring cereal cropping after mild winters or within landscapes dominated by grassland to reduce BYDV transmission.
- Use artificial flowers in margins to encourage predatory hoverfly larvae early in the season.

Biological Control
Key Crop Pests in Cereals

- Promote grassy margins *with* hedges to increase carabids and reduce slug incidence.
- Multiple cultivations [conflicts with cereal points: 12, 31] in dry conditions will reduce slug survival, particularly if a fine, firm seedbed is produced.
- Use a narrower drill coulter to hinder slug movement.
- Under lower tillage regimes, remove debris and stubble (slug habitat).
- Wheat can be drilled deeper in cloddy soils.
- If the previous approaches fail, apply iron ferric phosphate as an alternative

Biological Control
Key Crop Pests in OSR

- Encourage parasitoid wasps, carabids, rove beetles, and predatory flies
- In previously infested areas, use OSR in fields surrounded by hedges and woods, and avoid OSR crops in fields surrounded by field banks.
- Avoid spring brassicas close to fields that were previously damaged by root fly.
- Consider a finger weeder-type action [conflicts with OSR point: 15] to reduce pest emergence, and to allow access for parasitoids to pest hosts.

Biological Control
Key Crop Pests in OSR

- Resistance to pyrethroids is confirmed for the UK.
- Spray in early bud stage to protect parasitoids, if spraying is necessary.
- Intensively flowering field margins, increased brassica diversity in landscapes, and reduced ploughing following OSR [conflicts with OSR point: 30] will enhance parasitoids.
- Spring and winter rape crops in proximity will favour parasitoid migration upon emergence [conflicts with OSR points: 3, 7].
- Enhance carabids, tangle-web spiders, and wolf spiders, though control by the latter may be reduced by a greater variety of alternative prey [conflicts with cereal point: 4].
- Increased soil-N and plant density will increase plant vigour and prevent damage.
- Consider selecting varieties which emit more parasitoid-attracting herbivore-induce plant volatiles (HIPVs).

Biological Control
Key Crop Pests in OSR

- Cabbage seed weevil resistance to neonicotinoids partly confirmed in Poland.
- Insecticide application of winter OSR causes high mortality of parasitoids which can achieve 50 % of pest parasitism.
- Diversifying the landscape with brassicas will help enhance natural enemies.
- Encourage carabids.
- Early drilling of winter OSR can reduce risk of attack.
- Trap cropping with turnip rape followed by a sustainable insecticide application (only in the trap crop) may reduce weevil infestation in the maincrop OSR.

Biological Control
Key Crop Pests in Potatoes

- Encourage parasitoid wasps, predatory flies, and farmland birds
- Avoid potatoes if pest risk is high and lift early if damage is suspected.
- Use pea trap crops or mixed trap crops (e.g. buckwheat, wheat, beans).

Biological Control
Key Crop Pests in Peas & Field Beans

- Increased soil-N will increase plant vigour and prevent damage.
- Encourage carabid and rove beetles, consider the application of pathogenic nematodes.
- Avoid pea and bean cropping close to other legumes (esp. Clover and lucerne), uncultivated grassland, and fields recently cropped with pea and bean.
- Zero-tilled [conflicts with pea & bean points: 8, 14, 26] pea fields will reduce pest incidence and damage.
- Select resistant cultivars, which will increase pest susceptibility to pathogenic nematodes.

Biological Control
Key Crop Pests in Peas & Field Beans

- Encourage spiders, ladybirds, predatory flies, and lacewings by diversifying landscape.
- Consider inoculating crops with fungal endophyte to increase plant resistance to pests.
- Sow late emerging crops to prevent pea and field thrips in high risk areas.

Integrated management of black grass

- About 95–100% black-grass control is required to prevent populations increasing.
- Combine non-chemical control with herbicides to improve overall control and protect efficacy.

How to manage black grass summary
- Spring cropping (90% control)
- Fallowing/grass ley breaks (70–80% reduction of the seed bank per year)
- Ploughing (70% control)
- Delayed autumn drilling (>30% control)
- Competitive crops (<25% control)
- Preventing seed return and spread of resistant seeds
- Arable weeds and the role of the rotation

Spring cropping (90% control)

- About **80% of black-grass emergence** occurs in autumn.
- A **spring-sown crop provides** a wider window for control during the between-crop period.
- **Some spring-sown** crops offer more control than others.
- For example, **spring barley is more competitive than spring wheat**, and spring beans and linseed are not as competitive as spring cereals.
- Note: establishing crops in spring can be difficult, **especially on heavy soils, and herbicide choice is more limited.**

Fallowing/grass ley breaks
(70–80% reduction of the seed bank per year)

- Average black-grass seed decline in the soil is about 75% per year.
- Seed persistence data and farm experience both support the view that a one-year fallow or grass ley is not long enough to reduce high black-grass infestations to acceptable levels.
- After two years, less than 10% of seeds are likely to remain.
- This could still be a large number, and a longer break may be required.
- Failure to prevent seed return greatly undermines the value of a fallow or grass ley break.
- The cultivation strategy at end of fallow or grass ley break is important.
- Sufficient time needs to elapse between cultivating and sowing next crop to allow the destruction of black-grass seedlings emerging from residual seeds.

Ploughing (70% control)

- High-quality ploughing, with good inversion of the furrow, buries seeds to a depth which seedlings are unlikely to emerge (>5 cm).
- Black-grass seeds relatively non-persistent in seed bank, so ploughing brings few viable seeds to the surface.
- Especially true for rotational ploughing (e.g. ploughed once every 3–6 years).
- No-till and particularly shallow non-inversion tillage tend to favor black-grass, because freshly shed seeds stay near the soil surface.
- Failure to control black grass effectively in such systems can result in a much more rapid increase in infestation (more than tenfold per year) than occurs in systems based on annual ploughing.

Delayed autumn drilling (>30% control)

Delayed drilling (until after mid-October) of winter cereals have 3 main benefits:

- More weed seedling emerges before sowing for control with cultivations and/or glyphosate.
- Residual pre-emergence herbicides are often 25-30% more re-active when applied in later-drilled crops (because soil conditions are more likely to be optimal).
- Late-emerging black grass tends to be less competitive and produces fewer seeds per plant.
- Adequate drilling capacity, including drills for sub optimal soil conditions, is required to minimise the risks associated with delayed drilling.
- Always aim to drill fields with the heaviest black-grass infestations last.

Competitive crops (<25% control)

Crops can compete with weeds to varying degrees.

The following factors can make a crop better able to suppress weeds:

- The right species (e.g. barley is more competitive than wheat)
- High seed rates of winter cereals (e.g. >300 plants/m2)
- Narrow row spacing
- Good seedbeds and agronomy to favour strong, uniform crops

Preventing seed return and spread of resistant seeds

- Destroying (spraying glyphosate or cutting) patches of black grass in winter wheat in the first week of June will reduce viable seed return.
- Cutting or spraying earlier or later is likely to be less effective.
- Destroying crop in the same areas for 2–3 years maximises reductions.
- Hand-roguing is also feasible at low weed populations.
- Minimise spread of seeds and plants in combine harvesters, balers, cultivation equipment, straw or manure.
- Harvest weed-control systems are being tested in UK conditions.
- Such systems include chart decks/carts, which deposit seeds in a limited area of the field or use seed crushers to destroy weed seeds (over 90% of them) before residues are returned to the soil.

Use of straw

- Whether buying or selling straw, it is important to understand the quality of the product.
- Distribution of weed seeds can be associated with straw use.
- Be sure you are aware of the risks.

Arable weeds and the role of the rotation

- Soil contains many weed seeds – the 'seed bank'.
- Increases and decreases, as both weeds and crops set and shed seeds.
- Management of one weed species influences the quantity of other weed species, positively and negatively.
- Develop a holistic approach to weed management across the rotation