Environmental Land Management Test and Trial - Integrated Pest Management extension Final report - Defra project 253a

Walker, Philip; Creissen, Henry E.; Gadsby, John; Behrendt, Kath; Hartfield, Chris; Calatayud, Antonio; Cooney, Brid; Bartel, Elysia; Tricklebank, Harry; Alonso, Natasha; Botero Degiovanni, Hernan; Turner, Matthew

Print publication: 30/03/2023

Document Version
Publisher's PDF, also known as Version of record

Defra Tests & Trials




Environmental Land Management

Integrated Pest Management extension

Final report - Defra project 253a

30 March 2023

SRUC NFU ADAS

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TITLE

Title of report:	Final Report
T&T name:	Integrated Pest Management extension (project 253a)
Author (organisation):	ADAS, SRUC, NFU
Author (individual):	Philip Walker, Henry Creissen, John Gadsby, Kath Behrendt, Chris Hartfield, Antonio Calatayud, Brid Cooney, Elysia Bartel, Harry Tricklebank, Natasha Alonso, Hernan Degiovanni, Matthew Turner.
Date submitted:	30 March 2023
Version:	Version submitted to Defra
Reviewer name (where applicable):	Neil Paveley

This report was submitted to Defra by ADAS, SRUC and NFU, as part of the ELM Test and Trial programme.

Acknowledgements:

The authors acknowledge funding of the project by Defra, the work of colleagues in ADAS, SRUC and NFU involved in delivering the project, and technical input from the project steering committee.

REPORT SUMMARY

The project provided evidence for the co-design of the SFI IPM Standard and for determining the structure of economic incentives for farmer participation in the scheme. An online IPM Tool was developed which delivers guidance and reporting, helping farmers plan, implement and, record IPM.

The project was overseen by a steering group of stakeholders and addressed four ELM theme areas summarised in the sub-sections below.

Co-design of the IPM SFI Standard

- Paid actions being considered by Defra for inclusion in the SFI Standard were checked against the evidence related to their effectiveness, impact on biodiversity and breadth of applicability across crops.
  - Some of the proposed paid actions were justified, either on the grounds of positive biodiversity impact or good evidence for efficacy and scope for increased uptake. However, most of the proposed paid actions were limited in the range of pests against which they would be effective, so their impact on reducing the need for pesticide use would be limited.
  - The proposed paid actions were compared against a wider list of IPM actions, which identified additional actions for consideration, with greater potential for impact. Their suitability as paid actions depends on how they can be defined in the Standard and verified.
  - The need for flexibility in the IPM SFI Standard was identified, so farmers can implement actions that are feasible and beneficial in their cropping system.
- Defra published details of the IPM SFI Standard on 26 January 2023. This included a flexible choice of actions for farmers, with payment rates defined for each action
- The evidence from this T&T has identified a significant risk that the paid actions will achieve limited impacts in relation to reducing the risks associated with pesticide use.

Recommendation: There is considerable scope to further IPM and address the risks associated with pesticide use, through improved guidance and resources to support farmers and advisers, and by adding effective paid actions to the Standard.

Recommendation: Success achieved in practice should be reviewed against a baseline, in the years following introduction of the SFI IPM Standard. Methods are proposed to measure progress.

Incentive payment rates

- A broad group of possible paid actions was considered in workshops with farmers from the arable and horticultural sectors, to inform SFI payment rates. A choice experiment was used to understand risk/reward and explore how changes in payments would affect uptake.
- The workshops identified the proportion of participants already implementing each paid action, to estimate the extent to which incentives would be funding actions which are already being used.
- Some of the proposed paid actions were not practically feasible, or carried unacceptable financial risks, in some cropping systems. Inclusion of these actions in 'bundles' of paid actions (representing potential 'Introductory', 'Intermediate' or 'Advanced' levels - as proposed in draft versions of the SFI IPM Standard) led to very high levels of subsidy being indicated.

Recommendation: Flexibility within the SFI IPM Standard is key to ensuring wide scale uptake.

An IPM Tool for land management planning

- An online, interactive IPM Tool was developed for farmers and advisers to create, record and plan IPM activity.
- The IPM Tool guides users to: (i) identify important pests (invertebrates, weeds and diseases) that drive pesticide use on their farm, (ii) identify effective IPM measures for those pests, (iii) record a plan of IPM measures they will implement.
- Farmers and agronomists signed-up to become project participants and were invited to use the IPM tool to plan their IPM. 113 registered participants undertook this process, creating 231 plans, for the following crops: winter wheat (91), oilseed rape (33), winter barley (27), winter beans (20), grassland (16), sugar beet (11), peas (10), maize (8), potatoes (8), winter oats (6) and apples (1).
- **The IPM planning that resulted from using the IPM Tool, recorded substantial commitments to increase IPM actions compared to current practice.**
- Participants overwhelmingly indicated that they would recommend to other farmers to consider using the online IPM Tool to help plan crop-specific IPM.
- Barriers to using the online IPM Tool were: lack of awareness of the tool; computer literacy; fear (of consequences if they implement something incorrectly); lack of financial incentive for the time input and if the tool became mandatory.
- The online IPM Tool was complimented for its ease of use, suitable language for a farmer audience, logical flow and links to up-to-date information from respected organisations.

Recommendation: The IPM Tool should be made publicly available to provide guidance and aid IPM planning, as one of a range of tools and plans that will help farmers engage in the IPM SFI Standard (2023 cropping season).

Advice and guidance

- Advice and guidance will be critical for achieving Defra's public good aims, as paid actions in SFI are limited.
- Links to video and written guidance are provided on the 'landing page' of the IPM Tool.
- The IPM Tool and guidance were created to ensure that farmers could engage with IPM without agronomist support, although it is recognised and incentivised (through SFI) that agronomists should be a key source of advice and should be engaged in the planning process.
- There is a clear distinction and synergy between advice (from BASIS qualified advisers) and guidance, such as that provided through the IPM Tool.
- User feedback on the video and written guidance was positive.
- For the IPM Tool to remain of value, it will require annual updating or withdrawal of guidance. This is particularly important for guidance from the AHDB horticulture and potato legacy websites.
- Updates should be responsive to: (i) changes in research knowledge, and (ii) feedback from agronomists and farmers. The latter could be pro-actively facilitated and verified by establishing an IPM network.

Recommendation*:* Mechanisms need to be defined and implemented for annual updating of the IPM guidance provided through the IPM Tool.

DEFINITIONS AND ACRONYMS

Word or Acronym	Description or Definition
DEFRA	Department for Environment, Food and Rural Affairs.
NFU	National Farmers Union.
VI	Voluntary Initiative.
SFI	Sustainable Farming Initiative.
T&T	Test and Trial.
ELM	Environmental Land Management.
WP	Work Package.
IPM	Integrated Pest Management, where 'pest' refers collectively to pathogens, weeds and invertebrate pests.
IPM Plan	A generic term for a description of intended IPM actions. Also, the 'Voluntary Initiative (VI) IPM Plan' used to provide a metric of IPM uptake. Previously known as the IPM Assessment Plan.
IPM Tool	Online Tool, for use by farmers to plan decision making according to IPM principles.
CRD	Chemicals Regulation Division of the Health and Safety Executive.
AHDB	Agriculture and Horticulture Development Board.
PPPs	Plant Protection Products.
Broadacre crops	Arable crop species grown over a large area.
Non broadacre crops	Horticultural and other edible field crops.
Guidance (these definitions of guidance and advice will be used in the interviews with farmer participants)	Guidance is an impartial service which will help you to identify your options and narrow down your choices, but will not tell you what to do or which product to buy or practice to adopt; the decision is yours. Providers of guidance are responsible for the accuracy and quality of the information they provide but not for any decision made based on it.
Advice	Advice will recommend a specific product or course of action for you to take given your circumstances and goals. This will be personal to you, based on information you provide. Advice is provided by a qualified and regulated individual or organisation [e.g. through BASIS]. Providers of advice are responsible and liable for the accuracy, quality and suitability of the recommendation that they make.

INTRODUCTION

This project progressed from the work of the IPM T&T project 253, towards creation of an IPM SFI Standard and the associated guidance for planning and implementing IPM. The project provided evidence about the effectiveness and practical feasibility of potential paid actions and informed incentive levels.

Reducing the risks associated with use of plant protection products (PPPs) could contribute to the 25 Year Environment Plan, contributing to 'Reduced risk/impact of agrochemicals on wetlands, waterbodies and groundwaters' (Clean and plentiful water); and 'Reduced impact of agrochemicals on natural, semi-natural and other priority terrestrial and aquatic habitats and on declining species' (Thriving plants and wildlife).

Evidence from previous work

During 2021, the preceding IPM Test and Trial project 253 addressed three ELM theme areas:

Land Management Plans (LMPs) to record IPM public goods delivery: A prototype IPM LMP tool was developed in Excel for three example crops (wheat, potatoes and grassland), to enable farmers to produce an IPM-focussed LMP.

Advice and guidance: To assess the support farmers require to create an IPM LMP, farmer participants were sub-divided into three groups which received different levels of support. The outcomes from the groups were assessed.

Payment mechanisms: To provide insight into the possible basis for payment mechanisms, interviews with participants assessed the impact of IPM LMP guidance on farm practice and attitudinal change, and identified barriers and incentives to IPM uptake.

Key findings in project 253 during 2021 were:

- A baseline VI/NFU IPM assessment plan (now to be known as the 'VI IPM Plan') was completed by over 200 participant farmers, and demonstrated substantial existing IPM implementation and scope for increased IPM measures in all sectors.
- The IPM LMP Tool was well received by farmers: feedback was positive and 88% said they would recommend the process to other farmers.
- High levels of successful completion of IPM LMPs were obtained, even by the farmer group receiving the lowest level of support (access to the guidance in the tool and accompanying written guidance).
- Farmers completed the IPM LMP and created a report typically within one to two hours.
- **During the IPM LMP process, farmers committed to increased adoption of IPM beyond current practice, through specific practices recorded in the LMP.**
- The level of increased commitment in the LMPs was similar across the three groups receiving different levels of support.
- In subsequent interviews, key barriers to uptake of IPM were highlighted as 'economic', 'lack of knowledge or understanding of IPM', and 'mindset or habits'. 'Economic' factors were also highlighted as the biggest encouragement to implement IPM, followed by 'good advertisement of IPM' and 'education'.
- It was recommended to: (i) develop and test an IPM Tool (and associated guidance) for a wider range of priority crops, selected as being the focus of IPM SFI, (ii) test economic incentives to

explore to what extent they can increase commitment to change IPM practices, and (iii) identify how IPM planning and guidance could contribute towards an IPM SFI.

The work in Test and Trial 253 was completed in parallel with three major reviews of IPM, procured by AHDB and Natural England (Blake *et al.,* 2021; Young *et al.,* 2022; Cook *et al.,* 2023). These reviews of the evidence underpinned key parts of the work in project 253a, reported below. Note that parts of the analysis were based on an advanced draft version of the Cook *et al*. biodiversity review. The conclusions from the analysis were checked back against the final version of the review and no changes to conclusions were indicated.

Approaches used for this T&T

Detailed descriptions of the objectives, methods and results of each work package are given in the appendices.

In summary, this project addressed four ELM theme areas:

IPM Tool for land management planning (work package 1)

- Priority crops were identified, based on analysis of a combination of metrics related to the likely public good benefits from IPM.
- An online, interactive IPM Tool was developed for farmers and advisers to record and plan IPM activities. The IPM Tool differs from the prototype tested by users in 2021 by: (i) being developed as an interactive, online tool, which only presents information relevant to the crops and pests prevalent on the user's farm, (ii) extension of the IPM Tool to cover all priority crops, (iii) incorporating RPA mapping of fields to which the IPM planning relates.
- The IPM Tool enables planning for winter wheat, winter barley, winter oats, maize, improved grassland, potatoes, combining peas, vining peas, field beans and broad beans, oilseed rape, sugar beet, apple, and vegetable Brassicas (cabbage, cauliflower, brussels sprout and broccoli).
- The IPM Tool guides users to: (i) identify important pests (invertebrates, weeds and diseases) that can drive pesticide use on their farm, (ii) identify effective IPM control measures for those pests, (iii) record whether they will implement those IPM control measures in the current cropping season or intend to implement them next season.

Advice and Guidance (work package 2)

- Farmers, horticultural growers and agronomists (who signed-up to become project participants) were invited to complete crop plans, using the IPM Tool to record public goods delivery.
- Links to guidance are provided on the 'landing page' of the IPM Tool:
  - A video guide/demonstration on using the IPM Tool.
  - Videos which introduce good practice in IPM for each of the cropping sectors: arable, grassland and horticulture.
  - Written guidance outlining IPM best practice for all the crop types included in the IPM Tool.
  - Links within the IPM Tool direct users to context-sensitive guidance provided by AHDB, PGRO, BBRO and other independent organisations.
- The aim was to ensure that farmers could engage with SFI IPM without agronomist support, although it is recognised and incentivised (through SFI) that agronomists should be a key source of advice and should be engaged in the planning process.
- Farmer participants were welcome to engage with agronomists, as per their usual practice, to complete their crop plans using the IPM Tool.

SFI IPM Standard co-design (work package 3)

- The project provided evidence to Defra regarding the design of the IPM Standard. Paid actions proposed by Defra were checked against the evidence for criteria related to their effectiveness as IPM measures, impact on biodiversity and breadth of applicability across crops. The proposed paid actions were compared against a wider list of IPM actions to identify additional actions for consideration.
- Draft IPM SFI Standard paid actions, under consideration, were provided by Defra for review by the T&T project team on 21 July 2022, and updated subsequently on 17 August and 21 September.
- Feedback was provided by the project team on how the proposed paid actions could be included in the Standard.
- Methods were proposed to reconcile the requirement for flexibility (to account for different farming systems) with the accountability requirements for public spending in SFI.

Incentive payment rates (work package 4)

- A sample of farmers from the arable and horticultural sectors (31 in total) participated in two workshops to inform the choice of paid actions in the IPM SFI Standard and inform subsidy payment rates of such a scheme.
- Contrasting sectors were included, with differing market requirements and types of farming system, to determine if different sectors require differing approaches.
- Questionnaires were designed to collect information on: (i) the respondent and their enterprise, (ii) practicalities of implementing IPM activities related to the Standard, (iii) estimated costs of implementing different IPM activities and (iv) estimates of payment rates per level of involvement in the scheme.
- A choice experiment was also used to understand risk/reward elicitation and explore more directly how changes in the payments would affect uptake.

User feedback on the SFI IPM process and usefulness of guidance (work package 5)

- Questionnaires and 'one to one' interviews were used to evaluate how the different components of the IPM Tool and its associated guidance were received by participants. Analysis of the resulting IPM planning assessed commitment by users to increase IPM practices.
- Questionnaires were provided to all participants to provide feedback, after they had planned their IPM using the IPM Tool.
- In-depth 'behavioural insights' interviews were conducted with 44 users who planned their IPM using the IPM Tool.

Project reporting and recommendations (work package 6)

- Monthly steering group meetings, organised and reported through this work package, provided oversight and input from stakeholders.
- The interim report and this final report are deliverables from the work package.

FINDINGS

Current state of evidence on IPM and implications for SFI IPM

- The work on the IPM Tool, guidance and input to the SFI IPM Standard co-design process all relied substantially on three major reviews of IPM (Blake *et al*., 2021; Young *et al*., 2022; Cook *et al*., 2023). The reviews were of global literature on IPM. Although several hundred papers and reports were reviewed, major knowledge gaps were identified related to efficacy, economics and effects on biodiversity. This is likely to be because IPM is multi-factorial (there are many combinations of crops, pests, IPM actions and environments), making experimental or observational comparisons complex and resource intensive.
- The resulting uncertainty or limitations of analysis have been made explicit in the reports of the work packages (see appendices).
- Considering the impact of each of these knowledge gaps on the project and on the implementation of the SFI for IPM:
  - The effectiveness of many IPM actions against many pests have not been quantified adequately. IPM actions included in the IPM Tool and guidance are those for which there is already sufficiently strong evidence for efficacy. There are good mechanistic rationale that other actions may also be effective, but the evidence is insufficient for their inclusion currently.
  - Good experimental or observational evidence on the economics of IPM actions 'on-farm' would inform SFI incentives directly and may identify that there is a good economic case for farmers to implement certain actions in the absence of SFI incentives. In the absence of substantial economic data, farmer perceptions elicited in workshops and choice experiments were used to inform payment rates.
  - Biodiversity is a major policy driver for the SFI IPM standard. Measuring the impacts of IPM actions on non-target fauna and flora is complex. Many knowledge gaps remain and there are cases where particular actions are positive for some non-target groups, but negative for others. Proposed IPM paid actions were assessed against the current evidence whether, on balance, the effects would be positive, negative, neutral, or could not be assessed.

Recommendation: Greater progress could be made to increase IPM uptake, to achieve Defra's public good aims, if evidence gaps were filled.

Progress in this area is largely dependent on European funding through H2020 and Horizon Europe projects. Negotiations are ongoing for the UK's future relationship with Horizon Europe and the outcome remains uncertain.

Findings and recommendations

This section summarises the findings and recommendations related to the four themes of the T&T. Full descriptions of the evidence gathered are given in the appendices.

IPM Tool for land management planning

- The target number of participants was chosen (based on typical response rates) to deliver a sample of 100 user survey questionnaires and 50 'one to one' interviews, on which the analysis of user feedback would be based.

- From the 300 farmers and advisers who opted-in to being contacted about the project, the uptake was lower than expected, but the return rates of surveys and interviews were higher. We received 82 completed questionnaires and 44 completed interviews. This was close to target.
- The majority of participants planned their IPM using the IPM Tool in under two hours, with many participants completing the tool for the first crop in less than one hour and the second and subsequent crops in less than 30 minutes.
- The feedback regarding the video and written guidance was positive across the majority of participants, with most reporting agreement with the statements presented.
- Participants overwhelmingly indicated that they would recommend to other farmers to consider using the online IPM Tool and would use the tool again to create a new plan for the following harvest year.
- The online IPM Tool was praised for its ease of use, suitable language for a farmer audience and logical flow. Participants also perceived the tool to be useful for IPM because of the questions it raised which made them consider inputs and decisions.
- Strengths of the online IPM Tool are particularly based on the guidance, links to up-to-date data, thresholds and respected organisations were popular.
- The main motivation to continue using the IPM Tool was continued learning. Therefore, the tool will need to be regularly updated with robust data from respected organisations.
- Barriers to using the online IPM Tool were acknowledged as: awareness of the tool; computer literacy; fear (of consequences if they implement something incorrectly); lack of financial incentive for the time input and if the tool became the industry standard or mandatory.
- Planning crop-specific IPM using the IPM Tool recorded increased commitment to IPM measures, compared to current practice:
    - For invertebrate pests, the increased commitment for all crop groups (except grassland) ranged from 8 to 47% more IPM. There was a particularly high commitment to change recorded in the grassland group (103%).
    - The commitment to increase IPM from current practice for diseases in all crops ranged from 0 to 38%.
    - For weed control, the increased commitment to new IPM control measures recorded using the IPM Tool ranged from 19 to 52%.

Recommendation: : The IPM Tool should be made publicly available to provide guidance and aid IPM planning, as one of a range of tools and plans that will help farmers engage in the IPM SFI Standard (2023 cropping season). Actions to achieve this include:

- Updating the IPM Tool, based on user feedback.
- Adding a benchmarking function to enable farmer comparisons with peers (anonymised at a regional and crop level).
- Aligning the IPM Tool with other initiatives (VI, LEAF, NAP) to utilise earned recognition and reduce duplication.
- Planning for hosting/updating and putting IPR agreements in place.

- Upgrading security processes for public release.
- Stress testing for capacity to support larger numbers of users.
- Promotion (e.g. through stakeholder organisations represented on the project steering group).

Advice and guidance

- Advice and guidance will be critical for achieving Defra's public good aims, as paid actions in SFI are limited.
- There is a clear distinction and synergy between advice (from BASIS qualified advisers) and guidance provided through the IPM Tool.
- User feedback on the written guidance and videos was positive.
- Minor changes to the written guidance will be made in response to feedback.
- For the IPM Tool to remain of value, it will require annual checking and updating or withdrawal of guidance (both the pop-up guidance summaries and guidance accessed through links). This is particularly important for guidance from the AHDB horticulture and potato legacy websites.
- Updates should be responsive to: (i) changes in research knowledge, and (ii) feedback from agronomists and farmers. The latter could be pro-actively facilitated and verified by establishing an IPM network.
- **Recommendation***:* Mechanisms need to be defined and implemented for annual updating of the guidance in the IPM Tool.

SFI IPM Standard co-design

- The requirements of SFI are that paid actions should:
  - Result in a clear public good change to justify payment.
  - Be simple and workable for farmers, to encourage a high level of engagement.
  - Be verifiable and enforceable, without excessive auditing burden.
  - Provide tangible benefit to the environment (in this case, through IPM practices which can reduce the risks associated with pesticide use).
- To meet these requirements, SFI should incentivise IPM actions that are effective at controlling pests (thus reducing the need to use pesticides and the risks associated with that use) and (where there is evidence) beneficial to biodiversity. Relevant metrics analysed were:
  - Efficacy of the IPM action, strength of evidence for efficacy and potential for increased uptake.
  - The number of crop pests against which the IPM action is effective (as a measure of broad applicability and beneficial impact).
  - Biodiversity impact of the IPM action (depending on the balance between positive/neutral/negative effects).
- Three of the proposed paid actions (in the draft list of paid actions being considered by Defra during the project) were justified, either on the grounds of positive biodiversity impact or good evidence for IPM efficacy and scope for increased uptake. However, some of the proposed paid actions were limited in the range of pests against which they would be effective, so their impact on reducing the need for, and risks associated with, pesticide use would be limited:
  - *In-field non-cropped area* was supported by evidence of positive biodiversity impact. This paid action will have some benefits to control of a few pests.

- *Field history, rotation and break crops* was supported by evidence of positive biodiversity impact and can help to reduce the need for and risks associated with pesticide applications against multiple pests. Defining what constitutes a 'good IPM rotation' as a paid action would be complex. Two approaches were considered further: (i) inclusion of 'spring cropping' as a paid action, and (ii) defining a specified number of crop types within a defined period of years.
- *Precision application* was identified to have benefits targeting pesticide applications against multiple pests in many crops, thereby reducing risks.

- Four potential paid IPM actions were identified with strong evidence for positive impacts across a wide range of pests and crops:
  - Bioprotectants* and low risk PPPs.
  - Decision support, includings thresholds.
  - Varetial choice for disease and pest resistance.
  - Hygiene and prevention.

  *The generic term 'bioprotectants', is used in the report, as defined by the IBMA. But if a product is effective against a pest, then it should be considered as a 'biopesticide'.

- The evidence for these four actions was as strong, or stronger, than the draft list of paid actions proposed by Defra. However, their suitability as paid actions depends on the required information being widely available to farmers, and how they can be defined in the Standard and verified:
  - There are 24 low risk active substances registered in the UK. But a full list of low risk products is not available from CRD. It was concluded that low risk PPPs could not be included as a paid action in the IPM SFI Standard until further information is available.
  - Evidence collated for the use for decisions support systems found that there was good diversity of decision support available across crops, making it feasible to include decision support systems in the IPM SFI Standard. The initial aim should be to incentivise farmers to follow the guidance on some fields, to gain trust in the decision support.
  - Evidence collated for the use of disease and pest resistance varieties found that information to guide variety choice was available for a wide range of crops and it would be feasible to be included in the IPM SFI Standard.
  - Evidence on 'hygiene and prevention' found that many actions are crop specific. Widely applicable actions (destruction of crop residues, volunteers, weeds) are generally net negative for biodiversity impact. It was concluded that this action should not be included in the IPM SFI Standard.

- To achieve high uptake of IPM SFI actions, the paid actions should be relevant to farmers across a diverse range of crops. However, many IPM actions are only feasible and desirable in certain crops, soil types and farming systems. Hence many effective paid actions would not be feasible in all farming systems, nor in all crops in the rotation.
- During a three-year SFI agreement, there will be some fields in some years where it is not possible to implement particular actions.
- Flexibility in the operation of the SFI Standard would enable more effective IPM actions to be included and excessive payment rates to be avoided. Options presented to achieve flexibility were:
  - Choice of paid actions from a 'menu', with a requirement to achieve a given number of actions from the pick list. This approach has been shown to work in other countries.
  - Paid actions to be achieved on a specified percentage of the land area in the scheme.

- Payment rates defined for each action, enabling farmer choice of actions.

- Defra published details of the IPM SFI Standard on 26 January 2023. This included a flexible choice of actions for farmers, with payment rates defined for each action.
- For transparency, ADAS and SRUC provided a public response to the published standard on their websites, on behalf of the T&T project (following approval of the text by Defra). The full text of the response is given in appendix 4. In summary:
  - The SFI IPM Standard is a useful step to encourage IPM adoption.
  - There is a significant risk that the paid actions will achieve limited impacts in relation to the risks associated with pesticide use.

Recommendation: There is considerable scope to further IPM and address the risks associated with pesticide use, through improved guidance and resources to support farmers and advisers, and by adding effective paid actions to the Standard.

Recommendation: Success achieved in practice should be reviewed against a baseline, in the years following introduction of the SFI IPM Standard. This could be achieved by:

- Analysis of specific IPM actions in crop plans created using the IPM Tool, and their outcomes in relation to effectiveness of control and the risks associated with pesticide use.
- Analysis of the Defra Pest and Disease survey of wheat and oilseed rape. The survey provides a long-term data set on over 400 commercial fields per year, quantifying metrics related to: (i) IPM actions, (ii) pesticide use, (iii) levels of disease and pest control, (iv) prevalence of beneficials.

Incentive payment rates

- The findings from the farmer workshops are the perceptions of a sample of farmers and growers and should be interpreted accordingly.
- There was considerable variation between farmers on which of the proposed paid actions they were, or were not, implementing currently. Perceptions on which actions were desirable and practically feasible also varied accordingly. For other actions, there was broad consensus.
- The summary points from the discussions held at the workshop aligned with the results from the individually completed questionnaires.
- 'Bundles' of paid actions broadly representative of 'Introductory' or 'Intermediate' levels of the Standard were rated more highly than bundles of 'Advanced' actions. However, the barrier to adoption of particular bundles of actions was often determined by one or two actions which were widely considered too risky or not practically feasible in particular farming systems. Prohibitively high levels of payment would be required to incentivise such actions. Appendix 5 reports full analysis.
- Feedback from participants identified some actions for which there was little appetite for uptake and others for which there was more general support. In summary:
  - IPM planning was widely accepted as a valuable IPM action.
  - Many participants grow habitat for natural enemies, largely supported under other schemes. Few participants saw the value in growing habitat within the crop due to high costs and limited returns from pest control.
  - Crop diversity, in the form of increasing the number of crop types in the rotation was favoured over other actions, such as spring cropping, or avoiding consecutive cereal production.

- Companion cropping (including intercropping, under-sowing etc.) was the least popular option of all that were offered at the workshops. High failure rate, complex agronomy and high management costs were cited as the main barriers.
- Decision support systems are used where available and deemed relevant, and adoption is higher in horticulture. Incentive payments for technical advice and alternative pest control systems may increase uptake.
- Growers are avoiding using insecticides wherever possible, however the perceived high risks associated with not using them means that many growers would not consider avoiding them even if financial incentives are provided, as they would not cover high potential losses.
- Use of bioprotectants and low risk plant protection products is more common in horticulture. Incentive payments could increase adoption if they covered the potential economic losses due to reduced level and consistency of control.
- Most participants utilise disease or pest resistant varieties where they are available and marketable. Smaller area, more niche, horticultural crops may not be able to grow resistant varieties due to lack of availability or certain varieties being required to achieve market quality requirements. Incentives to increase adoption amongst largely arable farmers received support from the group.

- Some of the possible paid actions may not be applicable to certain groups of growers or feasible for specific crops, for example:
  - Incentives for planting habitat for natural enemies are not relevant to those renting land on a short term basis.
  - Not applying insecticide to, for example, a seed potato crop was considered extremely risky because of the aphid borne virus threat.
  - Spring cropping is risky on heavy land.

- The participants proposed a solution whereby, rather than actions being in fixed groups in different levels of the SFI Standard, each action has an appropriate payment rate that reflects its public good value and farm cost, and participants can implement those actions that are achievable in their farming system.

Recommendation: Flexibility within the SFI IPM Standard is key to ensuring wide scale uptake.

APPENDIX 1 – WORK PACKAGES SUMMARY AND MILESTONES

The project was delivered by ADAS in collaboration with SRUC, led by the NFU. A project steering committee met monthly to oversee the work and the project reports to Defra. The geographic scope of the work was England.

The project was delivered as six work packages which addressed the project objectives. Work package 4 was proposed separately (as requested by Defra) and implemented during the project to support the development of the SFI IPM Standard. This final report summarises methods, results and conclusions from all work packages.

Details of project milestones can be found in Table 1.1

Work Package 1

Delivering Objective 1: Simplify the IPM Tool for users, extend the range of key crops and integrate field mapping.

Work Package Lead: John Gadsby and Antonio Calatayud, ADAS.

Planned completion date for Objective 1: 31 December 2022.

Aim: Produce an online version of the IPM Decision Making Tool (IPM Tool) with enhanced functions for testing by participating farmers.

Outline: Work Package 1, led by John Gadsby and Antonio Calatayud, utilised the expertise of the ADAS Agriculture and Land Management group and Software Development team in developing the online version of IPM Tool for an expanded range of crops and updated the tool using feedback from the previous T&T.

Work Package 2

Delivering Objective 2: Create video guidance for crop sectors and specific written guidance for key crops.

Work Package Lead: Philip Walker and Brid Cooney, ADAS.

Planned completion date for Objective 2: 31 December 2022.

Aim: Provide user support for the completion of IPM Tool and engagement with the IPM SFI, through video guidance and written guidance.

Outline: Work Package 2 delivered guidance and support to support farmers in the completion of the IPM Tool. The team utilised the experience of the ADAS Agriculture and Land Management group, with the expertise of entomologists, weed scientists and pathologists in the ADAS Crop Protection group, and ADAS Marketing group to create video and written guidance across the cropping sectors arable, grassland and horticulture.

Work Package 3

Delivering Objective 3: Support co-design of the SFI IPM Standard in collaboration with Defra.

Work Package lead: Neil Paveley, ADAS.

Planned completion date for Objective: 31 August 2022.

Aim: Provide evidence to inform the production of the SFI IPM Standard in collaboration with Defra.

Outline: Work Package 3 was led by ADAS Technical Director Dr Neil Paveley working closely with Defra with the co-design of the SFI IPM Standard. The focus was on developing an action-based Standard.

Work Package 4

Delivering Objective 4: Determine the structure of economic incentives for farmer participation in the scheme.

Work Package lead: Henry Creissen and Hernan Degiovanni, SRUC.

Planned completion date for Objective: 31 December 2022.

Aim: To determine farmer willingness to participate in the scheme and provide evidence to inform incentive payment rates.

Outline: Work Package 4 was led by Dr Henry Creissen at SRUC working closely with support from ADAS. The focus was on delivering farmers workshops to identify information on the support needed to encourage the uptake of measures related to SFI IPM Standard and to inform subsidy payment rates for participation in the scheme.

Work Package 5

Delivering Objective 5: User feedback on clarity and streamlining of SFI IPM process and usefulness of guidance.

Work Package lead: Kath Behrendt, ADAS.

Planned completion date for Objective 4: 31 January 2023.

Aim: Evaluate farmers' views and understanding of engaging with the SFI IPM process through questionnaires and interviews.

Outline: Work Packages 5 was led by social scientists in the ADAS Policy and Economics group. WP5 provided an evaluation of participants views, understanding and experiences of using the online IPM Tool and the videos and written guidance developed through questionnaires and in-depth interviews.

Work Package 6

Delivering Objective 6: Project reporting and recommendations.

Work Package Lead: Neil Paveley and Philip Walker, ADAS.

Completion date for Objective 5: 31 March 2023

Aim: Report the evidence and provide conclusions, findings and recommendations from the project.

Outline: Work package 5, led by the Dr Neil Paveley and Philip Walker, coordinated communications with the Steering Group and produced the interim and final reports.

Table 1.1: Project Milestones.

Milestones	Timeframe
Analysed existing excel based IPM Tool to review. (Objective 1)	1 July 2022 to 31 August 2022
Identified priority crops for extending the IPM Tool. (Objective 1)	1 July 2022 to 31 August 2022
Supported Defra in the development of SFI IPM Standard. (Objective 3)	1 July 2022 to 31 August 2022
Completed monthly project meetings and reporting to steering group on work completed so far and evidence. (Objective 6)	1 July 2022 to 31 August 2022
Created video guidance: IPM overview arable, grassland and horticulture groups of crops. (Objective 2)	1 July 2022 to 30 November 2022

Created video guidance: SFI IPM Standard. (Objective 2)	1 July 2022 to 30 November 2022
Completed monthly project meetings and reporting to steering group on work completed so far and evidence. (Objective 6)	1 July 2022 to 30 September 2022
Recruited growers and farmers for participation into Test and Trial and completion of IPM Tool. (Objective 1)	1 July 2022 to 30 November 2022
Defined the requirements and delivered the IPM Tool online. (Objective 1)	1 July 2022 to 30 November 2022
Written guidance for expanded range of crops. (Objective 2)	1 July 2022 to 30 November 2022
Expanded the range of crops in the IPM Tool. (Objective 1)	1 September 2022 to 30 November 2022
Created video guidance: How to complete IPM Tool. (Objective 2)	1 September 2022 to 30 November 2022
Designed, produced, and distributed an online questionnaire to elicit farmers understanding, views and experiences of going through the SFI IPM process and utilising the video guidance, written guidance, and helpline. (Objective 5)	1 August 2022 to 30 November 2022
Develop workshops questionnaires and deliver workshops for arable and horticulture sectors. Present findings to steering group.	1 October 2022 to 30 November 2022
Implemented a technical help line for IPM Tool completion. (Objective 2)	1 October 2022 to 31 December 2022
Linked the IPM Tool with mapping. (Objective 1)	1 September 2022 to 31 December 2022
Undertaken qualitative evaluation of survey responses. (Objective 5)	1 September 2022 to 31 December 2022
Completed monthly project meetings and reporting to steering group on work completed so far and evidence. (Objective 6)	1 October 2022 to 30 November 2022
Interim Report delivery. (Objective 6)	1 October 2022 to 31 December 2022
Conducted face-to-face and/or telephone interviews with representative sample of farmers who have taken part in the process. (Objective 5)	1 October 2022 to 31 January 2023
Transcribed and undertaken thematic analysis of interview responses. Data review of completed IPM Tool by the two groups. (Objective 5)	1 October 2022 to 31 January 2023
Completed monthly project meetings and reporting to steering group on work completed so far and evidence. (Objective 6)	1 December 2022 to 28 March 2023
Final Report completed. (Objective 6)	1 January 2023 to 28 March 2023

APPENDIX 2 - WORK PACKAGE 1: PRODUCE AN ONLINE VERSION OF THE IPM DECISION MAKING TOOL WITH ENHANCED FUNCTIONS FOR TESTING BY PARTICIPATING FARMERS.

2.1 WP 1 METHODOLOGY

2.1.1 Recruitment of growers and farmers for participation into Test and Trial

Participants were invited to sign up to the project by completing a short entry level survey via a platform on the ADAS website. The recruitment platform was launched on the 14 July 2022 on the ADAS website https://adas.co.uk/news/farmers-growers-needed-to-help-develop-new-sustainable-farming-incentive-for-integrated-pest-management/. The entry level survey required participants to provide information on whether they are farmers or agronomists, on cropping types, geographical location and size of their farmed area. Recruitment for the project was promoted by various ADAS, SRUC and NFU platforms, industry contacts and farming press (see WP1 Supplementary material). The number of participants signed up on 31 January 2023 were 348. Taking into account those not growing any relevant crops or signed up to the project more than once, in total 313 participants were invited to complete the IPM Tool in phased releases as it was prepared for different groups of crops, as detailed in Table 2.1.

Table 2.1: Participant invite dates for phased release of IPM Tools by crop groups.

Crop	Launch 12th December	Release 2 22nd December	Release 3 12th January	Release 4 31st January	Release 4 31st January
Wheat	X				X
Barley	X				X
Oats	X				X
Maize	X				X
Potatoes	X				X
Improved Grassland	X				X
Peas		X			X
Beans		X			X
Oilseeds		X			X
Sugar Beet			X		X
Brassicas				X	
Apples				X	
Number Invited	**73**	**50**	**42**	**48**	**100**

2.1.2 Analysis of existing excel-based IPM Tool to review components to include in online version

The excel based IPM LMP Tool developed during the previous 253 T&T was analysed to further develop and improve the IPM Tool for the current T&T. High levels of successful completion of IPM LMPs were obtained, even with self-completion by farmers who had access to the guidance in the tool and accompanying written guidance. Most respondents agreed that the advice and/or guidance they received was useful in helping them complete the IPM LMP Tool, with 75% of respondents from the self-completer group agreeing the advice and/or guidance they received allowed them to complete the IPM LMP without any additional support. Based on this feedback, the design of the current IPM

Tool focussed on accessibility and ease of use, enabling self-completion by the user, with both written and video guidance provided for support. Users reported they found the in-tool links to external guidance to be useful, so this feature was kept in the current tool design.

Feedback from the previous T&T reported that many users found the excel based tool too prescriptive or inflexible and the process of completing it repetitive. Also, the excel-based platform was not supported on many of the users' devices, with most of the technical advice given by the helpline focussing on software issues to get the tool to load on excel. Therefore, it was proposed that the current IPM Tool should be an online version to allow greater flexibility for software support, be more user friendly and to allow additional features to be integrated without wholesale redesign.

Design of the online version of the IPM Tool was undertaken by ADAS Software Development team with support from the Agriculture and Land Management group for technical content. The IPM Tool was designed to remove the repetitiveness of the previous version by incorporating simple click boxes for each IPM option for identified key pests, diseases and weeds for each specific crop. The IPM Tool design was developed as an end-to-end collection and report process, which was automated and streamlined as much as possible. A mock-up version of the online IPM Tool was approved by Defra in July . The IPM Tool was developed based on the following guidelines:

1. User logs in or registers on the website.
2. The user creates a farm profile and enters general farm information.
3. User selects crops applicable to the farm in the current year.
4. User selects pests for each specific crop and then enters information for each specific pest
5. User selects diseases for each crop and then enters information for each specific disease.
6. User selects weeds affecting the whole farm and then enters information for each specific weed.
7. User saves the form.
8. An administrator can extract submitted data.

The IT requirements for the system included the following:

1. Website to allow users to enter data.
2. Database to hold all the information submitted by the users.
3. Capability for administrators to retrieve data from the database.

The data storage was designed to be capable of maintaining relationships between the data inputs, and managing these relationships.

Due to the personal data added into the database, direct access to it by users and applications was avoided. Access to the database was by a secure Web API that could only be accessed through the internet. This Web API was designed to grant and restrict access to the different parts of the database depending on the authorization level and authentication of each user.

The website would connect to the Web API to interact with the database. The Web API was designed to be flexible and self-explanatory to facilitate its integration.

An application was needed for internal data management of the data of the system. This application was only used by project administrators. The IPM Tool was hosted on the domain https://ipmtool.net/

2.1.3 Identify priority crops for extending coverage of the IPM Tool

Three criteria were used for identifying priority crops:

1. Crops where IPM can provide a 'clear public good change' and 'benefit to the environment' (as per the requirements for SFI).

2. Crops at risk due to potential loss of active substances against key pests.

3. Crops which provide engagement with a wide range of farming sectors.

One of the aims of IPM is to reduce adverse impacts associated with pesticide use, but it was found there were limitations in the evidence available (listed below) to inform the use of pesticide data to prioritise crops. So, the choice of priority crops did involve some subjective judgements as well as following the specified criteria.

The limitations in the evidence were:

1. The pesticide load indicator (currently under development) might be used in future to rank crops by pesticide load, thus providing evidence for prioritising crops based on potential impacts. As this was not available, pesticide usage data was considered to help identify priority crops.

2. There was no public domain analysis of likely future regulatory losses of key active substances. The review process for active substances (a.s.) is being established in Great Britain following exit from the EU. Outcomes of future reviews (and hence impacts of losses on particular crops) are difficult to predict. Reviews are conducted at the a.s. level and may result in loss of all products containing the a.s. Crops may be at greater risk if they are currently dependent on a small number of a. s. to control key pests. The loss of chemistry by regulation is compounded by the loss of effective chemistry due to resistance. Resistance usually affects all a.s. within a mode of action. Crop may be at greater risk of loss of control, where they are currently dependent on a small number of modes of action to control key pests. These losses may be further compounded post Brexit because GB registration costs mean it will not be economically viable for some companies to place some actives on the relatively small GB market.

3. IPM is multi-factorial making it complex to gather evidence on the effectiveness and environmental impact of IPM practices. The available evidence has been reviewed, but there are many knowledge gaps.

Considering the limitations of the evidence, the following criteria for selecting priority crops were based on those likely to offer greatest gains from IPM:

1. IPM practices that are effective against the major pests driving pesticide use.

2. High dependency of a small number of active substances/modes of action for controlling key economically important pests.

3. Good evidence for the effectiveness of IPM practices.

4. Scope for increased on-farm uptake of IPM practices.

5. High pesticide treated area (area of crop x number of applications).

6. IPM practices known to have environmental benefits (either directly or via reduced need for treatment).

To inform the selection of priority crops based on the six identified criteria, evidence was collected and a consensus agreed following consultation with Defra. To identify major pests which drive pesticide usage (criteria 1), ADAS Crop Protection experts familiar with making treatment decisions ranked (1 – 5) key economically important pests for both broadacre and non-broadacre cropping in England, based on crop economic losses, potential pesticide usage and prevalence of that pest. Pests with ratings 4 and 5 were considered to be high priority.

To identify number of active substances/modes of action available against key pests (criteria 2) data was collated from the HSE (Health and Safety Executive) database and correlated with the pests with

ratings 4 and 5. Pesticide treated area was taken from the Pesticide Usage Surveys (criteria 5) and crops were ranked by treated area both across and within sectors.

Evidence was collected from the AHDB IPM broadacre (Blake *et al.,* 2021) and AHDB non- broadacre (Young *et al.,* 2022) reviews to rank IPM practices that had good evidence of effectiveness (criteria 3) and scope for increased on farm uptake (criteria 4). Using data from the reviews, IPM practices across all cropping types were included if they met all of the following criteria:

(i) Effectiveness: >= 3

(ii) Strength of evidence of effectiveness: >=4

(iii) Potential minus current use: >=1

Following identification of the key IPM practices, these were further ranked by biodiversity impact (net positive, neutral or no evidence) using the IPM on Biodiversity review produced by ADAS for Natural England (Cook *et al.,* 2022) (criteria 6). IPM practices known to have a net positive biodiversity effect were given high priority. There was some subjective judgements applied to biodiversity impacts as there is no established method to value the positive or negative effects on different aspects of biodiversity, and there are many IPM practices for which the biodiversity effects are not known. To help manage this subjectivity, (i) judgements were required on whether the net effect of a practice is positive, (ii) IPM practices with net negative effects were excluded, and (iii) absence of evidence was interpreted as neutral.

2.1.4 Define the requirements and deliver the IPM Tool online

An online format of the IPM Tool was developed for the following identified priority crops; wheat, barley, oats, combining peas, vining peas, field beans, broad beans, oilseed rape, sugar beet, apple, maize, improved grassland, potatoes (ware and seed), cabbages, cauliflower, Brussels sprout and broccoli, with a separate IPM Tool developed for each crop or crop group where pest problems and IPM interventions were considered similar across those crops (e.g. a brassicas IPM Tool for cabbages, cauliflower, Brussels sprout and broccoli).

The IPM Tool was designed for each crop to guide users to: (i) identify priority pests (invertebrates, weeds and diseases) on their farm, (ii) identify effective IPM control measures for those pests, (iii) record whether they were already implementing these IPM control measures or whether they intended to implement new IPM control measures in the short or long term. This methodology was adopted to develop a structured IPM Tool that farmers would be able to complete without additional support (apart from IPM guidance integrated within the Tool, and the written and video guidance provided). Functionality is planned to be added to the IPM Tool that will allow a report to be generated upon completion. The report forms an IPM plan, recording the IPM actions the farmer is taking or intends to take. This methodology ensured that while the focus of project participation was on enabling IPM planning, it would also provide IPM learning by going through the process of completing the IPM Tool. An additional advantage of the methodology was that while the IPM Tool was designed to be self-completed, it could also be used with farmers receiving support from either an agronomist or advisor, with information on what proportion of users sought advice from an agronomist gathered as part of the feedback in WP5.

The AHDB IPM broadacre (Blake *et al.,* 2021) and AHDB non-broadacre (Young *et al.,* 2022) reviews identified IPM interventions that are effective at controlling specific pests (weeds, invertebrates and pathogens) in the priority crops. For the identified priority crops not included in the AHDB IPM reviews (sugar beet, maize and improved grassland), IPM interventions were collected through consultation with crop experts within ADAS and SRUC, and by reference to associated literature and guidance available for those crops. The collated IPM interventions for all the priority crops were then further reviewed by crop, invertebrate pest, weed and disease experts within ADAS who identified those actions not currently commercially available or of very low or unknown effectiveness. These were

removed from consideration for inclusion in the IPM Tool. The final list of interventions formed the basis of the IPM Tool and the guidance within it, so the tool: (i) guided farmers immediately towards useful control measures, (ii) provided a brief summary of about the control measures, and (iii) enabled the farmer to record whether they already implement each control measure or intend or not to implement the control measure, or it is unsuitable for their farming system.

The IPM Tool was ready for participant testing for wheat, barley, oats, improved grassland and potatoes on 12 December 2022. A sub-group of 73 random participants, from those that indicated they grow these crop groups in the initial survey, were selected to test these first versions of the IPM Tool. The front page of the IPM Tool provided the user links to the accompanying guidance to assist them in completing the tool, including instructional video guidance on how to complete the IPM Tool, video guidance on IPM strategies for arable, grassland and horticulture cropping groups , and crop specific IPM written guidance (see WP2 for details on guidance). An email helpline IPM@adas.co.uk was made available to users for those that needed support logging in to the IPM Tool. Participants were requested to complete the IPM Tool for more than one crop type, depending on their crops grown, by 1 January 2023. Following initial feedback from this sub-group, a navigation panel was added to the IPM Tool so users could select separate sections of the tool (ie weed, pest, disease issues and control pages) for each crop without having to move through each separate subsequent page within the tool.

The crop groups of peas, beans, oilseed rape were added to the IPM Tool for testing on 22 December and sugar beet on 12 January 2023. For these versions of the IPM Tool, a sub-group of 50 and 42 participants respectively were requested to complete the IPM Tool for more than one crop type, depending on their crops grown, by 30 January 2023. All remaining 100 participants that indicated they grow either wheat, barley, oats, improved grassland, potatoes, peas, beans, oilseed rape or sugar beet on the initial survey were invited to complete the IPM Tool on 25 January 2023. The final version of the IPM Tool that included apples and brassicas was completed on 31 January 2023, with 48 participants that indicated they grow these crops invited to complete the tool by 15 February 2023. There was an extended final completion date for all those previously invited to complete the IPM Tool but not registered of the 21 February 2023.

2.1.5 Link the IPM Decision Making Tool with mapping

The ability to select and allocate farm areas through a mapping component was built into the online IPM Tool, allowing spatial recognition of farm areas. The mapping platform used was RPA online maps, accessed using farm CPH and SBI numbers, with the associated license provided by Defra. Land parcels were allocated to a number of planned IPM interventions dependent on cropping within that parcel. This functionality was incorporated after construction of the online IPM Tool and participants who had previously completed the IPM Tool without the mapping functionality were invited to test this functionality and provide feedback through a short survey.

2.1.6 Creation of a report function to summarise the results of IPM planning

Reporting functionality was built into the IPM Tool to enable participants to summarise their answers in a printable format (by using print webpage within the browser). The report highlighted any crop pest issues which had been identified which did not have an appropriate control intervention selected as priorities for review through highlighting and bold font. Other responses were recorded as to the proposed time scale of adoption of intervention. This functionality was incorporated after construction of the online IPM Tool and participants who had previously completed the IPM Tool without the mapping functionality were invited to test this functionality and provide feedback through a short survey.

2.2 WP 1 RESULTS

2.2.1 Identify priority crops for extending coverage of the IPM Tool

ADAS crop protection experts familiar with making treatment decisions ranked (1 – 5) key economically important pests for both broadacre (Table 2.2) and non-broadacre crops (Table 2.3 to Table 2.8). Pests which ranked 4 and 5 were considered high priority and key pests.

Table 2.2: Pest Rankings for Broadacre Crops

Crop	Category Disease (D) Weed (W) Insect Pest (P)	Factor	Pest Ranking (1 - 5)
Cereals	W	Annual Grasses	5
Cereals	W	BLW - Tap Root	2
Cereals	W	All Weeds Pre-Emergence	5
Cereals	W	BLW - Fibrous Root	2
Cereals	W	Volunteer Potatoes	2
Cereals	P	BYDV Vectors	4
Cereals	P	Wheat Bulb Fly	3
Cereals	P	Slugs	4
Cereals	D	Septoria	5
Cereals	D	Yellow Rust	5
Cereals	D	Brown Rust	3
Cereals	D	Ear Blight	4
Cereals	D	Take-All	2
OSR	W	Annual Grasses	5
OSR	W	BLW - Tap Root	4
OSR	W	BLW - Fibrous Root	4
OSR	P	TuYV Vectors	4
OSR	P	Pollen Beetle	3
OSR	P	Cabbage Stem Flea Beetle	5
OSR	P	Slugs	3
OSR	D	Light Leaf Spot	5
OSR	D	Phoma Stem Canker	4
OSR	D	Clubroot	3
OSR	D	Sclerotinia Stem Rot	3
OSR	D	Verticillium Wilt	2
Potatoes	W	BLW - Fibrous Root	5
Potatoes	W	BLW - Tap Root	5
Potatoes	W	All Weeds Pre-Emergence	4
Potatoes	W	Annual Grasses	4
Potatoes	P	Potato Cyst Nematode	5 *(5)
Potatoes	P	Viruses (Aphid Borne)	2 *(5)
Potatoes	P	FLN and Spraing	3 *(3)
Potatoes	P	Wireworm	4 *(4)

Potatoes	D	Late Blight	5
Potatoes	D	Blackleg	5
Potatoes	D	Stem Canker and Black Scurf	2
Potatoes	D	Black Dot	3
Potatoes	D	Common Scab	4
Potatoes	D	Gangrene	3
Potatoes	D	Powdery Scab	4
Potatoes	D	Silver Scurf	3
Potatoes	D	Dry Rot	3
Potatoes	D	Storage Diseases	4
Potatoes	D	Viruses (Soil Borne)	3

*Need to consider ware and seed potatoes for pests (value for seed in brackets).

Table 2.3: Pest Rankings for Soft Fruit Crops

Crop	Category Disease (D) Weed (W) Insect Pest (P)	Factor	Pest Ranking (1 - 5)
Grapevine	W	Annual broad-leaved various	5
Grapevine	W	Annual grasses various	3
Grapevine	W	All weeds pre-emergence	3
Grapevine	P	Spotted winged drosophila	5
Grapevine	P	Moths	3
Grapevine	D	Downy Mildew	4
Grapevine	D	Botrytis	4
Grapevine	D	Powdery mildew	4
Grapevine	D	ESCA stem and root dieback	3
Strawberry	W	Perennial grasses	3
Strawberry	W	Perennial broad-leaved, various	4
Strawberry	W	Annual broad-leaved various	4
Strawberry	W	Annual grasses various	3
Strawberry	W	All weeds pre-emergence	5
Strawberry	P	Spotted winged drosophila	4
Strawberry	P	Thrips	4
Strawberry	P	Aphids	5
Strawberry	P	Vine weevil	3
Strawberry	P	Strawberry blossom weevil	3
Strawberry	D	Phytophthora spp	3
Strawberry	D	Powdery mildew	5
Strawberry	D	Botrytis	5
Strawberry	D	Verticillium	3
Strawberry	D	Colletotrichum	3
Raspberry	W	Perennial grasses	5
Raspberry	W	Perennial broad-leaved, various	4
Raspberry	W	Annual broad-leaved various	4
Raspberry	W	Annual grasses various	3
Raspberry	W	All weeds pre-emergence	4

Raspberry	P	Raspberry cane midge	5
Raspberry	P	Blackberry leaf midge	4
Raspberry	P	Spotted winged drosophila	5
Raspberry	P	Aphids	3
Raspberry	P	Raspberry leaf & bud mite	4
Raspberry	D	Phytophthora spp	3
Raspberry	D	Botrytis (cane & fruit)	5
Raspberry	D	Powdery mildew	3
Raspberry	D	Cane blight	3
Raspberry	D	Yellow rust	2

Table 2.4: Pest Rankings for Top Fruit Crops

Crop	Category Disease (D) Weed (W) Insect Pest (P)	Factor	Pest Ranking (1 - 5)
Apple	W	Perennial grasses	4
Apple	W	Perennial broad-leaved, various	4
Apple	W	Annual broad-leaved various	4
Apple	W	Annual grasses various	4
Apple	P	Aphids	4
Apple	P	Fruit tree spider mite	4
Apple	P	Lepidopterous caterpillars	5
Apple	D	Apple Scab	5
Apple	D	Canker	3
Apple	D	Powdery mildew	4
Apple	D	Replant disease	3
Pear	W	Perennial grasses	4
Pear	W	Perennial broad-leaved, various	4
Pear	W	Annual broad-leaved various	4
Pear	W	Annual grasses various	4
Pear	P	Pear sucker	5
Pear	P	Lepidopterous caterpillars	5
Pear	D	Pear Scab	5
Pear	D	Canker	3.

Table 2.5: Pest Rankings for Field Vegetable Crops

Crop	Category Disease (D) Weed (W) Insect Pest (P)	Factor	Pest Ranking (1 - 5)
Carrot	W	Perennial grasses	3
Carrot	W	Perennial broad-leaved, various	4
Carrot	W	Annual broad-leaved various	4
Carrot	W	Annual grasses various	3

Carrot	W	All weeds (pre-emergence)	5
Carrot	P	Aphids	4
Carrot	P	Carrot Fly	5
Carrot	P	Free Living Nematodes	3
Carrot	D	Alternaria	4
Carrot	D	Cavity Spot	5
Carrot	D	Powdery Mildew	3
Onion	W	Perennial grasses	3
Onion	W	Broad leaved weeds - tap root	4
Onion	W	Broad leaved weeds - fibrous root	4
Onion	W	Annual grasses various	3
Onion	W	All weeds (pre-emergence)	5
Onion	P	Bean seed fly	3
Onion	P	Thrips	5
Onion	P	Stem nematode	3
Onion	D	Fusarium basal rot	4
Onion	D	White rot	4
Onion	D	Downy Mildew	5

Table 2.6: Pest Rankings for Endive & Lettuce Crops.

Crop	Category Disease (D) Weed (W) Insect Pest (P)	Factor	Pest Ranking (1 - 5)
Endive & Lettuce	W	Perennial grasses	3
Endive & Lettuce	W	Annual broad-leaved various	4
Endive & Lettuce	W	Broad leaved weeds	4
Endive & Lettuce	W	All weeds (pre-emergence)	5
Endive & Lettuce	P	Aphids	5
Endive & Lettuce	P	Caterpillars	4
Endive & Lettuce	D	*Sclerotinia sclerotiorum*	3
Endive & Lettuce	D	Grey Mould	4
Endive & Lettuce	D	Rhizoctonia bottom rot (*R. solani*)	3
Endive & Lettuce	D	Downy Mildew	5

Table 2.7: Pest Rankings for Brassica Crops.

Crop	Category Disease (D) Weed (W) Insect Pest (P)	Factor	Pest Ranking (1 - 5)
Leafy Brassicas	W	Perennial grasses	3
Leafy Brassicas	W	Broad leaved weeds - tap root	4
Leafy Brassicas	W	Broad leaved weeds - fibrous root	4
Leafy Brassicas	W	Annual grasses various	3
Leafy Brassicas	W	All weeds (pre-emergence)	5

Leafy Brassicas	P	Aphids	4
Leafy Brassicas	P	Caterpillars	5
Leafy Brassicas	P	Cabbage Root Fly	3
Leafy Brassicas	D	Ringspot	3
Leafy Brassicas	D	Dark leaf spot - Alternaria	3
Leafy Brassicas	D	Light Leaf spot	4
Leafy Brassicas	D	Xanthomonas	5
Leafy Brassicas	D	Downy Mildew	3
Root Brassicas	W	Perennial grasses	3
Root Brassicas	W	Broad leaved weeds - tap root	4
Root Brassicas	W	Broad leaved weeds - fibrous root	4
Root Brassicas	W	Annual grasses various	3
Root Brassicas	W	All weeds (pre-emergence)	5
Root Brassicas	P	Aphids	4
Root Brassicas	P	Caterpillars	5
Root Brassicas	P	Cabbage Root Fly	3
Root Brassicas	D	Clubroot	3
Root Brassicas	D	Phoma leaf spot / canker	5
Root Brassicas	D	Scab	4

Table 2.8: Pest Rankings for Arable Crops.

Crop	Category Disease (D) Weed (W) Insect Pest (P)	Factor	Pest Ranking (1 - 5)
Rye & Triticale	W	Annual Grasses	5
Rye & Triticale	P	Aphids (BYDV)	5
Rye & Triticale	D	Yellow Rust	5*
Rye & Triticale	D	Brown Rust	5*
Rye & Triticale	D	Ergot	3
Rye & Triticale	D	Powdery Mildew	2
Beans, dry & fresh	W	Annual Grasses	5
Beans, dry & fresh	W	Broad leaf weeds	4
Beans, dry & fresh	P	Bruchid beetle	4
Beans, dry & fresh	P	Bean weevil	5
Beans, dry & fresh	P	Black bean aphid	4
Beans, dry & fresh	D	Botrytis	5
Beans, dry & fresh	D	Rust	5
Beans, dry & fresh	D	Sclerotinia	2
Peas, dry & fresh	W	Annual Grasses	5
Peas, dry & fresh	W	Broad leaf weeds	5
Peas, dry & fresh	P	Pea aphid	4
Peas, dry & fresh	P	Pea moth	4
Peas, dry & fresh	D	Botrytis	5
Peas, dry & fresh	D	Leaf spot	3
Peas, dry & fresh	D	Downy Mildew	4

Fodder Crops	W	Fat Hen	5
Fodder Crops	W	Nettle	4
Fodder Crops	W	Thistle	3
Fodder Crops	P	Flea beetle	4
Fodder Crops	P	Cabbage root fly	4
Fodder Crops	P	Flax flea beetle	4
Fodder Crops	D	Clubroot	5
Fodder Crops	D	Rhizoctonia	3
Fodder Crops	D	Mildew	4

*Yellow rust main disease of triticale. Brown Rust main disease of Rye.

IPM practices from the broadacre and non-broadacre reviews were selected that met all of the following criteria: (i) Effectiveness: >= 3, (ii) Strength of evidence of effectiveness: >=4, and (iii) Potential minus current use: >=1. For broadacre crops the number of IPM methods identified were 40 for oilseed rape, 40 for potatoes, 25 for cereals (Table 2.9). For non-broadacre crops the number of IPM methods identified were 81 for strawberry, 76 for raspberry, 48 for leaf brassicas, 47 for grapevine, 39 for fodder crops, 37 for endive and lettuce, 37 for apple, 32 for carrot, 31 for onion, 24 for pear, 19 for rye and triticale, 13 for beans and 10 for peas (Table 2.10).

Table 2.9: IPM methods above criteria for broadacre crops

Crop	No. IPM methods above criteria	Average Effectiveness (1-5)	Average Strength of the evidence (1-5)	Average P - C Use (1-5)
Oilseeds	40	3.8	4.4	1.3
Potatoes	40	3.7	4.0	1.3
Cereals	25	3.7	4.2	1.3

Table 2.10: IPM methods above criteria for non broadacre crops.

Crop	No. IPM methods above criteria	Average Effectiveness (1-5)	Average Strength of the evidence (1-5)	Average P - C Use (1-5)
Strawberry	81	3.8	4.5	1.4
Raspberry	76	3.9	4.6	1.3
Leaf Brassicas	48	3.7	4.1	1.5
Grape Vine	47	3.8	4.5	1.4
Fodder Crops	39	4.0	4.4	2.3
Root Brassicas	37	3.7	4.2	1.4
Endive/Lettuce	37	3.6	4.2	1.4
Apple	37	3.6	4.4	1.5
Carrot	32	3.8	4.2	1.5
Onion	31	3.8	4.1	1.6
Pear	24	3.7	4.5	1.3
Rye & Triticale	19	4.4	4.1	1.8
Beans	13	3.9	4.2	2.2
Peas	10	4.0	4.2	2.0

The identified IPM methods were ranked against the biodiversity review to identify those that were net positive, negative or neutral/lack of evidence for impact on biodiversity (Table 2.11 to Table 2.27).

Note that the analysis was based on a draft version of the review, so some specific findings may change. Crops not included in the biodiversity review were potato, grapevines, strawberry, raspberry, peas and beans. For these crops, the biodiversity impacts were included if an action was non crop specific in the review or were otherwise categorised as 'lack of evidence'. Most IPM practices were ranked as neutral as there was a lack of available evidence on whether or not such practices would have net positive or negative effect on biodiversity.

Field history, rotation and break crops were ranked as positive as there was an overall balance between net positive effects over negative. Some individual crops had their own effects on biodiversity like oilseed rape, potatoes and spring cropping, with relevant comments included in the tables. The review found that a varied rotation including spring and winter sown crops, grassland and fallow provides a wide range of habitats and food sources, however, a varied rotation alone is not enough to support a wide range of biodiversity, and additional non crop areas such as margins, hedgerows and woodland are necessary to provide year-round opportunities (Cook et al., 2022).

Decision support methods were ranked as neutral as there was no evidence to show that these methods provide either a direct improvement or hindrance to biodiversity in farmlands (Cook et al., 2022). Using these methods has the potential to reduce pesticide use, although there is little evidence available to show how reducing pesticide use directly improves biodiversity.

Net positive practices which could improve biodiversity included use of fallow land or set aside, minimum tillage methods, use of field margins, stubble management, forecasting, use of crop covers, and under-sowing and companion cropping. Net negative practices included the use of ploughing, deep non-inversion tillage and mechanical weeding.

Table 2.11: IPM methods and biodiversity impacts for cereals.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Varietal Choice	9	Neutral	Lack of evidence
Sowing date	4	Neutral	Delayed drilling can be effective in reducing weed, pest and disease levels
Nutrient management	1	Neutral	Lack of evidence
Hygiene and prevention	2	Neutral	Lack of evidence
Secondary cultivations (drilling method)	2	Positive	Min till methods better for biodiversity than deep tillage methods
Seed rate	2	Neutral	Lack of evidence
Decision support (including thresholds)	1	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Field history, rotation & break crops	1	Positive	Positive where additional non crop areas such as margins, hedgerows and woodland are included. Spring cropping decreases populations of Arthropods but can improve population of non-target plant species

Primary cultivations (crop residue burial)	1	Negative	Ploughing and deep non-inversion tillage damages insect populations and reduces soil organic matter
Seed testing	1	Neutral	Lack of evidence
Stubble management	1	Positive	Retaining a stubble after the harvest of the crop is already part of current environmental schemes

Table 2.12: IPM methods and biodiversity impacts for oilseed rape.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Varietal Choice	7	Neutral	Lack of evidence
Decision support (including thresholds)	6	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Field history, Rotation & break crops	4	Positive	Positive where additional non crop areas such as margins, hedgerows and woodland are included. Oilseed rape provides a source of nectar and pollen for beneficial insects
Hygiene and prevention	4	Neutral	Lack of evidence
Select low-risk locations	3	Neutral	Lack of evidence
Stubble management	3	Positive	Retaining a stubble after the harvest of the crop is already part of current environmental schemes
Primary cultivations (crop residue burial)	3	Negative	Ploughing and deep non-inversion tillage damages insect populations and reduces soil organic matter
Secondary cultivations (drilling method)	2	Positive	Min till methods better for biodiversity than deep tillage methods
Seed rate	2	Neutral	Lack of evidence
Sowing date	2	Neutral	Lack of evidence
Good drainage	1	Neutral	Lack of evidence
Lime	1	Neutral	Lack of evidence
Spatial separation	1	Neutral	Lack of evidence
Thermal control	1	Neutral	Lack of evidence

Table 2.13: IPM methods and biodiversity impacts for potato.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Field history, Rotation & break crops	7	Neutral	Potatoes in rotation can decrease populations of arthropods
Control volunteers & weeds	5	Neutral	Lack of evidence
Early harvest	5	Neutral	Lack of evidence
Varietal Choice	5	Neutral	Lack of evidence
Hygiene and prevention	3	Neutral	Lack of evidence
Mechanical weeding	2	Negative	Harmful to ground nesting species
Primary cultivations (crop residue burial)	2	Negative	Ploughing and deep non-inversion tillage damages insect populations and reduces soil organic matter
Seedbed quality	2	Neutral	Lack of evidence
Select low-risk locations	2	Neutral	Lack of evidence
Bioprotection + low risk PPP's	1	Neutral	Lack of evidence
Decision support (including thresholds)	1	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Good drainage	1	Neutral	Lack of evidence
Seed testing	1	Neutral	Lack of evidence
Sowing date	1	Neutral	Lack of evidence
Spatial separation	1	Neutral	Lack of evidence
Trap crops	1	Neutral	Lack of evidence

Table 2.14: IPM methods and biodiversity impacts for grapevine.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Hygiene and prevention	13	Neutral	Lack of evidence
Defoliation (incl. pruning, mowing, grazing)	6	Neutral	Lack of evidence
Select low-risk locations	5	Neutral	Lack of evidence

Decision support, incl. monitoring	4	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Control volunteers & weeds	3	Neutral	Lack of evidence
Environmental control (including overhead protection)	3	Neutral	Lack of evidence
Seed and young plant testing	3	Neutral	Lack of evidence
Nutrient management	2	Neutral	Lack of evidence
UV-C	2	Neutral	Lack of evidence
Variety choice/Breeding	2	Neutral	Lack of evidence
Bioprotectants microbial	1	Neutral	Lack of evidence
Bioprotectants semiochemical	1	Neutral	Lack of evidence
Physical exclusion of pests	1	Positive	Use of crop covers improves biodiversity for birds, mammals, arthropods and protected species.
Pre-plant soil tests	1	Neutral	Lack of evidence

Table 2.15: IPM methods and biodiversity impacts for raspberry

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Hygiene and prevention	25	Neutral	Lack of evidence
Defoliation (incl. pruning, mowing, grazing)	9	Neutral	Lack of evidence
Decision support, incl. monitoring	7	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Biennial cropping	5	Neutral	Lack of evidence
Environmental control (including overhead protection)	5	Neutral	Lack of evidence

Control volunteers & weeds	3	Neutral	Lack of evidence
Hand weeding/roguing	3	Neutral	Lack of evidence
Phytosanitary legislation	3	Neutral	Lack of evidence
Seed and young plant testing	3	Neutral	Lack of evidence
Variety choice/Breeding	3	Neutral	Lack of evidence
Biosecurity / industry regulation	1	Neutral	Lack of evidence
Drainage	1	Neutral	Lack of evidence
Mass monitoring (e.g. roller traps) or Suction	1	Neutral	Lack of evidence
Physical exclusion of pests	1	Positive	Use of crop covers improves biodiversity for birds, mammals, arthropods and protected species.
Precision irrigation	1	Neutral	Lack of evidence
Removal of alternative hosts	1	Neutral	Lack of evidence
Select low-risk locations	1	Neutral	Lack of evidence
Spatial separation	1	Neutral	Lack of evidence
Substrate	1	Neutral	Lack of evidence
Test & treat irrigation water	1	Neutral	Lack of evidence

Table 2.16: IPM methods and biodiversity impacts for strawberry.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Hygiene and prevention	24	Neutral	Lack of evidence
Defoliation (incl. pruning, mowing, grazing)	6	Neutral	Lack of evidence
Control volunteers & weeds	4	Neutral	Lack of evidence
Decision support, incl. monitoring	4	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Environmental control (including	4	Neutral	Lack of evidence

overhead protection)			
Precision irrigation	4	Neutral	Lack of evidence
Seed and young plant testing	4	Neutral	Lack of evidence
Clean stock	3	Neutral	Lack of evidence
Hand weeding/rouging	3	Neutral	Lack of evidence
Hot water dipping	3	Neutral	Lack of evidence
Variety choice/Breeding	3	Neutral	Lack of evidence
Nutrient management	2	Neutral	Lack of evidence
Physical exclusion of pests	2	Positive	Use of crop covers improves biodiversity for birds, mammals, arthropods and protected species.
Plant sauna	2	Neutral	Lack of evidence
Select low-risk locations	2	Neutral	Lack of evidence
Bioprotectants invertebrate biocontrols	1	Neutral	Lack of evidence
Drainage	1	Neutral	Lack of evidence
Mass monitoring (e.g. roller traps) or Suction	1	Neutral	Lack of evidence
Organic amendments	1	Neutral	Lack of evidence
Pre-plant soil tests	1	Neutral	Lack of evidence
Primary cultivations (crop residue burial)	1	Negative	Ploughing and deep non-inversion tillage damages insect populations and reduces soil organic matter
Removal of alternative hosts	1	Neutral	Lack of evidence
Sowing or planting date	1	Neutral	Lack of evidence
Substrate	1	Neutral	Lack of evidence
Test & treat irrigation water	1	Neutral	Lack of evidence
UV-C	1	Neutral	Lack of evidence

Table 2.17: IPM methods and biodiversity impacts for apple.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments

Hygiene and prevention	8	Neutral	Lack of evidence
Mechanical weeding	4	Negative	Can damage roots of trees
Bioprotectants Microbial	3	Neutral	Lack of evidence
N management	3	Neutral	Lack of evidence
Pruning/canopy management	3	Neutral	Lack of evidence
Bioprotectants Macrobiological	2	Neutral	Lack of evidence
Biostimulants & elicitors	2	Neutral	Lack of evidence
Decision support, incl. monitoring	2	Positive	Increased numbers of beneficial insect populations by avoiding unnecessary pesticide applications
Forecasting	2	Positive	Increased numbers of beneficial insect populations by avoiding unnecessary pesticide applications
Bioprotectants Botanical	1	Neutral	Lack of evidence
Bioprotectants Semiochemical	1	Neutral	Lack of evidence
Field history, rotation & break crops	1	Positive	Positive where additional non crop areas such as margins, hedgerows and woodland are included
Microbial bioprotectants	1	Neutral	Lack of evidence
Nutrient management	1	Neutral	Lack of evidence
Select low-risk locations	1	Neutral	Lack of evidence
Undersowing & Companion cropping	1	Positive	Increasing the number of plant/crop species increases beneficial populations
Variety choice / root stock choice	1	Neutral	Lack of evidence

Table 2.18: IPM methods and biodiversity impacts for pear.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Hygiene and prevention	9	Neutral	Lack of evidence
Mechanical weeding	4	Negative	Can damage roots of trees
Nutrient management	3	Neutral	Lack of evidence

Bioprotectants Botanical	2	Neutral	Lack of evidence
Variety choice / root stock choice	2	Neutral	Lack of evidence
Bioprotectants Microbial	1	Neutral	Lack of evidence
Bioprotectants Semiochemical	1	Neutral	Lack of evidence
Biostimulants & elicitors	1	Neutral	Lack of evidence
Pruning/canopy management	1	Neutral	Lack of evidence

Table 2.19: IPM methods and biodiversity impacts for carrot.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Hygiene and prevention	9	Neutral	Lack of evidence
Select low-risk locations	5	Neutral	Lack of evidence
Precision irrigation	3	Neutral	Lack of evidence
Decision support, incl. monitoring	2	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Field history, rotation & break crops	2	Positive	Positive where additional non crop areas such as margins, hedgerows and woodland are included
Variety choice	2	Neutral	Lack of evidence
Alternative seed treatments	1	Neutral	Lack of evidence
Bioprotectants Microbial	1	Neutral	Lack of evidence
Commodity substances/salts	1	Neutral	Lack of evidence
Control volunteers & weeds	1	Neutral	Lack of evidence
Early harvest	1	Neutral	Lack of evidence
Environmental control	1	Neutral	Lack of evidence

Fallow	1	Positive	Fallow land or set aside has been shown to be beneficial to bird populations
Growing in substrate not soil	1	Neutral	Lack of evidence
Mechanical weeding	1	Negative	Harmful to ground resting species

Table 2.20: IPM methods and biodiversity impacts for onion.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Hygiene and prevention	6	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Select low-risk locations	5	Neutral	Lack of evidence
Decision support, incl. monitoring	3	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Mechanical weeding	3	Negative	Harmful to ground nesting species
Precision irrigation	3	Neutral	Lack of evidence
Pre-plant soil tests	3	Neutral	Lack of evidence
Variety choice	2	Neutral	Lack of evidence
Alternative seed treatments	1	Neutral	Lack of evidence
Environmental control	1	Neutral	Lack of evidence
Hand weeding/roguing	1	Neutral	Lack of evidence
Seed and young plant testing	1	Neutral	Lack of evidence
Sowing or planting date	1	Neutral	Lack of evidence
Trap crops	1	Neutral	Lack of evidence

Table 2.21: IPM methods and biodiversity impacts for endive and lettuce.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments

Hygiene and prevention	7	Neutral	Lack of evidence
Select low-risk locations	7	Neutral	Lack of evidence
Mechanical weeding	4	Negative	Harmful to ground nesting species
Precision irrigation	4	Neutral	Lack of evidence
Field history, rotation & break crops	3	Positive	Positive where additional non crop areas such as margins, hedgerows and woodland are included
Decision support, incl. monitoring	2	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Fallow	2	Positive	Fallow land or set aside has been shown to be beneficial to bird populations
Pre-plant soil tests	2	Neutral	Lack of evidence
Spatial separation	2	Neutral	Lack of evidence
Bioprotectants Microbial	1	Neutral	Lack of evidence
Environmental control	1	Neutral	Lack of evidence
Growing in substrate not soil	1	Neutral	Lack of evidence
Physical exclusion of pests	1	Positive	Use of crop covers improves biodiversity for birds, mammals, arthropods and protected species.

Table 2.22: IPM methods and biodiversity impacts for leaf brassicas.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Select low-risk locations	9	Neutral	Lack of evidence
Hygiene and prevention	6	Neutral	Lack of evidence
Precision irrigation	6	Neutral	Lack of evidence
Decision support, incl. monitoring	5	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management

Mechanical weeding	5	Negative	Harmful to ground resting species
Field history, rotation & break crops	4	Positive	Positive where additional non crop areas such as margins, hedgerows and woodland are included
Spatial separation	4	Neutral	Lack of evidence
Variety choice	4	Neutral	Lack of evidence
Fallow	3	Positive	Fallow land or set aside has been shown to be beneficial to bird populations
Alternative seed treatments	1	Neutral	Lack of evidence
Bioprotectants Microbial	1	Neutral	Lack of evidence

Table 2.23: IPM methods and biodiversity impacts for root brassicas.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Select low-risk locations	7	Neutral	Lack of evidence
Hygiene and prevention	6	Neutral	Lack of evidence
Mechanical weeding	5	Negative	Harmful to ground resting species
Decision support, incl. monitoring	4	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Precision irrigation	4	Neutral	Lack of evidence
Field history, rotation & break crops	3	Positive	Positive where additional non crop areas such as margins, hedgerows and woodland are included
Fallow	2	Positive	Fallow land or set aside has been shown to be beneficial to bird populations
Seed and young plant testing	2	Neutral	Lack of evidence
Spatial separation	2	Neutral	Lack of evidence

Bioprotectants Microbial	1	Neutral	Lack of evidence
Pre-plant soil tests	1	Neutral	Lack of evidence

Table 2.24: IPM methods and biodiversity impacts for rye and triticale.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Control volunteers & weeds	4	Neutral	Lack of evidence
Hygiene and prevention	2	Neutral	Lack of evidence
Primary cultivations (crop residue burial)	2	Negative	Ploughing and deep non-inversion tillage damages insect populations and reduces soil organic matter
Sowing or planting date	2	Neutral	Lack of evidence
Variety choice	2	Neutral	Lack of evidence
Decision support, incl. monitoring	1	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Field history, rotation & break crops	1	Positive	Positive where additional non crop areas such as margins, hedgerows and woodland are included
Nutrient management	1	Neutral	Lack of evidence
Pre-cropping nutrition	1	Neutral	Lack of evidence
Secondary cultivations (drilling method)	1	Positive	Min till methods better for biodiversity than deep tillage methods
Seed and young plant testing	1	Neutral	Lack of evidence
Seed rate (incl. variable seed rate)	1	Neutral	Lack of evidence

Table 2.25: IPM methods and biodiversity impacts for beans.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Decision support, incl. monitoring	4	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to

			reduce pesticide usage through improved pest management
Select low-risk locations	2	Neutral	Lack of evidence
Variety choice	2	Neutral	Lack of evidence
Hygiene and prevention	1	Neutral	Lack of evidence
Microbial bioprotectants	1	Neutral	Lack of evidence
Primary cultivations (crop residue burial)	1	Negative	Ploughing and deep non-inversion tillage damages insect populations and reduces soil organic matter
Secondary cultivations (drilling method)	1	Positive	Min till methods better for biodiversity than deep tillage methods
Spatial separation	1	Neutral	Lack of evidence

Table 2.26: IPM methods and biodiversity impacts for peas.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Variety choice	3	Neutral	Lack of evidence
Decision support, incl. monitoring	2	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Field history, rotation & break crops	1	Positive	Positive where additional non crop areas such as margins, hedgerows and woodland are included. Spring peas shown to increase bee and arthropod populations
Hygiene and prevention	1	Neutral	Lack of evidence
Primary cultivations (crop residue burial)	1	Negative	Ploughing and deep non-inversion tillage damages insect populations and reduces soil organic matter
Secondary cultivations (drilling method)	1	Positive	Min till methods better for biodiversity than deep tillage methods
Select low-risk locations	1	Neutral	Lack of evidence

Table 2.27: IPM methods and biodiversity impacts for fodder crops.

Strategy	No. of potential use of IPM methods	Biodiversity Impact	Comments
Field history, rotation & break crops	8	Positive	Positive where additional non crop areas such as margins, hedgerows and woodland are included
Decision support, incl. monitoring	5	Neutral	These methods do not provide a direct improvement or hindrance to biodiversity in farmlands. Potential to reduce pesticide usage through improved pest management
Select low-risk locations	4	Neutral	Lack of evidence
Fallow	2	Positive	Fallow land or set aside has been shown to be beneficial to bird populations
Hygiene and prevention	2	Neutral	Lack of evidence
Lime	2	Neutral	Lack of evidence
Pre-plant soil tests	2	Neutral	Lack of evidence
Primary cultivations (crop residue burial)	2	Negative	Ploughing and deep non-inversion tillage damages insect populations and reduces soil organic matter
Removal of alternative hosts	2	Neutral	Lack of evidence
Secondary cultivations (drilling method)	2	Positive	Min till methods better for biodiversity than deep tillage methods
Seed rate (incl. variable seed rate)	2	Neutral	Lack of evidence
Spatial separation	2	Neutral	Lack of evidence
Hand weeding/rouging	1	Neutral	Lack of evidence
Nutrient management	1	Neutral	Lack of evidence
Stubble management	1	Positive	Retaining a stubble after the harvest of the crop is already part of current environmental schemes
Variety choice	1	Neutral	Lack of evidence

Pesticide treated area was collated from the Pesticide Usage Surveys and crops were ranked by treated area both across and within sectors (Table 2.28). For each cropping sector the following crops were included; Cereals: wheat, barley, oats, rye and triticale; Orchards: apple, pears, apricot, cherry plum and quince; Pulses (combinable): combing pea and field bean; Peans and Beans: vining pea and broad bean; Brassicas: cabbage, cauliflower, Brussels sprout, broccoli, collard, kale and oriental cabbages; Other Fodder Crops: fodder beet, fodder rape, swede and turnip; Other Vegetable: asparagus,

aubergine, courgette and summer squash; Other Soft Fruit: bilberry, cherry, blackberry, blackcurrant, redcurrant, blueberry, cranberry, gooseberry, raspberry, table grapes and wine grapes; Lettuce, Endive, Radicchio: baby leaf, balm, basil, bay, chicory, choi sum, endive, horseradish, lettuce, rocket, chervil, chives, coriander leaves and mustard.

Cereals represented the largest treated area (68.1%), followed by oilseeds, potatoes, sugar beet, combinable pulses and grassland (2.1 – 8.2%). Maize and orchards represented 1.0 to 1.4%, and all other crops were below 1% treated area. Note: IPM information for sugar beet, improved grassland, maize or other vegetables was not available from the reviews.

Table 2.28: Pesticide treated area across cropping sectors.

	Fungicide Treated area (ha)			
Cropping Sector	Fungicide	Insecticide	Herbicide	**Total (= % of total area)**
Cereals	20,974,867	961,138	13,823,770	35,759,774 (68.1%)
Oilseeds	1,314,149	892,119	2,110,867	4,317,135 (8.2%)
Potatoes	2,978,782	231,979	705,484	3,916,246 (7.5%)
Sugar Beet	770,191	252,336	1,673,045	2,695,572 (5.1%)
Pulses (Combinable)	475,403	355,872	824,823	1,656,098 (3.2%)
Grassland	14,643	216	1,107,364	1,122,222 (2.1%)
Maize	68,655	4,139	656,633	729,427 (1.4%)
Orchards (Apples, pears etc).	411,623	73,330	40,633	525,586 (1.0%)
Peas and beans	125,777	67,571	154,267	347,615 (0.7%)
Onions and Leeks	227,223	27,354	27,354	281,930 (0.5%)
Brassicas	75,905	92,039	62,260	230,204 (0.4%)
Carrots, Parsnips, Celery	25,183	89,748	81,171	196,103 (0.4%)
Other Fodder Crops	60,739	15,487	73,287	149,514 (0.3%)
Other Vegetable	61,143	26,698	50,209	138,050 (0.3%)
Other Soft Fruit (raspberry, grapevine etc).	91,068	17,622	19,078	127,767 (0.2%)
Strawberry	99,773	16,759	3,408	119,940 (0.2%)

Number of available active ingredients (Table 2.29) and modes of action (Table 2.30) was collated from the Health and Safety Executive (HSE) database and crops were ranked both across and within sectors. Cereals showed the highest number of active ingredients available (135), followed by potatoes (69) and oilseeds (61). The cropping sectors with the three lowest numbers of actives were pea and beans (21), onions and leeks (20) and lettuce, endive, radicchio (15).

Cereals showed the highest number of modes of action available (26), followed by potatoes (24) and oilseeds (22). The cropping sectors with the three lowest modes of action were sugar beet (9), grassland (9), pea and beans (9), lettuce, endive, radicchio (9), maize (7) and fodder crops (6).

Table 2.29: Number of active ingredients available across cropping sectors.

	No. of Active Ingredients			
Cropping Sector	Fungicide	Insecticide	Herbicide	**Total**
Cereals	58	9	68	135
Potatoes	44	7	18	69
Oilseeds	22	8	31	61
Orchards	24	16	8	48
Other Vegetable	15	19	5	39
Improved Grassland	2	1	30	33
Brassicas	11	13	6	30
Sugar Beet	5	5	18	28
Pulses (Combinable)	6	8	12	26
Maize	2	1	22	25
Carrots, Parsnips, Celery	12	8	5	25
Strawberry	18	5	2	25
Other Fodder Crops	3	2	18	23
Other Soft Fruit	13	3	6	22
Peas and beans	4	5	12	21
Onions and Leeks	10	4	6	20
Lettuce, endive, radicchio	8	5	2	15

Table 2.30: Number of mode of action available across cropping sectors.

	No. of Mode of Action			
Cropping Sector	Fungicide	Insecticide	Herbicide	**Total**
Cereals	10	3	13	26
Potatoes	12	5	7	24
Orchards	9	8	5	22
Other Vegetable	6	8	3	17
Oilseeds	3	4	8	15
Onions and Leeks	7	3	5	15
Brassicas	5	6	4	15
Carrots, Parsnips, Celery	5	6	2	13
Strawberry	7	4	2	13

Pulses (Combinable)	4	2	5	11
Other Soft Fruit	5	2	4	11
Sugar Beet	1	4	4	9
Improved Grassland	1	1	7	9
Peas and beans	2	2	5	9
Lettuce, endive, radicchio	5	3	1	9
Maize	1	1	5	7
Other Fodder Crops	1	2	3	6

The number of IPM methods which were above criteria for each cropping sector are show in Table 2.31. The number of IPM methods across cropping sectors ranged from 23 for peas and beans to 123 for other soft fruit. The cropping sectors which showed 2 or more IPM methods with net positive biodiversity impacts were other soft fruit (2), brassicas (12), strawberry (2), orchards (6) , cereals (5), oilseeds (9), other fodder crops (13), lettuce, endive, radicchio (6), carrots, parsnips, celery (3), combinable pulses (2) and peas and beans (2).

Note: IPM information for sugar beet, improved grassland, maize or other vegetables was not available from the reviews.

Table 2.31: IPM methods and biodiversity impacts across cropping sectors.

Cropping Sector	No. IPM methods above criteria	No. IPM methods above criteria, excl. negative for biodiversity	No. IPM methods above criteria and positive for biodiversity
Other Soft Fruit (raspberry, grapevine etc).	123	123	2
Brassicas	85	75	12
Strawberry	81	80	2
Orchards (Apples, pears etc).	61	53	6
Cereals	44	41	5
Oilseeds	40	37	9
Potatoes	40	36	0
Other Fodder Crops	39	37	13
Lettuce, endive, radicchio	37	33	6
Carrots, Parsnips, Celery	32	31	3
Onions and Leeks	31	28	0
Pulses (Combinable)	23	21	2

Peas and beans	23	21	2
Grassland	n/a	n/a	n/a
Maize	n/a	n/a	n/a
Sugar Beet	n/a	n/a	n/a
Other Vegetable	n/a	n/a	n/a

2.3 WP 1 CONCLUSIONS

2.3.1 Identify priority crops for inclusion in the IPM Tool

Using the data collected, priority cropping was selected which met at least one of the following criteria:

(i) High pesticide treated area of 1% or above of treated total area.

(ii) Two or fewer modes of action available within one or more of the pesticide groups (fungicide/herbicides/insecticides).

(iii) Number of IPM actions with net positive biodiversity impact of more than 2.

Least number of active ingredients available was not considered as a metric, as crops at risk of loss of effective chemical control were better identified by the number of modes of action available and the two metrics were highly related. Fewer than two modes of action means that resistance management is severely compromised as modes of action alternations or mixtures cannot be used to prevent the development of pesticide resistance.

Number of IPM methods available was not considered as a metric as all crop groups had a substantial number of effective IPM methods. Also there was no method to weight the relative importance of each IPM method, so the benefit between a crop with the fewest IPM methods could not be compared to a crop with the most.

Following selection of priority cropping which met the defined criteria, further cropping was excluded for the following reasons:

(i) Horticulture crops which the majority of the area grown is under protection i.e. strawberry and soft fruit, as the focus of SFI is on outdoor crops.

(ii) Cropping sectors which met at least one of the defined criteria but were under 1% of total pesticide treated area.

(iii) Cropping sectors which had a wide diversity of species with a diversity of different pest and disease problems i.e. lettuce, endive, radicchio includes balm, basil, bay, lettuce, choi sum, rocket, horseradish etc. as this level of diversity would over complicate the IPM Tool.

(iv) Within cropping sectors (i.e. cereals, pulses, brassicas) a subset of crops were selected which share similar pests and have similar control methods i.e. for brassicas cabbage, cauliflower, brussels sprout and broccoli were selected. This would enable IPM guidance in the tool to be applied to multiple crop species without additional complexity.

(v) Within cropping sectors individual crops were selected which had the highest cropping area i.e. for orchards, apple is the majority of the crop area.

The crops which were identified as priority cropping which met all the defined criteria were (Table 2.32): wheat, barley and oats (Cereals); combining peas, vining peas, field beans and broad beans (Pulses); oilseed rape (Oilseeds); sugar beet (Sugar Beet); apple (Orchards); maize (Maize); improved

grassland (Grassland); ware and seed potatoes (Potatoes); cabbages, cauliflower, brussels sprout, broccoli (Brassicas).

Table 2.32: Identified priority cropping.

Cropping Sector	Individual Crops Selected	No. of Selected Criteria Met	Include for Priority Cropping
Cereals	Wheat, Barley, Oats	2	Yes
Pulses	Combining Peas, Vining Peas, Field Beans, Broad Beans	2	Yes
Oilseeds	Oilseed Rape	2	Yes
Sugar Beet	Sugar Beet	2	Yes
Other Fodder Crops		2	No – under 1% treated area, wide diversity of cropping types.
Lettuce, endive, radicchio		2	No – under 1% treated area, wide diversity of cropping types.
Carrots, Parsnips, Celery		2	No – under 1% treated area.
Orchards	Apple	2	Yes
Maize	Maize	1	Yes
Grassland	Improved Grassland	1	Yes
Potatoes	Ware and Seed Potatoes	1	Yes
Brassicas	Cabbage, Cauliflower, Brussel Sprout, Broccoli	1	Yes
Other Soft Fruit		1	No – wide diversity of cropping types, majority area grown under protection.
Strawberry		1	No – under 1% treated, majority area grown under protection.
Onions and Leeks		0	No – below selected criteria.
Other Vegetable		0	No – below selected criteria.

2.3.2 IPM Tool completions

At the closing date for participants to complete IPM planning using the IPM Tool, there were 231 completed separate crop plans by 113 registered participants. The number of completed plans by different crop group were: General Practices 135, Grassland 16, Maize 8, Oilseed Rape 33, Peas 10,

Potatoes 8, Sugar Beet 11, Winter Barley 27, Winter Beans 20, Winter Wheat 91, Winter Oats 6, Apples 1 and zero for Brassicas. From the 313 participants invited to complete the IPM Tool, with the 113 registrations this gave a 36% return. On average participants completed 2 separate crop plans for each registration.

A key aim of developing the IPM Tool is to increase adoption of IPM control measures (interventions) beyond those currently in use on-farm. Table 2.33, Table 2.34 and Table 2.35 give the breakdown of the degree of commitments to increase adoption across the crop groups where information was provided in the IPM Tool for interventions against invertebrates, diseases and weeds respectively (general weed issues in all crop rotations and crop specific weed intervention measures for grassland and apples). Completing crop plans using the IPM Tool recorded increased commitment to IPM measures, compared against current practice. For interventions against invertebrate pests, increases in IPM measures ranged from 8 to 47% across all crop groups (except grassland). There was a particularly high commitment to change recorded in the grassland group (103%). The commitment to increased IPM from current practice for diseases in all crops was 0 to 38%. For weed control in general weeds in rotation, grassland and apples there was a 19 to 52% commitment to new IPM control measures recorded using the IPM Tool.

Data should be treated with caution for crops for which few IPM plans were completed.

Table 2.33: Degree of intention to adopt new IPM practices for invertebrate pests.

	Wheat	Barley	Oats	Oilseed Rape	Potatoes	Sugar Beet	Peas	Beans	Grassland	Maize	Apple
Total number of feasible IPM interventions (unsuitable interventions excluded)[1]	912	263	43	283	84	77	32	63	87	25	4
Total number of IPM interventions that are already current practice[2]	747	213	37	172	62	55	19	37	37	21	2
Total number of new IPM interventions which could be adopted[3]	165	50	6	111	22	22	13	26	50	4	2
Total number of new IPM interventions committed to in IPM Tool[4]	79	23	4	43	5	10	9	11	38	2	1
Percent of new IPM interventions committed to in IPM Tool[5]	48%	46%	67%	39%	23%	45%	69%	42%	76%	50%	50%
Percent of new IPM interventions as	11%	11%	11%	25%	8%	18%	47%	30%	103%	10%	50%

percentage of current practice[6]											

Table 2.34: Degree of intention to adopt new IPM practices for diseases.

	Wheat	Barley	Oats	Oilseed Rape	Potatoes	Sugar Beet	Peas	Beans	Grassland	Maize	Apple
Total number of feasible IPM interventions (unsuitable interventions excluded)[1]	861	241	26	304	87	49	40	140	63	21	4
Total number of IPM interventions that are already current practice[2]	760	217	25	255	79	48	40	111	39	20	4
Total number of new IPM interventions which could be adopted[3]	101	24	1	49	8	1	0	29	24	1	0
Total number of new IPM interventions committed to in IPM Tool[4]	63	13	1	16	1	1	0	13	15	1	0
Percent of new IPM interventions committed to in IPM Tool[5]	62%	54%	100%	33%	13%	100%	0%	45%	63%	100%	0%
Percent of new IPM interventions as percentage of current practice[6]	8%	6%	4%	6%	1%	2%	0%	12%	38%	5%	0%

Table 2.35: Degree of intention to adopt new IPM practices for weeds in grassland and apples.

	Grassland	Apple	General Weeds
Total number of feasible IPM interventions (unsuitable interventions excluded)[1]	176	61	1468
Total number of IPM interventions that are already current practice[2]	98	27	1047
Total number of new IPM interventions which could be adopted[3]	78	34	421

Total number of new IPM interventions committed to in IPM Tool[4]	45	14	201
Percent of new IPM interventions committed to in IPM Tool[5]	58%	41%	48%
Percent of new IPM interventions as percentage of current practice[6]	46%	52%	19%

[1] the number of feasible interventions (excluding those that are not relevant for a pest identified as a slight, moderate or significant issue on a farm). Note: the total in each row is of all the completed LMPs returned from that group.

[2] the number of interventions given in the previous row, minus the number of interventions that are already in current use on a farm.

[3] the number of interventions which could be adopted (by subtracting [2] from [1]).

[4] the number of interventions which farms committed to adopt in IPM planning in the short or long term.

[5] = [4] as a percentage of [3].

[6] = [4] as a percentage of [2].

2.4 WP 1 Supplementary Material

Promotion of the Project

The Sustainable Farming Incentive for Integrated Pest Management Test and Trial was publicised as follows:

ADAS promoted the project via the following activities: -

- Launched on the ADAS website on 14 July. ADAS Marketing Manager promoted the survey through Twitter (6K followers), Linkedln (7K followers), Facebook and other social media through ADAS Agricology (12K followers) and Agritech E (7k followers). Email sent to all ADAS marketing subscribers for farming and horticultural (900 members).
- ADAS Farming Association is a network of 140 growers and agronomists across Herefordshire (ADAS Rosemaund), Cambridgeshire (ADAS Boxworth), North Yorkshire (ADAS High Mowthorpe) and Nottinghamshire (ADAS Gleadthorpe). These members were contacted with details on the survey on 19 July.
- Local farming contacts known through ADAS Agriculture and Land Management consultancy provided details on the project (50 plus members).
- Details on project published in ADAS Crop Action on 28 July. Crop Action publication is a fortnightly update on key actions topics for crops (pest control, crop growth, fertiliser usage etc) which are sent to subscribers which include growers, agronomists and crop protection company representatives.
- Promoted internally to all ADAS consultancy staff to circulate to known farming contacts.
- Promoted via Falma contacts and Future Farming Resilience Fund (200 plus members).
- Promoted via UK Irrigation Association.

- Promoted via Farming Forum https://thefarmingforum.co.uk/index.php?resources/new-sustainable-farming-incentive-for-integrated-pest-management.266/
- Promoted via HortWeek https://www.hortweek.com/farmers-growers-needed-help-develop-new-sustainable-farming-incentive/fresh-produce/article/1793322
- Promoted via AICC.
- Promoted at AHDB Agronomy Conference on 6 Dec 2022.

SRUC promoted the project via the following activities:

- Distributed to local farming and agronomy contacts in England.

The NFU promoted the project via the following activities:

- Promoted on NFU website https://www.nfuonline.com/updates-and-information/sfi-standard-for-ipm-take-part-in-defra-s-test-and-trial/
- Promoted via steering group members; Voluntary Initiative, Natural England, LEAF, AHDB.
- Distributed via NFU membership.

Defra promoted the project via the following activities:

- Promoted to current SFI pilots scheme members.
- Promoted in FAS November Newsletter.

APPENDIX 3 - WORK PACKAGE 2: PROVIDE USER SUPPORT FOR THE COMPLETION OF IPM TOOL AND ENGAGEMENT WITH THE IPM SFI, THROUGH VIDEO GUIDANCE AND WRITTEN GUIDANCE.

3.1 WP 2 METHODOLOGY

3.1.1 Creating video guidance: IPM overviews for arable, grassland and horticulture

Videos were produced by ADAS which provided guidance on IPM practices for arable, grassland and horticultural crops. Videos scripts were developed by ADAS specialists and presented to the steering group on 11 November. The scripts were written to be a short IPM overview for each sector and were used as a guide for the videos and were not a verbatim script when filmed (see WP2 Results for example of script).

The videos were filmed on farms for the respective sectors. The grassland video was filmed on 23 November at a mixed livestock farm in Herefordshire. The arable video was filmed on 28 November at a LEAF member's farm near Huntingdon, Cambridgeshire. The horticulture video was filmed at Howard Nurseries on 24 November in an outdoor grown ornamental field near Diss, Suffolk.

Videos were designed as a talking head format for each presenter and then overlaid with demonstration screenshots of examples of IPM practices as mentioned in the videos (for example diverse margins). For arable and grassland videos the host farmer provided an interview on their farm and their current IPM practices. A weblink to the IPM Tool was provided at the end of each video.

The videos produced were short with less than 4 mins for each sector, to ensure the information was easy to follow and take in, and were subtitled. The videos were edited with VSDC video editor and uploaded to a YouTube channel. Links to the videos were provided on the front page of the IPM Tool.

3.1.2 Creating video guidance: IPM Standard

The SFI IPM Standard was published at the end of January 2023. Filming of the video was delayed until publication. An outline script and design idea for the video was submitted to Defra on 17 February for their approval (see WP2 Results for outline). The video was filmed on 22 March at a mixed arable farm in Norfolk.

3.1.3 Creating video guidance: How to complete the IPM Tool

An instructional guidance video was produced which outlined how to complete the IPM Tool. The instruction video was produced by ADAS digital marketing and presented by an ADAS consultant who is also a farmer. The video was filmed with the presenter recording their screen as they worked their way through the tool, to show users a demonstration of completing each section. This video was not intended to provide IPM advice but clear instructions on how to fill in each section. This video was subtitled and uploaded as an unlisted video on YouTube. A link to the video was provided on the front page of the IPM Tool.

3.1.4 Implementing a technical help line for IPM Tool completion

A technical helpline IPM@adas.co.uk was implemented through ADAS to provide software support for completion of the IPM Tool. The helpline was available to provide assistance for any technical or accessibility issue in using the tool. It was not to provide advice on how to fill in the crop plans or provide IPM advice; as the IPM Tool was designed to be self-completed without the need for further assistance.

The purpose of the helpline was to gather information on what prevented users from completing the IPM Tool in order to improve future versions of the IPM Tool, with initial feedback used to improve the design of the IPM Tool through the inclusion of the navigation panel. It is not intended that a helpline should be provided, or needed, for future users.

3.1.5 Writing guidance for the expanded range of crops included in the IPM Tool

Written guidance was produced which outlined IPM best practice for the range of crops to be included in the IPM Tool, namely: wheat, barley and oats (combined as guidance for cereals); combining peas, vining peas, field beans and broad beans (pulses); oilseed rape; sugar beet; apple; maize; improved grassland; ware and seed potatoes; cabbages, cauliflower, brussels sprout, broccoli (Brassicas). This basic guidance covered invertebrate pest, weed and disease management, cultural practices, resistance issues and plant protection measures for each crop. As IPM weed control was applicable across the whole farm rotation a separate guidance document was produced for weeds, with individual crop specific weed advice included in the crop specific guidance where required.

Guidance was produced by ADAS specialist entomologists, weed scientists and pathologists, and reviewed by the ADAS Agriculture and Land Management group so the guidance language and terminology were appropriate for use in farmer and grower advice. The guidance was designed to complement the information provided within the IPM Tool. A copy of the guidance produced was provided to the steering group for review. Links to the guidance were provided on the front page of the IPM Tool.

3.2 WP 2 RESULTS

Example video script - grassland

Introduction

Hello, I'm Philip Walker a crop protection specialist from ADAS and in today's video we are going to outline Integrated Pest Management (IPM) strategies for the control of insect pests, weeds and diseases in grassland. I am joined by one of my colleagues and fellow crop protection specialist Phil Bounds who is also a mixed livestock farmer in Herefordshire who manages his grassland using IPM techniques.

Phil could you tell us a bit about your farm and the IPM strategies you use.

Hello, I'm Phil Bounds, and I have an upland beef and sheep farm here in Herefordshire next to the Welsh border. I have about 50 hectares of permanent and long term grassland, and additional hill grazing rights on joining common land. We use a range of Integrated Pest Management strategies on the farm to control grassland pests, weeds and diseases and have found that these can be used effectively to reduce the use of chemical inputs. To give a few examples, to control pests, we add in a break crop between reseeding grassland, and carry out additional cultivations and heavy rolling after sowing. To reduce disease levels, we select disease resistant varieties, ensure appropriate nutrition and graze, mow or top swards to prevent them becoming too dense and lush. For weed control, we again top or mow weeds to prevent them going to seed, and increase seed rates where we have known weed problems. Where chemical control is required to control weeds, we use spot or patch spraying to minimise the level of use.

As Phil mentioned many of the principles of IPM are already commonly used in sustainable grassland production, and ADAS, in collaboration with SRUC and NFU, have developed an IPM Tool which provides information on how to use IPM strategies in a coordinated and planned approach. There is a link to the tool at the end of the video.

Insect Pests

The key insect pests in grassland are frit fly, leatherjackets, wireworm and slugs, and these cause crop damage through direct feeding. Permanent grassland and established leys are more tolerant of insect pests, and so most problems tend to arise with reseeds, particularly after long-term grass leys.

There are a range of effective IPM strategies that can be used to reduce the risk of damage from these pests. Where possible, avoiding sowing after long-term leys is an effective way of reducing pest pressure. For red clover, stem nematodes are best avoided by rotation and a break of several years. For frit fly, moving the sowing date to spring instead of autumn or delaying sowing for at least six weeks after ploughing are effective ways of reducing damage. Additional cultivations can also be used to reduce populations of wireworms, leatherjackets and slugs by exposing them to predation by birds. Heavy rolling after sowing can also be effective to ensure more rapid germination and kill or reduce the mobility of soil pests.

Using previous records of pest damage to estimate pest numbers is useful to predict timing of pest attacks and risk of economic damage. As the crop emerges, monitoring pest numbers and damage by visual inspection or trapping is an essential part of IPM.

Diseases

Grassland diseases can reduce not only yield, but also palatability and quality, and can affect sward composition. The most important grassland diseases are the foliar diseases crown rust, mildew and drechslera, with rhynchosporium, brown rust and ryegrass mosaic virus significant for hybrid and Italian ryegrass. Legumes are also susceptible to diseases such as clover rot and fusarium foot rot, and verticillium wilt can affect lucerne.

A range of IPM strategies can be used to reduce the risk of disease in grassland. A management technique to avoid disease build-up is regular grazing, mowing, or topping of grassland before leaves become significantly infected. Diseases such as rhynchosporium and drechslera can overwinter on crop debris, and so ploughing or minimising grass covers over-winter can reduce disease risk. A crown rust attack in the autumn can be dealt with by immediate grazing or cutting. Mildew and rhynchosporium can spread by infectious cereal volunteers, so destroying volunteers before reseeding can reduce disease pressure. Selecting disease resistant varieties of grass or clover in seed mixtures provides an effective way of supressing diseases in high-risk areas. Correct crop nutrition is also important, by avoiding excessive nitrogen application whilst ensuring the correct phosphorous, potash and pH status to stimulate vigorous growth.

Weeds

Grassland weeds can reduce yield by directly competing for light, water, nutrients, and other soil resources, and can also reduce nutritional value, palatability or even be toxic to livestock. IPM techniques can play a key role in the control of weeds in grassland, particularly where mixtures contain clover and chemical options are more limited. Minimising sward damage from poaching, compaction, ruts and manure heaps reduces the risk of weeds establishing in bare ground. Using crop rotation to disrupt crop and weed associations is an effective way of discouraging the growth and reproduction of certain weed species. Maintaining optimum soil fertility and pH will help ensure that herbage species persist instead of weeds, and improving drainage can reduce weed problems such as rushes and buttercup. Other effective practices include creating stale seedbeds, increasing seed rates or overseeding following tight grazing. Practices that prevent weeds going to seed such as mowing, topping, hand rouging or strimming can reduce perennial weed numbers.

Where chemical application is required to control a weed problem, natural chemicals such as plant extracts can give useful control of weeds such as fat hen, groundsel, and dock after repeat applications. Where specific herbicides are required to control weeds, targeted spot and patch spraying or weed wiping can be effective compared to broad-acre application.

Outro

Defra's sustainable farming incentive scheme is intended to provide payments for farmers implementing certain IPM actions. Further information on Defra SFI schemes can be found on their websites.

Example video script and outline – Introduction to SFI IPM Standards

In this video I'm going to introduce Defra's Sustainable Farming Incentive for Integrated Pest Management; or 'IPM' for short. This scheme will pay farmers for practices that can protect and enhance the natural environment. There are four IPM actions which you can be paid for on arable, grassland and horticultural crops:

- Completing an IPM assessment and producing an IPM plan.
- Establishing and maintaining flower-rich grass margins, blocks, or in-field strips
- Establishing a companion crop
- Committing to no use of insecticide

You can choose which of these actions are practical for your farm. And choose which land you enter into the SFI agreement with Defra for each action. Details of the payment rates can be found on the Defra website [link/screenshot]

If you are already doing some or all of these actions, then you can be paid to continue doing them – provided the actions are done according to the requirement of the scheme.

I'll illustrate what each of the four actions involves:

Completing an integrated pest management (IPM) assessment and producing an IPM plan.

The aim is that a member of the BASIS Professional Register who's qualified with the relevant BASIS Certificate in Crop Protection for the crops you're growing has visited your farm to:

- Complete an integrated pest management (IPM) assessment of the land entered into this action.
- Help you produce a written IPM plan for that land. This will help you to plan how to adopt a range of sustainable crop protection methods. **Overlay video/images of farming activity.**
- If you're a BASIS qualified adviser, you can complete the IPM assessment and produce the written IPM plan yourself.

Establish and maintain flower-rich grass margins, blocks, or in-field strips

The aim is that flower-rich grass margins, blocks or in-field strips are established and maintained on land entered into this action so there are flowering plants during the summer months into early autumn. This will help to:

- Provide habitat and foraging sites for invertebrates, including natural crop predators, wild pollinators such as bumblebees, solitary bees, butterflies and hoverflies, and farmland birds**. Overlay video/images of invertebrates.**
- Encourage natural crop predators as part of an IPM approach if located within proximity of cropped areas. **Overlay video/images of field margins, blocks and infield strips.**

Establish a companion crop

The aim is that a companion crop is established so it's growing with an arable or horticultural crop. This will help to:

- Support an IPM approach by acting as a trap crop for pests or by suppressing weeds,
- Provide a habitat for birds and invertebrates, including pollinators and natural crop pest predators. **Overlay video/screenshots of examples of companion cropping.**

No use of insecticide

The aim is that no plant protection products containing insecticide are used on land entered into this action. This will help to:

- Support an IPM approach by managing crop pests in a more sustainable way that limits the impacts of insecticides. **Overlay video of crop with beneficial insects.**

Farmer Interview

I am joined by xx, who farms xx hectares in [county]. Could you tell us a bit about your farm and how you foresee some of the SFI paid actions fitting into your farming system?

Further information on the SFI paid actions can be found on the Defra webpage.

3.3 WP 2 CONCLUSIONS

Conclusions on the feedback received for the guidance provided can be found under WP 5 conclusions (see Section 6.3).

APPENDIX 4 – WORK PACKAGE 3: CO-DESIGN THE IPM SFI STANDARD IN COLLABORATION WITH DEFRA.

4.1 WP 3 METHODOLOGY

4.1.1 Support Defra in the development of an IPM SFI Standard

The project team worked with Defra on the co-design of the SFI IPM Standard. The focus was on developing an action-based Standard. Evidence was collated to assess which paid actions could result in the greatest impact of IPM on pest control and biodiversity.

Two approaches were explored initially: i) identifying a simple set of IPM actions for inclusion in the Standard (the IPM Tool would become guidance alongside the Standard), and ii) simplifying the IPM Tool and integrating it within the IPM Standard (so the IPM Tool would become a method by which paid actions were defined and recorded). After presenting options for the two approaches, the preference of Defra was for the former.

Review of Evidence for draft Paid Actions for IPM SFI Standard

Draft IPM SFI Standard paid actions were provided by Defra [*SFI Standard Update 21.7.22 Confidential.ppt*] for review by the T&T project team. The proposed paid actions were:

- Encouraging natural predators (strips – margins/in-field, plots, corners, beetle banks).
- Cropping decisions (crop rotation/companion cropping/trap cropping/intercropping).
- Precision spraying/spot spraying of plant protection products (PPPs).

Paid actions related to planning and advice, training and an end of year 'insecticide free' payment, were outside the scope of the analysis described here.

An update on 17 August noted that: (i) precision application is likely to be included as a capital item, rather than a paid action, (ii) rotations are probably too complex to be included as a paid action, (iii) the Standard is focussed on outdoor crops (putting most soft fruit production out of scope of the Standard), and (iv) grassland is being considered separately.

All the proposed actions from 21 July were retained in the analysis for comparison. Soft fruit was included. Grassland was excluded.

The work reported here:

1. Analysed the proposed paid actions.
2. Analysed other potential paid actions, to assess whether greater impact could be achieved.

The same methodology was used for the two analyses and the results are presented in comparable tables.

IPM practices not included in the draft IPM SFI Standard, and for which evidence was gathered in the second analysis, were:

- Use of bioprotectants & low risk plant protection products (PPPs), biostimulants and elicitors.
- Primary cultivations (crop residue burial, defoliation) and secondary cultivations (drilling method, minimum tillage and rolling).
- Decision support (incl. thresholds and monitoring).
- Mechanical weeding and thermal control.
- Sowing date.
- Varietal choice.
- Stubble management.
- Nutrient management.

- Hygiene and prevention.
- Seed rate, seed testing, and use of alternative seed treatments.
- Low risk locations.
- Good drainage and use of lime.
- Spatial separation.
- Control of volunteers and weeds.
- Early harvest.
- Seedbed quality and pre planting soil tests.
- Leaving land fallow.
- Environmental control and growing in substrate.
- Physical exclusion of pests.

Some of these actions may not be suitable as paid actions due to their complexity or difficulty of verification. These other considerations were outside the evidence base of this analysis.

Sources of evidence

Evidence was collated from the AHDB IPM broadacre (Blake *et al.,* 2021) and AHDB non broadacre (Young *et al.,* 2022) reviews, and the Natural England IPM for Biodiversity review (Cook *et al.,* 2023).

The crops analysed were those for which evidence is available from the reviews, namely:

- Broadacre cereals
- Oilseeds
- Potato
- Grapevine
- Raspberry
- Strawberry
- Apple
- Pear
- Carrot
- Onion
- Lettuce and endive
- Leaf brassicas
- Root brassicas
- Minor cereals – rye and triticale
- Beans
- Peas
- Fodder crops

Metric

IPM SFI should incentivise IPM actions which are effective at controlling pests (thus reducing pesticide need) and beneficial to biodiversity. Relevant metrics are:

- Efficacy of the action, strength of evidence for efficacy and potential for increased uptake. The three metrics above were combined into a single 'Priority score'.
- The number of crop pests against which the action is effective – this indicates how widespread the IPM control benefits could be.
- Biodiversity impact of the action.

Using data from the reviews, IPM actions (proposed paid actions or potential paid actions) for each crop were categorised into red, amber or green, as follows: -

(i) Priority Score of IPM action – red within the lower quartile, amber between lower quartile and median, green above median.

(ii) Number of crop pests action is effective against - red within the lower quartile, amber between lower quartile and median, green above median.

(iii) Biodiversity impact – red negative, amber neutral or lack of evidence, green positive.

4.2 WP 3 RESULTS

4.2.1 Support Defra in the development of an IPM SFI Standard

Results for draft Paid Actions for IPM SFI Standard

For cereals the IPM methods listed in the IPM SFI Standard were mostly amber or green for priority score and biodiversity impact, but 5 out of 7 methods were red for the range of pests the action is effective against (Table 4.1). The exception was field history, rotation & break crops which had the highest number of pest controlled. Trap cropping was not a recognised action from the reviews for use on cereal pests.

Table 4.1: IPM methods and biodiversity impacts for cereals.

Strategy	Priority Score (range 4.8 – 12.8)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	6.2	7	Positive
Field history, rotation & break crops	7.6	26	Positive
Undersowing & Companion cropping	9.5	6	Lack of evidence
Cover Crops	8.9	7	Lack of evidence
Trap Cropping	n/a	0	Lack of evidence
Intercropping	8.6	5	Lack of evidence
Precision application	10.3	6	Lack of evidence

For oilseeds the IPM methods listed in the IPM SFI Standard were mostly amber or green for priority score and biodiversity impact, but 5 out of 7 methods were red for number of pests controlled (Table 4.2). The exceptions were in field non-cropped areas and field history, rotation & break crops which had high numbers of pests controlled.

Table 4.2: IPM methods and biodiversity impacts for oilseeds.

Strategy	Priority Score (range 5.0 – 12.8)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	7.7	11	Positive
Field history, rotation & break crops	9.5	13	Positive
Undersowing & Companion cropping	8.7	6	Lack of evidence

Cover Crops	8.4	5	Lack of evidence
Trap Cropping	10.0	2	Lack of evidence
Intercropping	8.0	4	Lack of evidence
Precision application	9.8	6	Lack of evidence

The biodiversity review did not include potato as a listed crop. For potato the IPM methods listed in the IPM SFI Standard were mostly amber or green for priority score, but 4 out of 7 methods were red for number of pests controlled (Table 4.3). The exception was field history, rotation & break crops which had a high number of pests controlled. Intercropping cropping was not a recognised action from the reviews for use on potatoes.

Table 4.3: IPM methods for potato.

Strategy	Priority Score (range 6.5 – 12.8)	No. of crop pests action is effective against
In field non-cropped areas	9.0	4
Field history, rotation & break crops	9.4	14
Undersowing & Companion cropping	9.6	4
Cover Crops	9.1	4
Trap Cropping	10.3	1
Intercropping	n/a	0
Precision application	9.6	5

None of the listed actions in the IPM SFI Standard were recognised for use on grapevines from the reviews (Table 4.4).

Table 4.4: IPM methods and biodiversity impacts for grapevine.

Strategy	Priority Score (range 3.0 – 13.8)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	n/a	0	Positive
Field history, rotation & break crops	n/a	0	Positive
Undersowing & Companion cropping	n/a	0	Lack of evidence
Cover Crops	n/a	0	Lack of evidence
Trap Cropping	n/a	0	Lack of evidence
Intercropping	n/a	0	Lack of evidence

Precision application	n/a	0	Lack of evidence

In field non-cropped areas and precision application were the only listed actions recognised for use on raspberry and strawberry (Tables 4.5 and 4.6). Note: the biodiversity review did not include raspberry or strawberry.

Table 4.5: IPM methods for raspberry.

Strategy	Priority Score (range 6.8 – 13.5)	No. of crop pests action is effective against
In field non-cropped areas	8.8	1
Field history, rotation & break crops	n/a	0
Undersowing & Companion cropping	n/a	0
Cover Crops	n/a	0
Trap Cropping	n/a	0
Intercropping	n/a	0
Precision application	9.8	5

Table 4.6: IPM methods for strawberry.

Strategy	Priority Score (range 5.3 – 12.8)	No. of crop pests action is effective against
In field non-cropped areas	8.6	2
Field history, rotation & break crops	n/a	0
Undersowing & Companion cropping	n/a	0
Cover Crops	n/a	0
Trap Cropping	n/a	0
Intercropping	n/a	0
Precision application	11.2	5

Field history, rotation & break crops, undersowing & companion cropping and cover crops were the only listed actions recognised for use on apple or pear (Tables 4.7 and 4.8).

Table 4.7: IPM methods and biodiversity impacts for apple.

Strategy	Priority Score (range 6.8 – 12.3)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	n/a	0	Positive

Field history, rotation & break crops	11.3	3	Positive
Undersowing & Companion cropping	10.7	2	Positive
Cover Crops	8.0	4	Lack of evidence
Trap Cropping	n/a	0	Lack of evidence
Intercropping	n/a	0	Lack of evidence
Precision application	n/a	0	Lack of evidence

Table 4.8: IPM methods and biodiversity impacts for pear.

Strategy	Priority Score (range 6.8 – 12.3)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	n/a	0	Positive
Field history, rotation & break crops	10.8	2	Positive
Undersowing & Companion cropping	n/a	0	Positive
Cover Crops	8.0	4	Lack of evidence
Trap Cropping	n/a	0	Lack of evidence
Intercropping	n/a	0	Lack of evidence
Precision application	n/a	0	Lack of evidence

Field history, rotation & break crops, cover crops, trap cropping and precision application were the actions recognised for use on carrot or onion (Tables 4.9 and 4.10). Field history, rotation & break crops and precision application were green or amber for both priority score and number of pests controlled.

Table 4.9: IPM methods and biodiversity impacts for carrot.

Strategy	Priority Score (range 5.3 – 14.0)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	n/a	0	Positive
Field history, rotation & break crops	10.2	7	Positive
Undersowing & Companion cropping	n/a	0	Lack of evidence
Cover Crops	8.0	1	Lack of evidence
Trap Cropping	n/a	0	Lack of evidence
Intercropping	n/a	0	Lack of evidence
Precision application	11.2	3	Lack of evidence

Table 4.10: IPM methods and biodiversity impacts for onion.

Strategy	Priority Score (range 5.3 – 14.0)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	n/a	0	Positive
Field history, rotation & break crops	10.1	5	Positive
Undersowing & Companion cropping	n/a	0	Lack of evidence
Cover Crops	8.0	1	Lack of evidence
Trap Cropping	10.8	1	Lack of evidence
Intercropping	n/a	0	Lack of evidence
Precision application	11.7	3	Lack of evidence

Field history, rotation & break crops, undersowing & companion cropping, cover crops, trap cropping and precision application were the listed actions recognised for use on endive and lettuce or leafy brassicas (Tables 4.11 and 4.12). Field history, rotation & break crops and precision application were green for both priority score and number of pests controlled.

Table 4.11: IPM methods and biodiversity impacts for endive and lettuce.

Strategy	Priority Score (range 3.0 – 13.8)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	n/a	0	Positive
Field history, rotation & break crops	9.8	8	Positive
Undersowing & Companion cropping	n/a	0	Lack of evidence
Cover Crops	7.0	1	Lack of evidence
Trap Cropping	n/a	0	Lack of evidence
Intercropping	10.5	2	Lack of evidence
Precision application	9.9	5	Lack of evidence

Table 4.12: IPM methods and biodiversity impacts for leaf brassicas.

Strategy	Priority Score (range 7.0 – 12.3)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	n/a	0	Positive
Field history, rotation & break crops	9.9	9	Positive
Undersowing & Companion cropping	8.7	6	Lack of evidence

Cover Crops	7.0	1	Lack of evidence
Trap Cropping	n/a	0	Lack of evidence
Intercropping	8.8	1	Lack of evidence
Precision application	10.2	6	Lack of evidence

Field history, rotation & break crops, undersowing & companion cropping, cover crops, intercropping and precision application were the listed actions recognised for use on root brassicas (Table 4.13). Field history, rotation & break crops, undersowing and companion cropping and precision application were green or amber for both priority score and number of pests controlled.

Table 4.13: IPM methods and biodiversity impacts for root brassicas.

Strategy	Priority Score (range 7.3 – 12.5)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	n/a	0	Positive
Field history, rotation & break crops	11.1	8	Positive
Undersowing & Companion cropping	9.3	6	Lack of evidence
Cover Crops	8.0	1	Lack of evidence
Trap Cropping	n/a	0	Lack of evidence
Intercropping	8.8	1	Lack of evidence
Precision application	10.4	4	Lack of evidence

All listed actions except for in field non-cropped areas were recognised for use on rye and triticale (Table 4.14). Field history, rotation & break crops was the only action green or amber for both priority score and number of pests controlled.

Table 4.14: IPM methods and biodiversity impacts for rye and triticale.

Strategy	Priority Score (range 7.8 – 13.0)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	n/a	0	Positive
Field history, rotation & break crops	9.6	4	Positive
Undersowing & Companion cropping	11.5	1	Lack of evidence
Cover Crops	10.5	1	Lack of evidence
Trap Cropping	7.8	1	Lack of evidence
Intercropping	10.0	1	Lack of evidence

Precision application	11.8	1	Lack of evidence

The biodiversity review did not include beans and peas as a listed crop. Field history, rotation & break crops, undersowing & companion cropping, cover crops, intercropping and precision application were the listed actions recognised for use on beans and peas (Tables 4.15 and 4.16). Undersowing & companion cropping, cover crops, intercropping and precision application were green or amber for both priority score and number of pests controlled. Trap cropping was recognised for use on peas with a green priority and amber for number of pests controlled.

Table 4.15: IPM method for beans.

Strategy	Priority Score (range 7.0 – 12.8)	No. of crop pests action is effective against
In field non-cropped areas	n/a	0
Field history, rotation & break crops	8.2	3
Undersowing & Companion cropping	10.0	4
Cover Crops	9.9	2
Trap Cropping	n/a	0
Intercropping	9.0	2
Precision application	10.8	2

Table 4.16: IPM methods for peas.

Strategy	Priority Score (range 6.3 – 12.8)	No. of crop pests action is effective against
In field non-cropped areas	n/a	0
Field history, rotation & break crops	7.9	3
Undersowing & Companion cropping	10.4	2
Cover Crops	9.9	2
Trap Cropping	9.8	1
Intercropping	9.0	2
Precision application	10.8	2

Field history, rotation & break crops, undersowing & companion cropping and trap cropping were the listed actions recognised for use on fodder crops (Table 4.17). Field history, rotation & break crops and undersowing & companion were green for both priority score and number of pests controlled.

Table 4.17: IPM methods and biodiversity impacts for fodder crops.

Strategy	Priority Score (range 5.5 – 13.0)	No. of crop pests action is effective against	Biodiversity Impact
In field non-cropped areas	n/a	0	Positive
Field history, rotation & break crops	10.1	8	Positive
Undersowing & Companion cropping	9.7	5	Lack of evidence
Cover Crops	n/a	0	Lack of evidence
Trap Cropping	11.3	1	Lack of evidence
Intercropping	n/a	0	Lack of evidence
Precision application	n/a	0	Lack of evidence

Results for other Potential Paid Actions

For cereals the IPM methods not included in the Standard were amber or green for bioprotectants & low risk PPP's, secondary cultivations, sowing date, varietal choice, nutrient management, hygiene and prevention, seed rate, low-risk locations, seed bed quality and fallow land (Table 4.18). All other methods were rated red in at least one of the categories.

Table 4.18: IPM methods and biodiversity impacts for cereals.

Strategy	Priority Score (range 4.8 – 12.8)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	8.5	11	Lack of evidence
Primary cultivations (crop residue burial)	8.0	19	Negative
Secondary cultivations (drilling method)	8.2	11	Positive
Decision support (incl. thresholds)	9.0	19	Neutral
Mechanical Weeding	9.3	3	Negative
Sowing Date	8.2	21	Lack of evidence
Varietal Choice	9.7	18	Lack of evidence
Stubble Management	9.8	6	Positive
Nutrient Management	8.7	8	Lack of evidence
Hygiene and prevention	9.0	7	Lack of evidence
Seed Rate	8.2	10	Lack of evidence
Seed Testing / Seed Treatments	8.4	3	Lack of evidence

Select low-risk locations	8.6	10	Lack of evidence
Good Drainage	6.3	1	Lack of evidence
Lime	7.8	1	Lack of evidence
Spatial separation	6.4	6	Lack of evidence
Thermal control	8.5	4	Lack of evidence
Control volunteers & weeds	7.5	10	Lack of evidence
Early harvest	9.2	4	Lack of evidence
Seedbed quality	7.8	11	Lack of evidence
Biostimulants & elicitors	7.5	2	Lack of evidence
Pruning/canopy management	n/a	0	Lack of evidence
Fallow land	8.9	6	Positive
Environmental control	n/a	0	Lack of evidence
Growing in substrate	n/a	0	Lack of evidence
Pre-plant soil tests	n/a	0	Lack of evidence
Physical exclusion of pests	n/a	0	Positive

For oilseeds the IPM methods not included in the Standard were mostly amber or green for all categories, including bioprotectants & low risk PPP's, secondary cultivations, decision support, sowing date, varietial choice, stubble management, hygiene and prevention, seed rate, low-risk locations, spatial separation and seed bed quality (Table 4.19). Decision support and varietal choice scored high for both priority score and number of pests controlled.

Table 4.19: IPM methods and biodiversity impacts for oilseeds.

Strategy	Priority Score (range 5.0 – 12.8)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	7.9	9	Lack of evidence
Primary cultivations (crop residue burial)	9.1	13	Negative
Secondary cultivations (drilling method)	8.4	11	Positive
Decision support (incl. thresholds)	9.5	18	Neutral
Mechanical Weeding	9.5	3	Negative

Sowing Date	8.8	10	Lack of evidence
Varietal Choice	10.5	12	Lack of evidence
Stubble Management	9.9	7	Positive
Nutrient Management	9.2	3	Lack of evidence
Hygiene and prevention	9.7	6	Lack of evidence
Seed Rate	9.7	7	Lack of evidence
Seed Testing / Seed Treatments	n/a	0	Lack of evidence
Select low-risk locations	9.7	8	Lack of evidence
Good Drainage	10.8	1	Lack of evidence
Lime	8.8	1	Lack of evidence
Spatial separation	8.9	7	Lack of evidence
Thermal control	8.9	4	Lack of evidence
Control volunteers & weeds	9.3	1	Lack of evidence
Early harvest	7.3	2	Lack of evidence
Seedbed quality	8.3	9	Lack of evidence
Biostimulants & elicitors	7.8	2	Lack of evidence
Pruning/canopy management	n/a	0	Lack of evidence
Fallow land	8.5	4	Positive
Environmental control	n/a	0	Lack of evidence
Growing in substrate	n/a	0	Lack of evidence
Pre-plant soil tests	n/a	0	Lack of evidence
Physical exclusion of pests	n/a	0	Positive

The biodiversity review did not include potato as a listed crop. For potato the IPM methods not included in the Standard were a mixture of red, amber or green for all categories (Table 4.20). Decision support, varietal choice, hygiene and prevention, seed testing, low risk locations, control of volunteer and weeds, early harvest and seed bed quality were the IPM methods not to include any red categories.

Table 4.20: IPM methods for potato.

Strategy	Priority Score (range 6.5 – 12.8)	No. of crop pests action is effective against
Bioprotectants & low risk PPP's	7.9	12
Primary cultivations (crop residue burial)	9.0	12
Secondary cultivations (drilling method)	7.8	1
Decision support (incl. thresholds)	9.6	14
Mechanical Weeding	10.0	4
Sowing Date	9.9	2
Varietal Choice	9.9	16
Stubble Management	9.0	4
Nutrient Management	10.5	1
Hygiene and prevention	10.4	10
Seed Rate	n/a	0
Seed Testing / Seed Treatments	10.0	10
Select low-risk locations	9.4	11
Good Drainage	9.1	3
Lime	n/a	0
Spatial separation	9.8	3
Thermal control	9.7	4
Control volunteers & weeds	9.6	14
Early harvest	9.5	9
Seedbed quality	9.0	6
Biostimulants & elicitors	n/a	0
Pruning/canopy management	n/a	0
Fallow	8.5	4
Environmental control	n/a	0

Growing in substrate	n/a	0
Pre-plant soil tests	n/a	0
Physical exclusion of pests	n/a	0

For grapevines the IPM methods not included in the Standard were amber or green for bioprotectants & low risk PPP's, decision support, varietal choice, hygiene and prevention, seed testing and seed treatments, low-risk locations, spatial separation and control of volunteers & weeds (Table 4.21). Other methods were rated red in at least one of the categories.

Table 4.21: IPM methods and biodiversity impacts for grapevine.

Strategy	Priority Score (range 3.0 – 13.8)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	9.5	8	Lack of evidence
Primary cultivations (defoliation)	10.0	6	Negative
Secondary cultivations (drilling method)	n/a	0	Positive
Decision support (incl. thresholds)	11.0	6	Neutral
Mechanical Weeding	n/a	0	Negative
Sowing Date	n/a	0	Lack of evidence
Varietal Choice	10.5	4	Lack of evidence
Stubble Management	n/a	0	Positive
Nutrient Management	9.8	2	Lack of evidence
Hygiene and prevention	10.6	13	Lack of evidence
Seed Rate	n/a	0	Lack of evidence
Seed Testing / Seed Treatments	9.7	5	Lack of evidence
Select low-risk locations	11.6	5	Lack of evidence
Good Drainage	n/a	0	Lack of evidence
Lime	n/a	0	Lack of evidence
Spatial separation	11.6	4	Lack of evidence
Thermal control	8.3	2	Lack of evidence
Control volunteers & weeds	10.2	6	Lack of evidence

Early harvest	n/a	0	Lack of evidence
Seedbed quality	n/a	0	Lack of evidence
Biostimulants & elicitors	11.6	3	Lack of evidence
Pruning/canopy management	n/a	0	Lack of evidence
Fallow	n/a	0	Positive
Environmental control	9.5	3	Lack of evidence
Growing in substrate	n/a	0	Lack of evidence
Pre-plant soil tests	10.0	1	Lack of evidence
Physical exclusion of pests	11.8	1	Positive

The biodiversity review did not include raspberry and strawberry as a listed crops. For both the IPM methods not included in the Standard were amber or green for bioprotectants & low risk PPP's, decision support and hygiene and prevention; with varietal choice, seed testing and seed treatments also included for raspberry and control of volunteers & weeds also included for strawberry (Tables 4.22 and 4.23). All other methods were rated red in at least one of the categories.

Table 4.22: IPM methods for raspberry.

Strategy	Priority Score (range 6.8 – 13.5)	No. of crop pests action is effective against
Bioprotectants & low risk PPP's	9.7	17
Primary cultivations (defoliation)	9.6	10
Secondary cultivations (drilling method)	n/a	0
Decision support (incl. thresholds)	11.0	11
Mechanical Weeding	n/a	0
Sowing Date	9.5	1
Varietal Choice	10.8	9
Stubble Management	n/a	0
Nutrient Management	11.0	4
Hygiene and prevention	10.5	26
Seed Rate	n/a	0

Seed Testing / Seed Treatments	10.5	10
Select low-risk locations	11.1	2
Good Drainage	11.3	1
Lime	n/a	0
Spatial separation	9.6	3
Thermal control	7.6	6
Control volunteers & weeds	9.9	6
Early harvest	n/a	0
Seedbed quality	10.5	1
Biostimulants & elicitors	10.5	6
Pruning/canopy management	n/a	0
Fallow	n/a	0
Environmental control	10.9	5
Growing in substrate	11.5	1
Pre-plant soil tests	10.3	1
Physical exclusion of pests	10.5	2

Table 4.23: IPM methods for strawberry.

Strategy	Priority Score (range 5.3 – 12.8)	No. of crop pests action is effective against
Bioprotectants & low risk PPP's	10.1	16
Primary cultivations (crop residue burial)	9.8	7
Secondary cultivations (drilling method)	n/a	0
Decision support (incl. thresholds)	10.6	8
Mechanical Weeding	n/a	0
Sowing Date	10.0	3
Varietal Choice	10.4	5

Stubble Management	n/a	0
Nutrient Management	10.6	3
Hygiene and prevention	10.2	29
Seed Rate	n/a	0
Seed Testing / Seed Treatments	10.5	5
Select low-risk locations	10.8	4
Good Drainage	12.3	1
Lime	n/a	0
Spatial separation	9.5	2
Thermal control	6.1	4
Control volunteers & weeds	10.5	12
Early harvest	n/a	0
Seedbed quality	9.5	2
Biostimulants & elicitors	10.5	5
Pruning/canopy management	n/a	0
Fallow	n/a	0
Environmental control	10.8	5
Growing in substrate	12.5	1
Pre-plant soil tests	11.5	2
Physical exclusion of pests	11.3	3

For apple and pear the IPM methods not included in the Standard were amber or green for bioprotectants & low risk PPP's, decision support, varietal choice, nutrient management, hygiene and prevention, and pruning/canopy management. All other methods were rated red in at least one of the categories (Tables 4.24 and 4.25).

Table 4.24: IPM methods and biodiversity impacts for apple.

Strategy	Priority Score (range 6.8 – 12.3)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	9.9	14	Lack of evidence

Primary cultivations (defoliation)	9.1	4	Negative
Secondary cultivations (drilling method)	n/a	0	Positive
Decision support (incl. thresholds)	10.6	4	Neutral
Mechanical Weeding	9.5	4	Negative
Sowing Date	n/a	0	Lack of evidence
Varietal Choice	9.3	5	Lack of evidence
Stubble Management	n/a	0	Positive
Nutrient Management	11.0	4	Lack of evidence
Hygiene and prevention	9.6	12	Lack of evidence
Seed Rate	n/a	0	Lack of evidence
Seed Testing / Seed Treatments	n/a	0	Lack of evidence
Select low-risk locations	9.8	2	Lack of evidence
Good Drainage	n/a	0	Lack of evidence
Lime	n/a	0	Lack of evidence
Spatial separation	10.0	1	Lack of evidence
Thermal control	7.1	4	Lack of evidence
Control volunteers & weeds	n/a	0	Lack of evidence
Early harvest	8.8	1	Lack of evidence
Seedbed quality	n/a	0	Lack of evidence
Biostimulants & elicitors	9.0	2	Lack of evidence
Pruning/canopy management	11.0	5	Lack of evidence
Fallow	n/a	0	Positive
Environmental control	n/a	0	Lack of evidence
Growing in substrate	n/a	0	Lack of evidence
Pre-plant soil tests	n/a	0	Lack of evidence

Physical exclusion of pests	11.1	2	Positive

Table 4.25: IPM methods and biodiversity impacts for pear.

Strategy	Priority Score (range 6.8 – 12.3)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	9.2	9	Lack of evidence
Primary cultivations (defoliation)	9.1	4	Negative
Secondary cultivations (drilling method)	n/a	0	Positive
Decision support (incl. thresholds)	10.0	3	Neutral
Mechanical Weeding	9.5	4	Negative
Sowing Date	n/a	0	Lack of evidence
Varietal Choice	9.4	8	Lack of evidence
Stubble Management	n/a	0	Positive
Nutrient Management	10.8	3	Lack of evidence
Hygiene and prevention	9.5	11	Lack of evidence
Seed Rate	n/a	0	Lack of evidence
Seed Testing / Seed Treatments	n/a	0	Lack of evidence
Select low-risk locations	8.3	1	Lack of evidence
Good Drainage	n/a	0	Lack of evidence
Lime	n/a	0	Lack of evidence
Spatial separation	10.8	1	Lack of evidence
Thermal control	7.1	4	Lack of evidence
Control volunteers & weeds	n/a	0	Lack of evidence
Early harvest	n/a	0	Lack of evidence
Seedbed quality	n/a	0	Lack of evidence
Biostimulants & elicitors	8.5	1	Lack of evidence
Pruning/canopy management	10.2	3	Lack of evidence

Fallow	n/a	0	Positive
Environmental control	n/a	0	Lack of evidence
Growing in substrate	n/a	0	Lack of evidence
Pre-plant soil tests	n/a	0	Lack of evidence
Physical exclusion of pests	11.8	2	Positive

For carrot and onion the IPM methods not included in the Standard were amber or green for bioprotectants & low risk PPP's, decision support, varietal choice, hygiene and prevention, low-risk locations, thermal control, and biostimulants & elicitors; with sowing date and pre-plant soil tests also included for onion (Table 4.26 and 4.27). All other methods were rated red in at least one of the categories.

Table 4.26: IPM methods and biodiversity impacts for carrot.

Strategy	Priority Score (range 5.3 – 14.0)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	9.8	11	Lack of evidence
Primary cultivations (crop residue burial)	n/a	0	Negative
Secondary cultivations (drilling method)	n/a	0	Positive
Decision support (incl. thresholds)	11.1	3	Neutral
Mechanical Weeding	8.3	4	Negative
Sowing Date	n/a	0	Lack of evidence
Varietal Choice	11.4	4	Lack of evidence
Stubble Management	n/a	0	Positive
Nutrient Management	9.0	1	Lack of evidence
Hygiene and prevention	11.1	9	Lack of evidence
Seed Rate	n/a	0	Lack of evidence
Seed Testing / Seed Treatments	11.5	1	Lack of evidence
Select low-risk locations	9.8	6	Lack of evidence
Good Drainage	n/a	0	Lack of evidence
Lime	n/a	0	Lack of evidence

Spatial separation	n/a	0	Lack of evidence
Thermal control	8.2	5	Lack of evidence
Control volunteers & weeds	11.0	1	Lack of evidence
Early harvest	10.5	1	Lack of evidence
Seedbed quality	9.8	1	Lack of evidence
Biostimulants & elicitors	10.3	3	Lack of evidence
Pruning/canopy management	n/a	0	Lack of evidence
Fallow	12.5	1	Positive
Environmental control	9.8	1	Lack of evidence
Growing in substrate	12.5	1	Lack of evidence
Pre-plant soil tests	11.6	2	Lack of evidence
Physical exclusion of pests	n/a	0	Positive

Table 4.27: IPM methods and biodiversity impacts for onion.

Strategy	Priority Score (range 5.3 – 14.0)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	10.4	11	Lack of evidence
Primary cultivations (crop residue burial)	n/a	0	Negative
Secondary cultivations (drilling method)	n/a	0	Positive
Decision support (incl. thresholds)	11.6	4	Neutral
Mechanical Weeding	9.6	5	Negative
Sowing Date	11.0	3	Lack of evidence
Varietal Choice	11.6	4	Lack of evidence
Stubble Management	n/a	0	Positive
Nutrient Management	11.0	1	Lack of evidence
Hygiene and prevention	11.2	6	Lack of evidence
Seed Rate	n/a	0	Lack of evidence

Seed Testing / Seed Treatments	13.4	2	Lack of evidence
Select low-risk locations	9.9	5	Lack of evidence
Good Drainage	n/a	0	Lack of evidence
Lime	n/a	0	Lack of evidence
Spatial separation	n/a	0	Lack of evidence
Thermal control	8.1	5	Lack of evidence
Control volunteers & weeds	12.0	1	Lack of evidence
Early harvest	n/a	0	Lack of evidence
Seedbed quality	10.5	1	Lack of evidence
Biostimulants & elicitors	11.3	3	Lack of evidence
Pruning/canopy management	n/a	0	Lack of evidence
Fallow	n/a	0	Positive
Environmental control	11.5	1	Lack of evidence
Growing in substrate	n/a	0	Lack of evidence
Pre-plant soil tests	12.7	3	Lack of evidence
Physical exclusion of pests	n/a	0	Positive

For endive and lettuce the IPM methods not included in the Standard were amber or green for bioprotectants & low risk PPP's, sowing date, hygiene and prevention, low-risk locations, spatial separation, biostimulants & elicitors and fallow (Table 4.28). All other methods were rated red in at least one of the categories.

Table 4.28: IPM methods and biodiversity impacts for endive and lettuce.

Strategy	Priority Score (range 3.0 – 13.8)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	10.0	9	Lack of evidence
Primary cultivations (crop residue burial)	n/a	0	Negative
Secondary cultivations (drilling method)	n/a	0	Positive
Decision support (incl. thresholds)	12.3	2	Neutral
Mechanical Weeding	8.6	4	Negative

Sowing Date	8.0	3	Lack of evidence
Varietal Choice	12.8	1	Lack of evidence
Stubble Management	n/a	0	Positive
Nutrient Management	n/a	0	Lack of evidence
Hygiene and prevention	10.2	8	Lack of evidence
Seed Rate	n/a	0	Lack of evidence
Seed Testing / Seed Treatments	n/a	0	Lack of evidence
Select low-risk locations	10.6	8	Lack of evidence
Good Drainage	n/a	0	Lack of evidence
Lime	n/a	0	Lack of evidence
Spatial separation	8.5	3	Lack of evidence
Thermal control	8.3	1	Lack of evidence
Control volunteers & weeds	n/a	0	Lack of evidence
Early harvest	n/a	0	Lack of evidence
Seedbed quality	9.8	1	Lack of evidence
Biostimulants & elicitors	8.6	4	Lack of evidence
Pruning/canopy management	n/a	0	Lack of evidence
Fallow	9.0	3	Positive
Environmental control	7.7	2	Lack of evidence
Growing in substrate	12.5	1	Lack of evidence
Pre-plant soil tests	11.1	2	Lack of evidence
Physical exclusion of pests	11.3	1	Positive

For leaf and root brassicas the IPM methods not included in the Standard were amber or green for bioprotectants & low risk PPP's, decision support, sowing date, hygiene and prevention, seed testing and seed treatments, low-risk locations, spatial separation, biostimulants & elicitors and fallow; with varietal choice and seedbed quality also included for leaf brassicas (Tables 4.29 and 4.30). All other methods were rated red in at least one of the categories.

Table 4.29: IPM methods and biodiversity impacts for leaf brassicas.

Strategy	Priority Score (range 7.0 – 12.3)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	9.9	8	Lack of evidence
Primary cultivations (crop residue burial)	n/a	0	Negative
Secondary cultivations (drilling method)	n/a	0	Positive
Decision support (incl. thresholds)	10.6	5	Neutral
Mechanical Weeding	9.5	5	Negative
Sowing Date	9.0	1	Lack of evidence
Varietal Choice	10.4	4	Lack of evidence
Stubble Management	n/a	0	Positive
Nutrient Management	9.0	1	Lack of evidence
Hygiene and prevention	9.6	6	Lack of evidence
Seed Rate	n/a	0	Lack of evidence
Seed Testing / Seed Treatments	10.8	3	Lack of evidence
Select low-risk locations	9.8	9	Lack of evidence
Good Drainage	n/a	0	Lack of evidence
Lime	n/a	0	Lack of evidence
Spatial separation	10.6	4	Lack of evidence
Thermal control	8.5	1	Lack of evidence
Control volunteers & weeds	n/a	0	Lack of evidence
Early harvest	n/a	0	Lack of evidence
Seedbed quality	8.5	5	Lack of evidence
Biostimulants & elicitors	9.1	6	Lack of evidence
Pruning/canopy management	n/a	0	Lack of evidence
Fallow	11.0	3	Positive
Environmental control	10.0	1	Lack of evidence

Growing in substrate	n/a	0	Lack of evidence
Pre-plant soil tests	n/a	0	Lack of evidence
Physical exclusion of pests	n/a	0	Positive

Table 4.30: IPM methods and biodiversity impacts for root brassicas.

Strategy	Priority Score (range 7.3 – 12.5)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	10.0	7	Lack of evidence
Primary cultivations (crop residue burial)	n/a	0	Negative
Secondary cultivations (drilling method)	n/a	0	Positive
Decision support (incl. thresholds)	11.6	4	Neutral
Mechanical Weeding	9.4	5	Negative
Sowing Date	n/a	0	Lack of evidence
Varietal Choice	n/a	0	Lack of evidence
Stubble Management	n/a	0	Positive
Nutrient Management	n/a	0	Lack of evidence
Hygiene and prevention	10.8	6	Lack of evidence
Seed Rate	n/a	0	Lack of evidence
Seed Testing / Seed Treatments	12.5	4	Lack of evidence
Select low-risk locations	11.3	7	Lack of evidence
Good Drainage	n/a	0	Lack of evidence
Lime	n/a	0	Lack of evidence
Spatial separation	12.3	2	Lack of evidence
Thermal control	9.5	1	Lack of evidence
Control volunteers & weeds	n/a	0	Lack of evidence
Early harvest	n/a	0	Lack of evidence
Seedbed quality	n/a	0	Lack of evidence

Biostimulants & elicitors	9.7	4	Lack of evidence
Pruning/canopy management	n/a	0	Lack of evidence
Fallow	12.5	2	Positive
Environmental control	n/a	0	Lack of evidence
Growing in substrate	n/a	0	Lack of evidence
Pre-plant soil tests	8.3	1	Lack of evidence
Physical exclusion of pests	n/a	0	Positive

For rye and tricticale the IPM methods not included in the Standard were amber or green for sowing date, varietal choice, nutrient management, hygiene and prevention, and control of volunteers and weeds (Table 4.31). All other methods were rated red in at least one of the categories.

Table 4.31: IPM methods and biodiversity impacts for rye and triticale.

Strategy	Priority Score (range 7.8 – 13.0)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	n/a	0	Lack of evidence
Primary cultivations (crop residue burial)	12.6	2	Negative
Secondary cultivations (drilling method)	12.0	1	Positive
Decision support (incl. thresholds)	10.5	1	Neutral
Mechanical Weeding	8.8	4	Negative
Sowing Date	11.0	3	Lack of evidence
Varietal Choice	13.0	2	Lack of evidence
Stubble Management	9.0	1	Positive
Nutrient Management	9.8	3	Lack of evidence
Hygiene and prevention	12.3	2	Lack of evidence
Seed Rate	9.3	1	Lack of evidence
Seed Testing / Seed Treatments	12.5	1	Lack of evidence
Select low-risk locations	n/a	0	Lack of evidence
Good Drainage	9.5	1	Lack of evidence

Lime	n/a	0	Lack of evidence
Spatial separation	8.8	3	Lack of evidence
Thermal control	10.5	1	Lack of evidence
Control volunteers & weeds	11.5	5	Lack of evidence
Early harvest	n/a	0	Lack of evidence
Seedbed quality	9.3	1	Lack of evidence
Biostimulants & elicitors	n/a	0	Lack of evidence
Pruning/canopy management	n/a	0	Lack of evidence
Fallow	n/a	0	Positive
Environmental control	n/a	0	Lack of evidence
Growing in substrate	n/a	0	Lack of evidence
Pre-plant soil tests	n/a	0	Lack of evidence
Physical exclusion of pests	n/a	0	Positive

The biodiversity review did not include beans and peas as a listed crop. For both the IPM methods not included in the Standard were amber or green for bioprotectants & low risk PPP's, decision support, varietal choice, stubble management, nutrient management and hygiene and prevention; with low-risk locations, spatial separation, and control of volunteers and weeds also included for beans (Tables 4.32 and 4.33). All other methods were rated red in at least one of the categories.

Table 4.32: IPM methods for beans.

Strategy	Priority Score (range 7.0 – 12.8)	No. of crop pests action is effective against
Bioprotectants & low risk PPP's	12.0	1
Primary cultivations (crop residue burial)	9.8	2
Secondary cultivations (drilling method)	12.0	1
Decision support (incl. thresholds)	11.0	4
Mechanical Weeding	11.0	1
Sowing Date	8.3	2
Varietal Choice	10.3	2

Stubble Management	9.9	5
Nutrient Management	9.5	2
Hygiene and prevention	10.6	2
Seed Rate	10.5	1
Seed Testing / Seed Treatments	n/a	0
Select low-risk locations	9.4	3
Good Drainage	n/a	0
Lime	n/a	0
Spatial separation	9.3	3
Thermal control	10.5	1
Control volunteers & weeds	11.3	2
Early harvest	n/a	0
Seedbed quality	7.0	1
Biostimulants & elicitors	n/a	0
Pruning/canopy management	n/a	0
Fallow	12.3	1
Environmental control	n/a	0
Growing in substrate	n/a	0
Pre-plant soil tests	n/a	0
Physical exclusion of pests	n/a	0

Table 4.33: IPM methods for peas.

Strategy	Priority Score (range 6.3 – 12.8)	No. of crop pests action is effective against
Bioprotectants & low risk PPP's	10.9	2
Primary cultivations (crop residue burial)	9.8	3
Secondary cultivations (drilling method)	12.0	1

Decision support (incl. thresholds)	11.0	2
Mechanical Weeding	11.0	1
Sowing Date	9.3	1
Varietal Choice	9.3	3
Stubble Management	9.4	6
Nutrient Management	9.0	2
Hygiene and prevention	10.6	2
Seed Rate	10.5	1
Seed Testing / Seed Treatments	8.3	1
Select low-risk locations	9.8	1
Good Drainage	n/a	0
Lime	n/a	0
Spatial separation	9.5	0
Thermal control	10.5	0
Control volunteers & weeds	n/a	0
Early harvest	n/a	0
Seedbed quality	7.0	1
Biostimulants & elicitors	n/a	0
Pruning/canopy management	n/a	0
Fallow	12.3	1
Environmental control	n/a	0
Growing in substrate	n/a	0
Pre-plant soil tests	n/a	0
Physical exclusion of pests	n/a	0

For fodder crops the IPM methods not included in the Standard were amber or green for secondary cultivations, decision support, varietal choice, stubble management, hygiene and prevention, seed

rate, low-risk locations, lime, spatial separation, control of volunteers & weeds, seedbed quality and fallow (Table 4.34). All other methods were rated red in at least one of the categories.

Table 4.34: IPM methods and biodiversity impacts for fodder crops.

Strategy	Priority Score (range 5.5 – 13.0)	No. of crop pests action is effective against	Biodiversity Impact
Bioprotectants & low risk PPP's	n/a	0	Lack of evidence
Primary cultivations (crop residue burial)	8.8	6	Negative
Secondary cultivations (drilling method)	9.5	2	Positive
Decision support (incl. thresholds)	10.7	5	Neutral
Mechanical Weeding	7.0	2	Negative
Sowing Date	6.3	1	Lack of evidence
Varietal Choice	10.7	3	Lack of evidence
Stubble Management	8.2	6	Positive
Nutrient Management	6.9	3	Lack of evidence
Hygiene and prevention	12.8	2	Lack of evidence
Seed Rate	11.2	2	Lack of evidence
Seed Testing / Seed Treatments	n/a	0	Lack of evidence
Select low-risk locations	9.9	5	Lack of evidence
Good Drainage	n/a	0	Lack of evidence
Lime	9.9	2	Lack of evidence
Spatial separation	9.4	3	Lack of evidence
Thermal control	n/a	0	Lack of evidence
Control volunteers & weeds	9.5	5	Lack of evidence
Early harvest	n/a	0	Lack of evidence
Seedbed quality	8.8	2	Lack of evidence
Biostimulants & elicitors	n/a	0	Lack of evidence

Pruning/canopy management	n/a	0	Lack of evidence
Fallow	9.0	3	Positive
Environmental control	n/a	0	Lack of evidence
Growing in substrate	n/a	0	Lack of evidence
Pre-plant soil tests	n/a	0	Lack of evidence
Physical exclusion of pests	n/a	0	Positive

Summary Tables

Paid actions included in the draft Standard:

Table 4.35: Summary of crops where there is evidence for the proposed paid action having a positive impact.

+ indicates green or orange ranking across metrics for efficacy/strength of evidence/scope for increased uptake, number of pests controlled and biodiversity impact.

	Crop (see key below table)																
Strategy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
In field non-cropped areas		+				+											
Field history, rotation & break crops	+	+	+				+	+	+	+	+	+	+	+			+
Undersowing & Companion cropping							+					+	+		+	+	+
Cover Crops															+	+	
Trap Cropping																+	
Intercropping															+	+	
Precision application			+		+	+			+	+	+	+	+		+	+	

Crop key: 1 cereals; 2 oilseeds; 3 potato; 4 grapevine; 5 raspberry; 6 strawberry; 7 apple; 8 pear; 9 carrot; 10 onion; 11 lettuce; 12 leaf brassicas; 13 root brassicas; 14 rye/tritcale; 15 beans; 16 peas; 17 fodder crops.

Potential paid actions not included in draft Standard:

Table 4.36: Summary of crops where there is evidence for the proposed paid action having a positive impact.

+ indicates green or orange ranking across metrics for efficacy/strength of evidence/scope for increased uptake, number of pests controlled and biodiversity impact.

	Crop (see key above)																
Strategy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Bioprotectants & low risk PPP's	+	+		+	+	+	+	+	+	+	+	+	+			+	

Primary cultivations (crop residue burial)			+		+										+	+	
Secondary cultivations (drilling method)	+	+															+
Decision support (incl. thresholds)	+	+	+	+	+	+	+	+	+	+		+	+		+	+	+
Mechanical Weeding																	
Sowing Date	+	+								+	+			+			
Varietal Choice	+	+	+	+	+		+	+	+	+		+		+	+	+	+
Stubble Management	+	+													+	+	+
Nutrient Management	+						+	+						+	+	+	
Hygiene and prevention	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Seed Rate	+	+															+
Seed Testing / Seed Treatments			+	+	+							+	+				
Select low-risk locations	+	+	+	+					+	+	+	+	+		+		+
Good Drainage																	
Lime																	+
Spatial separation		+									+	+	+		+		+
Thermal control									+	+							
Control volunteers & weeds	+		+			+								+	+		+
Early harvest			+														
Seedbed quality	+	+	+									+					+
Biostimulants & elicitors									+	+		+	+				
Pruning/canopy management							+	+									
Fallow	+										+	+	+				+
Environmental control																	
Growing in substrate																	
Pre-plant soil tests										+							
Physical exclusion of pests																	

Crop key: 1 cereals; 2 oilseeds; 3 potato; 4 grapevine; 5 raspberry; 6 strawberry; 7 apple; 8 pear; 9 carrot; 10 onion; 11 lettuce; 12 leaf brassicas; 13 root brassicas; 14 rye/tritcale; 15 beans; 16 peas; 17 fodder crops.

4.3 WP 3 CONCLUSIONS

Paid Actions Included in the draft IPM SFI Standard

- Three of the proposed paid actions were justified by the evidence, either on the grounds of positive biodiversity impact or good evidence for efficacy and scope for increased uptake. However, most of the proposed paid actions were limited in the range of pests against which they would be effective, so their impact on reducing the need for and risks associated with pesticide use would be limited. The likely impact of specific actions is summarised below:
- *In-field non-cropped area* was supported by evidence of positive biodiversity impact. This paid action was proposed to be considered primarily as a good integrated farm management practice, which will have benefits to control of a few pests, rather than being primarily an IPM practice.
- *Field history, rotation and break crops* was supported by evidence of positive biodiversity impact and can help to reduce the need for pesticide applications against multiple pests in many crops. There are many possible rotations, each optimised to control particular pests in particular crops, cropping systems and environments (soil type etc). However, defining and verifying what constitutes a 'good IPM rotation' as a paid action was considered to be complex and probably unachievable. Defra SFI Standard team identified spring cropping as a potential for inclusion in the Standard, for which further advice was provided by the project team (see WP3 Supplementary material).
- *Precision application* was identified to have benefits targeting pesticide applications against multiple pests in many crops, thereby reducing risks Uptake of precision application was proposed, in principle, to be fostered either as a paid action or by supporting capital investment.
- Further guidance was provided to the Defra SFI Standard team on the proposed paid actions as the IPM SFI Standard was updated on 21 September 2022.

Potential Paid Actions not included in the draft IPM SFI Standard

- Four potential paid actions were identified with strong evidence for positive impacts across a wide range of pests and crops, specifically:

  i) Bioprotectants and low risk PPPs.

  (ii) Decision support, includings thresholds.

  (iii) Varetial choice.

  (iv) Hygiene and prevention.
- The evidence for these actions was as strong, or stronger, than the current proposed paid actions.
- Their suitability as paid actions was dependent on how they could be defined and verified.
- The proposed and potential paid actions, for which there was strong evidence for impact, was considered to be effective across a diverse range of arable and horticultural crops. Therefore the proposal for a single Standard was considered feasible.
- Further guidance was provided to the Defra SFI Standard team on how the proposed paid actions could feasibility be included in the IPM SFI Standard (see WP3 Supplementary material).
- Evidence collated for the use of bioprotectants and low risk PPPs found that from liaison between Defra and CRD it was confirmed that there are 24 low risk active substances. Currently there was not a full list available from CRD for the number of low risk products available therefore it was concluded that this could not be included in the IPM SFI Standard until further information was made available.

- Evidence collated for the use of hygiene and prevention found that not all actions would be widely applicable and many are crop specific. Also widely applicable actions (destruction of crop residues, volunteers, weeds) are generally net negative for biodiversity impact. Therefore it was concluded that this could not feasibility be included in the IPM SFI Standard.
- Evidence collated for the use of disease and pest resistance varieties found that easily accessed information was available for a wide range of crops and it would be feasible to be included in the IPM SFI Standard. A draft example Standard was provided to Defra on 6 October 2022 for resistant varieties (see WP3 Supplementary material).
- Evidence collated for the use for decisions support systems found that there was good diversity of decision support available across crops, making it technically feasible to include decision support systems in the IPM SFI Standard. It was concluded that there been under-investment in DSS development and validation in the UK, so the initial aim would be to incentivise farmers to follow the guidance on some fields, in order to gain trust. A draft example Standard was provided to Defra on 6 October 2022 for decision support systems (see WP3 Supplementary material).

Feedback on Paid Actions included in the published IPM SFI Standard

Defra published the IPM paid actions on 26 January 2023 (Table 4.37).

Table 4.37: Paid actions, payment rates and intended impacts of the IPM SFI 2023 Standard

SFI 2023 standard	Action	Payment rate	Main positive environmental impacts	New action or variation of CS option
Integrated pest management	Complete an integrated pest management (IPM) assessment and produce an IPM plan	£989 per year	Not applicable	New
Integrated pest management	Establish and maintain flower-rich grass margins, blocks, or in-field strips	£673 per hectare	Biodiversity, carbon, water quality, soil health, climate adaptation	AB8 variation
Integrated pest management	Establish a companion crop	£55 per hectare	Climate adaptation, biodiversity, water quality, soil health	New
Integrated pest management	No use of insecticide	£45 per hectare	Biodiversity	New

For transparency, ADAS and SRUC published a response to the IPM SFI standard on their websites, on behalf of the T&T group. The text was notified to Defra in advance and publication agreed. The statement text is reproduced below:

The T&T project has:

- Summarised evidence from hundreds of research papers and reports on the effectiveness of different IPM actions.
- Provided expert input to Defra on the practicality and beneficial impacts from potential paid actions.
- Worked with farmers to determine how IPM actions fit within different farming systems, and to indicate payment rates required to incentivise uptake of paid actions.

In providing independent technical oversight, the project team make the following observations on the SFI IPM Standard:

- ADAS and SRUC welcome the publication of the SFI IPM Standard.
- A clear message to Defra was the importance of flexibility to choose those IPM actions that are achievable on farms with different cropping practices and conditions. That flexibility has been provided in SFI.
- Funding of IPM planning as a paid action is a useful step. The project is currently testing an IPM Tool to aid planning. A hundred farmers and agronomists have trialled the tool, and their feedback will be used to improve it. We are working to align the IPM Tool with existing IPM plans by the Voluntary Initiative and LEAF, to avoid duplication of effort.
- The paid actions on flower rich margins/strips, companion cropping and no insecticide use are all actions which are readily visible or understandable by tax-payers, and verifiable for auditing. However, the evidence base shows there are better IPM actions for farmers.
- A pre-season decision to not use insecticide is not within the principles of IPM, whereby treatments are used according to need.
- The role of the project team has been to provide evidence to inform design of the Standard through Defra's Tests and Trials Programme. Some policies adopted in this Standard do not align with the evidence gathered and the recommendations made.
- Other possible paid actions were identified by the project which would be more effective as IPM control measures for insect pests, weeds and diseases, but were not included in the Standard at this stage. These include increasing use of: precision application, crop diversity in the rotation, pest and disease resistant varieties, and decision support.

In summary:

- The SFI IPM Standard is a useful step to encourage IPM adoption.
- There is a significant risk that the paid actions will achieve limited impacts in relation to the risks associated with pesticide use.

4.4 WP 3 Supplementary Material

Evidence for inclusion of spring cropping in the IPM SFI Standard

Evidence was collated from the AHDB IPM broadacre (Blake *et al*., 2021) and AHDB non broadacre (Young *et al*., 2022) reviews, the Natural England IPM for Biodiversity review (Cook *et al*., in draft), the 2007 Defra report 'The potential for increasing the area of spring cropping to enhance biodiversity (IFO130)' and through consultation with ADAS specialists on pathology, entomology and weed science on the IPM benefit of including spring cropping in rotation. A summary of the findings below were presented to Defra at the project meeting on 14 September 2022:

- Generally spring crops are less susceptible to pest damage than autumn sown crops primarily because they establish and grow quickly, and reach a growth stage at which they are no longer susceptible to common pests.
- Incorporating a spring crop into a winter dominated rotation does allow for a fallow period and can achieve similar effects to a full fallow, with greater diversity of weed species and an increase in soil seed bank.
- The interval between harvesting a crop and the drilling of the next one can be used to control weeds by cultivations or use of glyphosate.
- It was generally found that most spring crops have similar or less pesticides applied than winter crops.
- The biodiversity benefits were found to be as a result of the lower density structure and more open canopy with improved seed availability encouraging bird feeding and breeding.

Evidence for inclusion of hygiene and prevention in the IPM SFI Standard

Evidence was collated from the AHDB IPM broadacre (Blake *et al*., 2021) and AHDB non broadacre (Young *et al*., 2022) reviews, the Natural England IPM for Biodiversity review (Cook *et al*., in draft), and through consultation with ADAS specialists on pathology, entomology and weed science on the IPM benefit of hygiene and prevention. A summary of the findings below were presented to Defra at the project meeting on 14 September 2022:

- Maintaining good farm hygiene was the most widely applicable action. This involved the cleaning of farm equipment and limiting the movement of infected soils.
- Use of certified seed was applicable across all cropping types. In some crops similar benefits to seed health can be obtained by home saved seed that has been tested/treated appropriately.
- Limiting transport of contaminated straw from weed infested sites was applicable across all cropping types.
- The ploughing of crop residues at the end of the crop was particularly important in areas of intensive cropping to prevent spread of foliar and trash borne infections, but ploughing has negative effects on soil biodiversity.
- Many actions are crop specific for outdoor vegetables, potatoes, salad crops and orchards.

Evidence for inclusion of resistant varieties in the IPM SFI Standard

For the use of resistant varieties to become a paid action, farmers and agronomist would need readily available access to information on the disease and pest resistance of crop varieties. A summary of the information available in the public domain for the main crops was presented to Defra at the project meeting on 14 September 2022:

- Wheat, Barley, Oats, Oilseeds – AHDB Recommended Lists (RL) for cereals and oilseeds is published annually and can be accessed online https://ahdb.org.uk/knowledge-library/recommended-lists-for-cereals-and-oilseeds-rl
- Peas and Beans – PGRO produces descriptive List for combining peas and winter and spring beans, which can be accessed online https://www.pgro.org/choice-of-varieties-and-pgro-recommended/
- Sugar Beet – BBRO Recommended List (RL) is published annually and can be accessed online https://bbro.co.uk/sugar-beet-varieties/recommended-list/
- Apple and Pear – No national lists produced. Most varieties grown in the UK are from non-UK breeding lines and information is available direct from some specialist nurseries.
- Maize – Maize Growers Association produce variety information which is only available for members. The BSPB Forage Maize Crop Group organise independent Descriptive List testing for forage maize varieties, which is managed by NIAB and can be assessed online https://www.niab.com/research/agronomy-and-farming-systems/variety-evaluation-and-management/bspb-forage-maize. Further lists are available on plant breeders' websites such as LG Seeds, KWS and RAGT.
- Grassland – AHDB England and Wales Recommended Grass and Clover Lists (RGCL) can be assessed online https://ahdb.org.uk/recommended-grass-and-clover-lists
- Potatoes – The European Cultivated Potato Database maintained by Science and Advice for Scottish Agriculture (SASA) provides up to date information on potato varieties https://www.europotato.org/. The AHDB Potatoes Independent Variety Trials (IVT) programme produced independent resistance data for pests, diseases and pathogens up to 2018. Data was published in the Potato Variety Database and can be assessed online https://potatoes.agricrops.org/
- Brassicas – No national list produced, and independent trials no longer funded by AHDB. Variety trials in UK are organised by the seed companies e.g. Elsoms, and reported at open days, conferences and published in catalogues. Historic AHDB variety information can be found via https://horticulture.ahdb.org.uk/knowledge-library/brassica-resources

Evidence for inclusion of decision support systems in the IPM SFI Standard

For the use of decision support system to become a paid action, farmers and agronomist would need readily available access to DSS. A summary of the systems available by public domain (IPM Decisions and AHDB) for the main cropping key pest and diseases were presented to Defra at the project meeting on 14 September 2022:

- Orange wheat blossom midge.
- Cutworm
- Saddle gorge midge.
- BYDV.
- Potato late blight.
- Septoria leaf blotch.
- Pollen beetle.
- Phoma stem canker.
- Sclerotinia in oilseed rape.
- Light leaf spot.
- Wheat bulb fly.
- Carrot fly.
- Cabbage root fly.
- Aphids (multiple crops).

Example Standard text - resistant varieties

Apparently simple potential paid actions, such as the use of resistant varieties, can still pose challenges to define what farmers would need to do to meet the Standard. For example:

- The important diseases and pests differ between crops and locations – so which diseases and pests should the Standard require resistance against?
- The level of resistance available differs between crops and pests, and resistance in different crops is measured on different scales - so what constitutes a 'resistant variety'?
- Resistant varieties may not exist for all crops in the rotation on the land in the Standard.

Example wording for Standards was provided (below) to illustrate how paid actions could be defined. The format used in the SFI Soil Standard was adopted:

Proposed action for intermediate or advanced:

Action X: Grow crop varieties which have good resistance against diseases and insect pests

The action's aim

You must achieve this action's aim, which is to:

• Grow varieties which have good resistance against key diseases and pests on a percentage of your land in the Standard

This will provide more crop resilience against diseases and pests, and reduce the need for pesticide treatments.

What to do

Decide which key diseases and insect pests are prevalent on your farm; particularly to identify those which drive most pesticide treatment. Using the IPM planning tool to create an IPM management plan (for the intermediate or advanced Standard) will have completed this action.

Find out whether variety resistance is available against some or all of those key diseases and pests. Variety resistance ratings against diseases and pests in different major crops are available here [link] or through the IPM planning tool.

Grow varieties which have above average resistance ratings for [two] or more of the key diseases or pests, on [80]% of your land in the Standard.

When to do it

Variety choice needs to be made before seed ordering or deciding what seed to home save. This will normally coincide with pre-season IPM planning.

You must follow the points described in the section above (What to do) every year of your agreement, because new varieties become available that may enable a higher level of disease or pest resistance.

How to do it

Key diseases and pests and the varieties chosen for their above average resistance can be recorded digitally (in the IPM planning tool) or on paper. The records should include the resistance ratings against the key diseases or pests.

You may find it helpful to read the guidance on IPM planning [link].

What evidence to keep

You must keep a record of the seed bought or home-saved - including the varieties bought and their quantities. You must supply this evidence when we ask for it.

Records from mobile seed treatment can help substantiate the varieties and land areas sown from home-saved seed.

Example Standard text - decision support

Proposed action for intermediate or advanced:

Action [Z]: Use decision support systems (DSS) to inform the need for pesticide treatments

The action's aim

You must achieve this action's aim, which is to:

- Use pesticides according to need, using decision support* to help inform treatment decisions.

This will help avoid unnecessary treatments which would otherwise create environmental impacts and financial costs.

*Decision support includes, for example, published treatment thresholds, and online systems to estimate the risk of diseases and insect pests based on weather conditions.

What to do

Decide which key diseases, insect pests and weeds are prevalent on your farm; particularly to identify those which drive most pesticide treatment. Using the IPM planning tool to create an IPM management plan (for the intermediate or advanced Standard) will complete this action.

Find out whether there are decision support tools available to guide pesticide treatment decisions for some of those diseases, pests and weeds. Information on available decision support tools is available here [link] or through the IPM planning tool.

Option A: If you already have confidence in particular decision support tools, use the information from the decision support tools as one part of the evidence used to decide on the need for pesticide treatment (alongside, for example, knowledge of the crop varieties grown, the crop rotation and previous experience of the disease, pest or weed on your farm).

Option B: Assess the potential value of decision support tools for use in future seasons by: (i) consulting the decision support system during the part of the growing season where treatment decisions are being made, (ii) noting the risk prediction and how it could have influenced your treatment decisions, and (iii) comparing the prediction with subsequent pest, disease or weed pressure.

A combination of options A and B can be used for different crops or for different pests, diseases or weeds within the land in the Standard. The total area of land within the Standard in which A or B is implemented will be [70]%.

When to do it

A list of the key pests, diseases and weeds on your farm should be made during pre-season IPM planning.

Finding available decision support systems can also be done pre-season or at any time before the first treatment decisions need to be made.

You must follow the points described in the section above (What to do) every year of your agreement, because (i) new decision support tools are likely to become available, and (ii) using options A or B over a number of seasons will build experience in their use.

How to do it

Keep a record of the decision support systems consulted at the time of pesticide treatment decisions. This can be noted in your pesticide treatment records if you wish.

The record should note whether consulting the decision support system influenced the treatment decision (option A) or was noted to gain experience in the predictive value of the system (option B).

It is accepted that consulting a decision support system may increase or decrease your assessment of the risk of crop loss, depending on the circumstances at the time of the decision for a particular crop.

If a BASIS qualified adviser makes pesticide treatment recommendations for your crops, the paid actions can be completed by them on your behalf. You will still be responsible for ensuring the paid actions of the IPM Standard have been met and for providing evidence (see section below 'What evidence to keep').

You may find it helpful to read the guidance on IPM planning [link].

What evidence to keep

Records of the decision support systems consulted at the time of pesticide treatment decisions.

Records can be digital (for example, within farm management software) or on paper.

You must supply this evidence when we ask for it.

APPENDIX 5 - WORK PACKAGE 4: TO DETERMINE THE STRUCTURE OF ECONOMIC INCENTIVES FOR FARMER PARTICIPATION IN THE SFI SCHEME

5.1 WP 4 METHODOLOGY

5.1.1 Development of questionnaire to elicit information on support needed to encourage uptake of measures related to standards

Questionnaires were designed to collect information on a) the respondent and their enterprise, b) practicalities of implementing IPM activities related to the standards, c) estimated costs of implementing different IPM activities, and d) estimates of payment rates per level of involvement in the scheme.

A choice experiment was also used to understand risk/reward elicitation and explore directly how changes in the payments would affect uptake. The experiment used ten tables containing a set of bundles along their columns; each bundle containing different IPM actions described along the rows that generated a different subsidy per bundle. Respondents were asked to rank those bundles from the most preferred to the least preferred. Respondents were also asked if they would adopt the most preferred bundle in each table, to incorporate the possibility that none of the bundles would be preferred by the respondent. The option "none" was incorporated into the econometric analysis as the baseline group which represented a choice of doing nothing and receiving no subsidy. The experiment was designed to be simple and easily understood by growers/farmers of all levels of education, and as short as possible to maximise the response rate. The questionnaire allowed the introduction of several key potential drivers of bundle selection such as age or farming experience. Both questionnaires were completed during the workshop. Questionnaires were designed using Microsoft Forms.

5.1.2 Recruitment of farmers/growers to participate in sector specific workshops

Workshop participants (farmers/growers) were selected based on farm type/crops grown (arable/outdoor horticulture) and willingness to engage in discussions on the feasibility, risks and costs associated with a set of actions related to the specific standards. Most of these participants were selected from the candidate list identified in WP1. Email invitations were sent out prior to each half day workshop, which were conducted online via Microsoft Teams.

5.1.3 Workshop design

Two online workshops (one arable focused, one outdoor horticulture focused) with the selected group of farmers/growers were held in November 2022. The arable focused workshop was held on 3 November and involved 23 participants. The horticulture focused workshop was held on 15 November 2022 and involved 8 participants. At each workshop research staff from SRUC and ADAS presented the project, the proposed SFI IPM Standards and associated actions, and the questionnaire (including the choice experiment) used to inform subsidy payment rates. After an initial introduction, the workshop group was split into sub-groups of 7-10 participants for discussion on each standard individually and what is required to achieve it. Breaking out into smaller groups encourages all participants to contribute to the discussion. An ADAS/SRUC facilitator was present in each sub-group to answer questions and steer the discussion towards the questions contained within the questionnaire, which farmers completed during the workshop. The horticulture workshop was smaller than the arable one, so there was no need to break out into smaller discussion groups.

The importance of grower/farmer participation and how data would be handled was emphasised, as was the importance of the potential outcome of the experiment. A participatory communication

strategy was used, where stakeholders are put at the forefront of the social choice. Participants were reimbursed for their time in attending the workshops.

5.1.4 Analysis of workshop questionnaire data and development of key policy messages

The quantitative data on the risks, practicalities, knowledge requirements and costs associated with IPM activities related to the IPM standards was analysed along with the economic data collected. Findings were used to generate key policy messages and guidance on payment incentives.

5.1.5 Proposed standards to be evaluated

Seven IPM topics and the related IPM actions that might incentivise IPM uptake were discussed and evaluated:

Topic 1: Training and planning

Topic 2: Habitat for natural enemies

Topic 3: Crop diversity

Topic 4: Pest and disease resistance

Topic 5: Decision support

Topic 6: No insecticide/molluscicide

Topic 7: Pesticide alternatives

Note that the inclusion of these topics in the workshops does not imply that any particular action will, or will not, be included in the SFI IPM Standard.

Each topic and the associated paid actions were discussed as a whole group or sub-group, each of which was facilitated by a T&T project team member. The topics were as follows:

Table 5.1: Topic 1: Training and Planning.

Action	Further information
Have a crop specific IPM plan.	A separate written plan is made for each crop (first developed in last T&T project).
Have a whole farm IPM plan.	e.g. the Voluntary Initiative IPM plan, LEAF plan or similar.
Receive advice on IPM planning and Implementation from BASIS Qualified Adviser.	1 visit per year of agreement. This action is combined with the whole farm IPM plan.
IPM training (workshops, webinars, events).	CPD point scheme.

Table 5.2: Topic 2: Habitat for natural enemies.

Action	Further information
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm).	e.g. wildflower and tussocky grass mixtures. Connectivity (wildlife corridors) between biodiversity refuges must be considered. Focus is on encouraging natural enemies e.g. predators, parasitoids.
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm) + Grow an in-field habitat of at least 1% of the land (such as beetle bank or planted strip).	NB: action requires that you grow habitat for natural enemies on at least 4% of the land.

Table 5.3: Topic 2: Crop diversity.

Action	Further information
Include at least one spring crop in every 3 years of the rotation.	Agreement is 3 years long.
No second winter cereals grown in the rotation.	Agreement is 3 years long.
Include at least 3 different crop types (spring cereal, winter cereal, brassica, legume, root, tuber, maize, other) in a 4-year rotation.	The farmer provides evidence of cropping in the year preceding the three years of the agreement. This enables sight of four years of a rotation. The paid action is for what is done within the three years of the agreement. The crops grown within the three years will depend on the crops grown in the preceding year.
Include a companion crop on at least 10% of the land.	e.g. Undersowing, Intercropping, Trap cropping.

Table 5.4: Topic 4: Resistant varieties (square brackets show indicative values).

Action	Further information
Grow resistant varieties.	Resistant varieties have above average resistance ratings for [two] or more of the key diseases or pests, on [80]% of your land in the standard. May include variety mixtures.

Table 5.5: Topic 5: Decision support.

Action	Further information
Use of Decision Support Systems/Decision Support Tools.	Where available. May include published treatment thresholds, and online systems to estimate the risk of diseases and insect pests based on weather conditions.

Table 5.6: Topic 6: No insecticide/molluscicides.

Action	Further information
Insecticide/molluscicides not applied to all land in standard.	Retro specific payment if achieved.

Table 5.7: Topic 7: Pesticide alternatives.

Action	Further information
Bioprotectants and low risk PPPs.	Where available.

Table 5.8: Topic 8: Precision/targeted PPP application (proposed by workshop participants).

Action	Further information
Precision/targeted PPP application.	GPS guided spraying, boom section control to avoid overlaps, variable rate spraying, weed wipers, droplet applicator etc. Equipment used noted on spray sheet for auditability. Could be a combination of £reward/ha and grants for purchasing equipment. Contractor using precision equipment would benefit from increased workload.

5.2 WP 4 RESULTS

5.2.1 Summary of workshop discussions around proposed IPM Standards

The main findings from both the arable and outdoor horticulture focused workshops are summarised below. Facilitator notes were the primary method of data collection.

Topic 1: Training and Planning

- IPM planning was widely accepted as good practice. The majority of growers/farmers are already completing some form of IPM plan whether that be the NFU/VI or LEAF whole farm IPM assessment plan or a crop specific IPM plan for their customers (e.g. retailers). Plans must be aligned to reduce any repetition/duplication between them.
- There is demand for crop specific plans (IPM Tool) but they must be dynamic (accounting for crop nuances and the time of year etc.) and allow for the incorporation of in-field observations so farmers can more easily input information which may help to better quantify the benefits IPM.
- It is important that the IPM plans are accepted by quality assurance/certification schemes.
- IPM plans/IPM Tools can be used as a central repository of information which allows the best practice information on successful and commonly adopted IPM measures to be shared, and which may serve to encourage uptake of best practice and raise awareness of possible new interventions or products.
- There is an issue in that IPM education and training is often aimed at the lower adopters of IPM, with little valuable information being provided to those already implementing IPM to a high level. IPM training must be relevant to the intended audience.
- BASIS trained agronomist(s) may be on site in many horticultural businesses. Some arable farmers are also BASIS registered. Support for receiving advice from BASIS registered agronomist is only likely to benefit the >10% farmers who currently do not consult one.
- Not all participants were receptive to the idea of being rewarded for continued professional development (CPD) in IPM, auditable through a CPD point or similar scheme. Participants do not want another scheme and would prefer instead something compatible with BASIS/NRoSO schemes that are currently in existence. Some were concerned that farmers simply do not have the time to upskill themselves. As this scheme is not mandatory it was not seen as a barrier by all participants, and some welcomed the opportunity to be rewarded for increasing their IPM knowledge.

Topic 2: Habitat for natural enemies

- Creating habitat for natural enemies is often seen as a biodiversity/conservation goal, and unlikely to change current IPM practice in many crops, though benefits may be achieved in permanent cropping systems e.g. top fruit and some soft fruit.
- The practices are likely included in other conservation/biodiversity schemes therefore such overlaps will need to be investigated with clear information being provided to the SFI participant.
- It is imperative to define what constitutes natural enemy habitat. Different natural enemies require different habitats, and these may vary from crop to crop over the rotation. Creating these habitats increases pests as well as beneficials, which requires balancing in the favour of the predators. Overwintering habitat that facilitates early emergence of enemies is key.
- Evidence from research on crop specific mixes - to improve beneficials or act as catch crops etc. and dissemination of best management practice, is essential in order to avail of the potential benefits.
- In-field measures were widely considered bad practice as they take land out of production (which can be very costly for premium crops), take time to yield results (often several years making them ineffective if moving between fields in rotation), they complicate the agronomy (multiple crops growing and interacting together), and there is little evidence showing any benefit in terms of crop protection. Agronomist awareness of parasitized pests etc. needs to be improved to avoid unnecessary sprays, which effect pests and natural enemies.

- The retailer/consumer presents a significant barrier to adoption in some horticultural crops as penalties for 'contaminated batches' filled with beneficial insects are costly for the grower. Customer education may help to dissolve some of these barriers. As IPM is unlikely to achieve 100% control, and unless public perceptions around appearance are changed, pesticides will always be needed to keep the crop "perfect".
- There is no incentive for many horticultural growers to create such habitats as they would not be eligible for payment because they are not the land occupier for the 3-year duration of the standard.

Topic 3: Crop diversity

- Crop rotation measures are largely focused on arable farmers and are not applicable to permanent crops. For horticultural crops grown in rotation, spring cropping is common practice. Few horticultural crop producers grow many cereals and therefore are unlikely to grow consecutive cereals.
- Horticultural crops grown in rotation are often grown on rented land. The grower may not be the land occupier for the duration of the standard, which precludes them from receiving payment. However, the potential SFI payment may be considered with rent calculations.
- There was a great deal of support for the measure that rewards growing 3 different crops in a 4-year rotation because it provides flexibility for the grower.
- The feasibility and profitability of spring cropping is questionable as this practice may not be suitable for heavy land, as the crop would be unprofitable due to low yield and poor yield stability.
- The suggestion of reward for not growing consecutive cereals puzzled some participants as some pest and disease cycles can be broken through implementation of a cereal dominated rotation e.g. oats as a break crop for the soil borne cereal disease take-all (causal agent, *Gaeumannomyces tritici)*.
- Companion crops may be useful in promoting natural enemies in permanent cropping areas but can be expensive and often fail and create pest issues e.g. slugs, weeds.
- Payment should be for attempting companion cropping as failure rates are high which may result in, what in effect is, a species monoculture if the companion fails to grow.
- The criteria that constitute a companion crop must be clearly defined to avoid use of very short cropping periods (e.g. less than 2 months) as the benefits are unlikely to be realised in such a short period of time. The inclusion of those growing temporary pasture should also be considered.
- Mixed end-products from intercropping etc. may result in marketability issues if it is not possible to separate the harvest products.
- Companion cropping may be best considered in a separate topic e.g. pesticide alternatives.
- Trap crops can be used in rotation e.g. barley grown as aphid trap crop, or they may be located at the edge of field e.g. sticky nightshade (*Solanum sisymbriifolium*) etc. for potato cyst nematode (PCN) control. Biofumigants e.g. certain mustards, grown across whole field prior to potato crop for PCN control, might also be considered but should come with guidance on management e.g. maceration and incorporation techniques and timing. There are concerns about the impact of such practices on soil biology as the gas produced, mustard gas, is a broad-spectrum biocide.

Topic 4: Resistant varieties

- Resistant varieties are often used where available and marketable. Market constraints act as a barrier to variety mixture production where grain homogeneity is a priority e.g. for malting.

- Disease/invertebrate pest resistant varieties are not available in some sectors/crops and the market often dictates what variety is grown. This is especially true for fresh horticultural produce.
- The required information is often hard to find for some crops (i.e. those not on recommended/approved variety lists).
- Varietal resistance status can change as pathogens and pests evolve resistance which may have implications for home-saved seed.
- There was a suggestion that certain varieties could be classified 'SFI varieties', however this approach doesn't account for farm specific pest issues.
- The consensus was that incentives for growing resistant varieties may help increase uptake in the arable sector, particular for smaller/part-time farmers who might make their decisions based on treated yields rather than untreated yields or disease resistance rating.

Topic 5: Decision support

- There are many decision support systems (DSS) and decision support tools (DST) for some crops, but few for others. When they are used, they are considered as a guide to indicate when pest issues may occur, which encourages field monitoring.
- Agronomists are more likely than farmers to use them. Agronomists may be best placed to make such decisions as they walk crops across multiple farms and so will have a good understanding of the observed pest pressure, in addition to information provided by the predictive models of the DSS, which allows them to make better informed decisions.
- The DSS/DST must be frequently evaluated by an independent body. Some in circulation have not been revalidated for decades and may no longer be fit for purpose.
- Many pesticides are used in a protective/prophylactic manner which limits the use of the DSS/DTS when it comes to interventions related to thresholds that rely on curative action of pesticides.
- Mobile in-field weather stations (and possibly even spore traps) are favoured as they provide precise information which allow the DSS/DST to make better predictions.
- Many buyers of horticultural produce require 'spray justification' (on ICSS score sheets) based on recommendations from a BASIS qualified agronomist, therefore 'action threshold' information from the DSS/DST is often required.

Topic 6: No insecticide/molluscicides

- The perception was that this is not auditable as it may be impossible to convincingly demonstrate that a pesticide was not applied.
- It is unlikely to change current practice as insecticides are only used when potential loss is very high due to the high financial cost of spray and the implications for natural enemies.
- There will be a crop and regional bias e.g. more aphids in warmer south of the UK, more slugs in the wetter west and north of the UK.
- There can be big variations in treatments used between years (some years lots of insecticide spraying in response to pest pressure and others not), so rewards provided on an annual basis are likely to reflect these trends.
- Difficulties may arise if rewards for overall pesticide reductions undermine consistency in production. Food security should remain the top priority.
- Loss of seed treatments due to regulation often results in more broad-spectrum sprays.

- There were questions raised about why a payment for avoiding use of herbicides and fungicides is not being considered.
- The only molluscicide available is ferric phosphate which is considered a low-risk pesticide. It is not detectable by the water companies as it's naturally occurring making it nearly impossible to audit.

Topic 7: Pesticide alternatives

- Nearly all participants expressed concern over the effectiveness and consistency of the performance of virtually all biopesticides/elicitors/microbial biocontrol agents.
- There exists very little, independently verified data on pesticide alternatives available to growers. R&D is required to optimise their performance.
- There are few pesticide alternatives (biopesticide, biological control agent etc.) currently commercially available. A fast-track approval process, when product safety is proven, may increase their availability.
- Where they are available their low perceived cost-effectiveness often precludes their use in non-premium crops.
- There was some suggestion that it should be the responsibility of the producer to show cost-effectiveness, and they should not be subsidised with public money.
- Biological alternatives to pesticides may not be as safe as some perceive them to be. They have potential to mutate, evolve and potentially become invasive species.
- Some biological alternatives to pesticides have compatibility issues with natural enemies.
- Pesticide alternatives might also include non-chemical control measures such as mechanical weeders and physical barriers like nets and fleeces, which are expensive but do reduce the need for insecticides, although they may increase risks associated with diseases (due to increased humidity) and weeds (the protective environment shields the weeds from control measures including pesticides).

Additional topic proposed by participants at workshop: Precision/targeted PPP application

- It was suggested by participants in both the arable and horticulture workshops that appropriate and precise use of pesticides should be incentivised.
- The use of GPS guided spraying, boom section control to avoid overlaps, variable rate spraying, weed wipers, droplet applicator etc. may all be considered as examples of best practice.
- Weeding equipment e.g. inter-row mechanical, laser, electric, foam, autonomous, flame throwers and pesticide application equipment e.g. boom sprayers, controlled droplet applicators, may be prohibitively expensive. Some grants for purchasing equipment are already in existence.
- Smaller, specialist businesses probably won't own the equipment that larger arable farms do, so they would contract this work out.
- The contractor using precision equipment would benefit from increased business if the payment were for usage rather than by way of a grant to purchase equipment.
- Auditability could be relatively simple as the application equipment make and model can be noted on the spray sheet.

5.2.2 Analysis of the individually completed workshop questionnaires

For practices currently adopted or being considered for adoption, the following information was collected via online questionnaires that were individually completed during the workshop. Participants' estimations for incentivisation rates are included where the information was provided (see section 5.2.3).

Topic 1: Training and Planning

- Nearly all have, or would consider having, a whole farm IPM plan (32/33, Table 5.9) and a crop specific IPM plan (27/33, Table 5.9). The main reasons for completing an IPM plan were numerous and included reduced pesticide use, improved biodiversity, better pest control, improved farm resilience and increased crop product quality. Incentives to encourage others to complete an IPM would pay for time to complete the plan and technical advice on completing them. Participants suggested incentives ranging from £5 - £30/ha, though some were unsure as they did not know how long the crop specific IPM plan (IPM Tool) would take them to complete.
- Most use (20/33, Table 5.9), or would consider using (5/13, Table 5.9), an agronomist. Two participants would not consider it as they are BASIS qualified and therefore do their own agronomy. Those that did use an agronomist cited many benefits including increased yield, better pest control, reduced pesticide use, improved profitability, increased crop product quality. Participants suggested incentives ranging from £30/ha to £100/ha to pay for agronomist fees.
- There was a great deal of interest in training. The main benefits cited were improved farm resilience and better pest control. Incentives would cover time and travel expenses. Participants were not sure how to estimate rates as both time and travel expenses can vary a great deal from person to person. The few (6/33, Table 5.9) that would not consider it either don't have the time and do not perceive it to be necessary as their agronomist makes the decisions.

Table 5.9: Current and potential adoption of actions related to Topic 1 'Training and Planning'.

Categories	Whole farm IPM plan	Receive advice from BASIS agronomist on IPM planning	Complete IPM training	Crop specific IPM plan
Does not do it	8	13	17	21
Does it	25	20	16	12
Total	33	33	33	33
Of those not doing it:				
Not considering it	1	8	7	6
Considering it	7	5	10	15
Total	8	13	17	21

Topic 2: Habitat for natural enemies

- Many are already growing habitat for natural enemies, under other schemes. Others (6/9, Table 5.10) would consider doing so if the incentive supported them for costs related to establishment, labour, income foregone. The main perceived benefit was improved biodiversity followed by better pest control, reduced pesticide use, and improved farm resilience. Participants suggested incentives ranging from £25/ha to £550/ha, with figures of £500-£550/ha estimated to cover labour and income foregone, respectively. Those that would not consider it cited reasons that included increased risk from pests (including weeds and diseases), rotational considerations, cost of implementation and a lack of benefit to crop protection. [Note: unclear whether these values were proposed per ha of the habitat or per ha of land in the scheme].
- Around half of the participants (15/33, Table 5.10) grow in-crop habitat. The benefits cited were the same as above with improved biodiversity being the most cited benefit. Most of those who have not adopted this practice would not consider doing so (4/18, Table 5.10) due to the high level of investment. Cited reasons were the same as above i.e. establishment costs, labour, income foregone and a lack of benefit to crop protection particularly as it may increase the threat from pests.

Table 5.10: Current and potential adoption of actions related to Topic 2 'Habitat for natural enemies'.

Categories	Grow habitat for natural enemies	Grow habitat for natural enemies in-crop
Does not do it	9	18
Does it	24	15
Total	33	33
Of those not doing it:		
Not considering it	3	14
Considering it	6	4
Total	9	18

Topic 3: Crop diversity

- Around half of participants (15/33, Table 5.11) were already growing spring crops. The main benefits being improved farm resilience, better pest control and increased profitability.
- Incentives for spring cropping are highly unlikely to change current practice. Only 1 of the 18 who do not grow spring crops would consider doing so. The main barrier to growing spring crops is unsuitable land. Market constraints, low profitability and low yield were also cited as barriers.
- Incentives for growing second cereals are unlikely to decrease this practice as it does not apply to horticultural crops. The main barrier to not growing consecutive cereals was reduced profitability. Unsuitable land was also cited as a barrier.
- Most farmers (18/30, Table 5.11) do rotate crops primarily to improve farm resilience, achieve better pest control and improve profitability and yields. Those not considering it (12/15, Table

5.11) cited complicated agronomy as the main barrier. Many of those participants are horticulturists who often rent land or grow permanent crops e.g. apples/pears, which prevents the adoption of crop rotations.

- Few farmers (3/33, Table 5.11) grow companion crops and only 1 would consider attempting this practice. The main barriers to adoption were that it is unsuitable for the crop and the crop rotation, the agronomy is too complicated, and it may increase threat from pests.

Table 5.11: Current and potential adoption of actions related to Topic 3 'Crop Diversity'.

Categories	Spring crops in rotation	Never grow successive winter cereals	3 different crop types in rotation	Grow companion crop
Does not do it	18	23	15	30
Does it	15	10	18	3
Total	33	33	33	33
Of those not doing it:				
Not considering it	17	20	12	29
Considering it	1	3	3	1
Total	18	23	15	30

Topic 4: Resistant varieties

- Most participants (24/33, Table 5.12) are already growing disease/invertebrate pest resistant varieties to improve profits and farm resilience. They are also doing this to achieve better pest control whilst reducing pesticide use.
- Some growers (4/9, Table 5.12) would not consider it as resistant varieties may not be available/marketable and/or the income foregone is too high due to lower yields and crop quality.

Table 5.12: Current and potential adoption of actions related to Topic 4 'Pest and disease resistance'.

Categories	Grow resistant varieties
Does not do it	9
Does it	24
Total	33
Of those not doing it:	
Not considering it	4

Considering it	5
Total	9

Topic 5: Decision support

- Most participants (23/33, Table 5.13) use DSS/DST. The main advantage being improved profits followed by better pest control, improved farm resilience and reduced pesticide use.
- Incentives to increase use would cover cost of the DSS/DST (estimated at £10/ha) and time to use the system (estimated at £50/ha). Potential economic losses due to ineffective tools was also cited as a reason for incentivisation payment but no monetary values were provided.
- Some growers (4/10, Table 5.13) would not consider using DSS/DST due to a lack of trust. Availability of relevant DSS/DST for the participants crops or problem pests was another reason cited.
- Research is needed to provide evidence for their effectiveness.

Table 5.13: Current and potential adoption of actions related to Topic 5 'Decision support'.

Categories	Use Decision Support Systems/Tools
Does not do it	10
Does it	23
Total	33
Of those not doing it:	
Not considering it	4
Considering it	6
Total	10

Topic 6: No insecticide/molluscicides

- Some participants (9/33, Table 5.14) do not use insecticides, citing improved biodiversity and the practice being unnecessary as reasons for adoption of actions.
- Some growers (7/24, Table 5.14) who do currently use insecticides would consider not using them if incentive payments for technical advice and alternative pest control systems were on offer. Estimates ranged from £20/ha (for advice) to £80-100/ha for alternative control measures and income foregone due to yield losses.
- Most participants (24/33. Table 5.14) who use insecticides would not stop due to the potential costs associated with not using insecticides (i.e. reduced yield and quality). A lack of suitable alternative control measures was also cited as a key barrier to adoption of actions.

Table 5.14: Current and potential adoption of actions related to Topic 6 'No insecticides /molluscicides'.

Categories	Stop using insecticides/molluscicides
Does not do it	24
Does it	9
Total	33
Of those not doing it:	
Not considering it	17
Considering it	7
Total	24

Topic 7: Pesticide alternatives

- Nearly half (15/33, Table 5.15) of the participants use bioprotectants and low risk PPP, citing improved biodiversity and reduced pesticide use as the main benefits.
- The practice is more common amongst horticulturists.
- Of the 18 participants who do not use them, 10 would use them if incentive payments were introduced to cover economic losses due to reduced level of control (estimated at £100/ha) and consistency of control (estimated at £50/ha). Payment for technical advice in the region of £150/ha and equipment costs (estimated at £140/ha) may encourage further uptake.
- The main reason for not considering adoption of actions was a lack of trust, with participants stating they have not tested any or are unaware of them.

Table 5.15: Current and potential adoption of actions related to Topic 7 'Pesticide Alternatives'.

Categories	Use bioprotectants/low risk plant protection products (PPP)
Does not do it	18
Does it	15
Total	33
Of those not doing it:	
Not considering it	8
Considering it	10
Total	18

Preferred options within each proposed level of the scheme

The participants were asked in this part of the questionnaire to rank their preferred options for each of the 3 levels of the scheme.

When applying weights according to their position e.g. in Table 5.16, 1st position was awarded a score of 4, 2nd position a score of 3, etc. which was multiplied by the number of participants votes. The summed ranked order is as follows:

1st - Have a whole farm IPM plan.

2nd - Receive advice on IPM planning and Implementation from BASIS Qualified Adviser.

3rd - IPM training (workshops, webinars, events).

4th - Use of DSS/DST.

Table 5.16: Participants ranking of IPM actions proposed for Introductory level of the SFI Standard.

IPM actions proposed for Introductory level	1st (most preferred)	2nd	3rd	4th (least preferred)
Have a whole farm IPM plan	17	5	4	5
IPM training (workshops, webinars, events)	3	12	9	7
Receive advice on IPM planning and Implementation from BASIS Qualified Adviser	10	11	8	2
Use of DSS/DST	1	3	10	17

When applying weights according to their position e.g. in Table 5.17, 1st position was awarded a score of 6, 2nd position a score of 5, etc. which was multiplied by the number of participants votes. The summed ranked order is as follows:

1st - Have a crop specific IPM plan.

2nd - Variety resistance (to 2 or more important diseases/pests on farm).

3rd - Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm).

4th - Include at least one spring crop in the rotation within the standard (every 3 years).

5th - Bioprotectants and low risk PPPs where available.

6th - No second winter cereals grown in the rotation.

Table 5.17: Participant rankings of IPM actions proposed for Intermediate level of the SFI Standard.

IPM actions proposed for Intermediate level	1st (most preferred)	2nd	3rd	4th	5th	6th (least preferred)
Bioprotectants and low risk PPPs where available	0	2	8	8	5	8

Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm)	6	4	9	8	0	4
Have a crop specific IPM plan	19	8	0	3	1	0
Include at least one spring crop in the rotation within the standard (every 3 years)	3	3	6	3	13	3
No second winter cereals grown in the rotation	0	1	2	3	9	16
Variety resistance (to 2 or more important diseases/pests on farm)	3	13	6	6	3	0

When applying weights according to their position e.g. in Table 5.18, 1st position was awarded a score of 4, 2nd position a score of 3, etc. which is multiplied by the number of participants votes. The summed ranked order is as follows:

1st - Include at least 3 different crop types (spring cereal, winter cereal, brassica, legume, root, tuber, maize, other) in a 4 year rotation.

2nd - Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm) + Grow an in-field habitat of at least 1% of the land (such as beetle bank or planted strip).

3rd - Include a companion crop on at least 10% of the land (e.g. undersowing, intercropping, trap cropping).

4th - Insecticide/molluscicides not applied to all land in standard.

Table 5.18: Participant rankings of IPM actions proposed for Advanced level of the SFI Standard.

IPM actions proposed for Advanced level	**1st (most preferred)**	2nd	3rd	4th **(least preferred)**
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm) + Grow an in-field habitat of at least 1% of the land (such as beetle bank or planted strip)	9	10	7	5
Include a companion crop on at least 10% of the land (e.g. undersowing, intercropping, trap cropping)	6	4	10	11
Include at least 3 different crop types (spring cereal, winter cereal, brassica, legume, root, tuber, maize, other) in a 4 year rotation	11	12	4	4
Insecticide/molluscicides not applied to all land in standard	5	5	10	11

5.2.3 Econometric analysis to identify payments incentives for engaging with the SFI Standard at different level

Ten tables were presented to workshop participants to elicit their preference for the three levels of IPM uptake considered by Defra's tier system: Introductory, Intermediate, and Advanced. These names are not used, in order to reduce the likelihood of the presence of a lexicographic bias in the data collected. Instead, generic names are used: Bundle 1, Bundle 2, and Bundle 3. The following are two examples of the tables represented:

Actions	Bundle 1	Bundle 2	Bundle 3
Have a whole farm IPM plan	✓	✓	✓
Receive advice on IPM planning and Implementation from BASIS Qualified Adviser	✓	✓	✓
IPM training (workshops,webinars, events)	✓	✓	✓
Use of DSS/DST			
Have a crop specific IPM plan			
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm)		✓	✓
Include at least one spring crop in the rotation within the standard (every 3 years)		✓	✓
No second winter cereals grown in the rotation			
Variety resistance (to 2 or more important diseases/pests on farm)			
Bioprotectants and low risk PPPs where available			
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm) + Grow an in-field habitat of at least 1% of the land (such as beetle bank or planted strip)			✓
Include at least 3 different crop types (spring cereal,winter cereal, brassica, legume, root, tuber, maize, other) in a 4 year rotation			
Include a companion crop on at least 10% of the land (e.g., undersowing, intercroping, or tra cropping)			✓
Insecticide/molluscicides not applied to all land in standard			✓
Subsidy (£/ha)	87	134	251

Figure 5.1: Example of Choices Available to Respondents.

Actions	Bundle 1	Bundle 2	Bundle 3
Have a whole farm IPM plan	✓	✓	✓
Receive advice on IPM planning and Implementation from BASIS Qualified Adviser	✓	✓	✓
IPM training (workshops,webinars, events)	✓	✓	✓
Use of DSS/DST	✓	✓	✓
Have a crop specific IPM plan		✓	✓
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm)		✓	✓
Include at least one spring crop in the rotation within the standard (every 3 years)		✓	✓
No second winter cereals grown in the rotation		✓	✓
Variety resistance (to 2 or more important diseases/pests on farm)		✓	✓
Bioprotectants and low risk PPPs where available		✓	✓
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm) + Grow an in-field habitat of at least 1% of the land (such as beetle bank or planted strip)			✓
Include at least 3 different crop types (spring cereal,winter cereal, brassica, legume, root, tuber, maize, other) in a 4 year rotation			✓
Include a companion crop on at least 10% of the land (e.g., undersowing, intercroping, or tra cropping)			✓
Insecticide/molluscicides not applied to all land in standard			✓
Subsidy (£/ha)	101	217	352

Figure 5.2: Example of Choices Available to Respondents.

Respondents were asked to rank these bundles from the most preferred to the least preferred and indicate whether they would adopt the most preferred bundle if they were subsidized to do so. The latter question is considered to indicate whether respondents would prefer to adopt none of the bundles offered in a particular table, which is then used as the baseline group. Five tables of the type shown in Figure 5.1 were initially presented to respondents followed by five extra tables of the type shown in Figure 5.2. The difference between the igures presented is the amount offered by the subsidy.

The following econometric model was run using the data collected from the questionnaire:

$$y_i = \beta_0 + \beta_1 * i_1 + \beta_2 * i_2 + \beta_3 * i_3 + \beta_4 * subsidy + controls + \varepsilon_i \quad (1)$$

Where y_i is a dichotomous variable that indicates which bundle is preferred when compared with the others in the table. In addition, i_1, i_2, and i_3 are dummy variables that control for the characteristics of bundles 1, 2, and 3 respectively. Moreover, the variable *subsidy* captures the influence of the subsidy on bundle selection. Some control variables are also introduced, such as age, education, agriculture experience, or gender to control for other potential drivers of bundle selection. Finally, ε_i is the error term of the regression model. This variable is assumed to follow either a logistic or a normal distribution with mean 0 and standard deviation σ_ε. When the error term follows a logistic distribution, equation (1) is estimated using a logit model, and when it follows a normal distribution, equation (1) is estimated using a probit model.

One important feature of equation (1) is that it can be used to determine the monetary valuation of each of the bundles presented. The monetary valuation of bundle 1 is computed as $\frac{(|\beta_0+\beta_1|)}{\beta_4}$, for bundle 2 is $\frac{(|\beta_0+\beta_1+\beta_2|)}{\beta_4}$, and for bundle 3 is $\frac{(|\beta_0+\beta_1+\beta_2+\beta_3|)}{\beta_4}$. These bundles are incremental because they capture the incremental valuation of each of the bundles, which are increasing in the adoption cost. The following results are obtained (Table 5.21).

Table 5.19: Distribution of the ranking of bundles per table presented.

Distribution of the ranking of bundles per table presented								
Bundles	1st position	2nd position	3rd position	Subsidy (£/ha)	1st position	2nd position	3rd position	Subsidy (£/ha)
Bundle 1	9	17	5	87	16	9	6	101
Bundle 2	14	9	8	134	10	16	5	217
Bundle 3	8	5	18	251	5	6	20	352
Bundles	1st position	2nd position	3rd position	Subsidy (£/ha)	1st position	2nd position	3rd position	Subsidy (£/ha)
Bundle 1	14	12	5	44	14	13	4	51
Bundle 2	11	16	4	67	8	16	7	109
Bundle 3	6	3	22	125	9	2	20	176
Bundles	1st position	2nd position	3rd position	Subsidy (£/ha)	1st position	2nd position	3rd position	Subsidy (£/ha)
Bundle 1	17	12	2	87	13	13	5	101
Bundle 2	9	16	6	107	10	17	4	174
Bundle 3	5	3	23	150	8	1	22	211
Bundles	1st position	2nd position	3rd position	Subsidy (£/ha)	1st position	2nd position	3rd position	Subsidy (£/ha)
Bundle 1	18	8	5	78	16	10	5	91
Bundle 2	7	21	3	94	10	18	3	152
Bundle 3	6	2	23	125	5	3	23	176
Bundles	1st position	2nd position	3rd position	Subsidy (£/ha)	1st position	2nd position	3rd position	Subsidy (£/ha)
Bundle 1	18	10	3	70	19	8	4	81
Bundle 2	9	20	2	80	9	21	1	130
Bundle 3	4	1	26	100	3	2	26	141

- Except in one case, bundle 1 is the most preferred bundle in all tables presented.

- The most common ranking, regardless of the level of the subsidy, is bundle 1, bundle 2, and bundle 3. This implies that the most preferred tier is the basic one, followed by intermediate, which in turn is followed by the advanced tier.
- Lower subsidies tend to result in a more likely ranking of bundle 1, bundle 2, and bundle 3. Higher subsidies may potentially lead to a ranking of bundle 2, bundle 1, and bundle 3. Hence, the advanced tier is the less preferred and, consequently, the less likely to be adopted. In contrast, with a sufficiently high subsidy, bundle 2 becomes the most preferred bundle, which increases the likelihood that the intermediate tier is adopted.
- One of the reasons cited for ranking bundle 1 first was: "*I might struggle to find suitable companion crops to grow with my chosen crop. I might find it difficult to then destroy that crop afterwards. There could be weed issues in following crops. I would not want to say I would "never" do a particular action. Spring crops might not always be suitable or able to establish in a wet spring. A drought and a dry summer might make spring crops unviable*."
- Another reason cited for ranking bundle 1 first was: "*We couldn't commit to one spring crop every 3 years. Similarly, we couldn't commit to three different crop types in a 4 year rotation. One of the biggest challenges we face is fitting the scheme to our 7 year rotation and the 7 years is dictated by vining peas (and disease risk management). We grow 4 different crop types over 7 years, but part of our rotation wouldn't meet the 3* in *4 requirement. It would be better if all of the actions had a number of points attributed to them and you could pick and choose - with the tiers being achieved by the total number of points you have. That way growers could pick and choose better to suit their land and location*."
- A reason cited for choosing bundle 2 was: "*I would adopt this bundle. We are already most of the actions anyway. The actions that would be most challenging would be the habitat creation and not applying insecticides. All our land for conventional crops is rented and we would need to get agreement and cooperation from landlords to grow the habitats. For some of the crops that we grow, there is a 0-insect tolerance policy, which would be difficult to achieve without insecticides*."
- A reason cited for choosing bundle 3 as the most preferred, but not willing to adopt it if asked for, was: "*The payment rates do not look attractive. Cost of taking land out of production could be more than the incentive. Wheat prices might look more attractive as a way of making up for lost BPS*."

Estimating equation (1), the following payment rates were obtained for each IPM tier (Table 5.22).

Table 5.20: Required payments per tier (£/ha)

Required payments per tier (£/ha)				
Tiers	Basic Actions		Enhanced Actions	
	Logit	Probit	Logit	Probit
Basic	45	37	97	60
Intermediate	193	188	482	450
Advanced	486	485	1238	1204

- Basic actions refer to the combination of actions in Figure 5.1. Enhanced actions refer to the combination of actions in Figure 5.2.
- The basic tier requires a subsidy per ha in the bracket [37£, 45£] to be adopted by the sample of respondents. The subsidy has to be increased to be in the bracket [60£, 97£] to incentivise the uptake of the basic tier composed of a set of enhanced actions.

- The intermediate tier requires a subsidy per ha in the bracket [188£, 193£] to be adopted by the sample of respondents. The subsidy has to be increased to be in the bracket [450£, 482£] to incentivise the uptake of the intermediate tier composed of a set of enhanced actions.
- The intermediate tier requires a subsidy per ha in the bracket [485£, 486£] to be adopted by the sample of respondents. The subsidy has to be increased to be in the bracket [1204£, 1238£] to incentivise the uptake of the advanced tier composed of a set of enhanced actions.
- In the econometric results obtained, neither farm size, age, education level, or agri-sector affected bundle selection. Therefore, the results indicate that the only drivers of bundle selection are the actions considered per bundle and the subsidy.

5.3 WP 4 CONCLUSIONS

- These are the perceptions of a sample of farmers and growers and must be treated accordingly. Some of the barriers to adoption may be perceived impassable but this may not always be the case. The summary points from the discussions held at the workshop aligned with the results from the individually completed questionnaires.
- Flexibility within the Standard is key to ensuring wide scale uptake. Some of the options may not be applicable to certain groups of growers e.g. incentives for planting habitat for natural enemies, or not growing consecutive cereals, are not relevant to those renting land on a short term basis or those not growing cereals, respectively. Some actions may not be considered feasible for specific crops e.g. not applying insecticide to a seed potato crop is considered extremely risky because of the aphid borne virus threat. Spring cropping is risky on heavy land.
- IPM planning was widely accepted as a valuable IPM action. Dynamic crop-specific plans that can be updated throughout the year (and ideally remotely) and which guide users to relevant information are highly desired by the group.
- Many participants grow habitat for natural enemies, largely supported under other schemes. Few participants saw the value in growing habitat within the crop due to high costs and limited/delayed returns. They are not relevant for many crops or cropping systems but are well suited to some permanent cropping situations e.g. top fruit.
- Crop diversity, in the form of increasing the number of crop types in rotation was favoured over other actions e.g. spring cropping, or avoiding consecutive cereal production. The later were viewed very much as arable options and not relevant to horticulture. Where arable farmers are not growing spring crops it is often because of a lack of suitable land to grow a profitable spring crop.
- Companion cropping (including intercropping, under-sowing etc.) was the least popular option of all that were offered at the workshops. High failure rate, complex agronomy and high management costs were cited as the main barriers.
- Decision support systems are used where available and deemed relevant, and adoption is higher in horticulture. Incentive payments for technical advice and alternative pest control systems may increase uptake.
- Growers are not using insecticides wherever possible, however the perceived high risks associated with not using them means that many growers would not consider avoiding them even if financial incentives are provided, as they would not cover the potential losses. Payments for technical advice and alternative pest control systems may increase uptake amongst some growers/farmers.
- Cited benefits of using bioprotectants and low risk plant protection products were improved biodiversity and reduced use of other pesticides. The practice is more common amongst

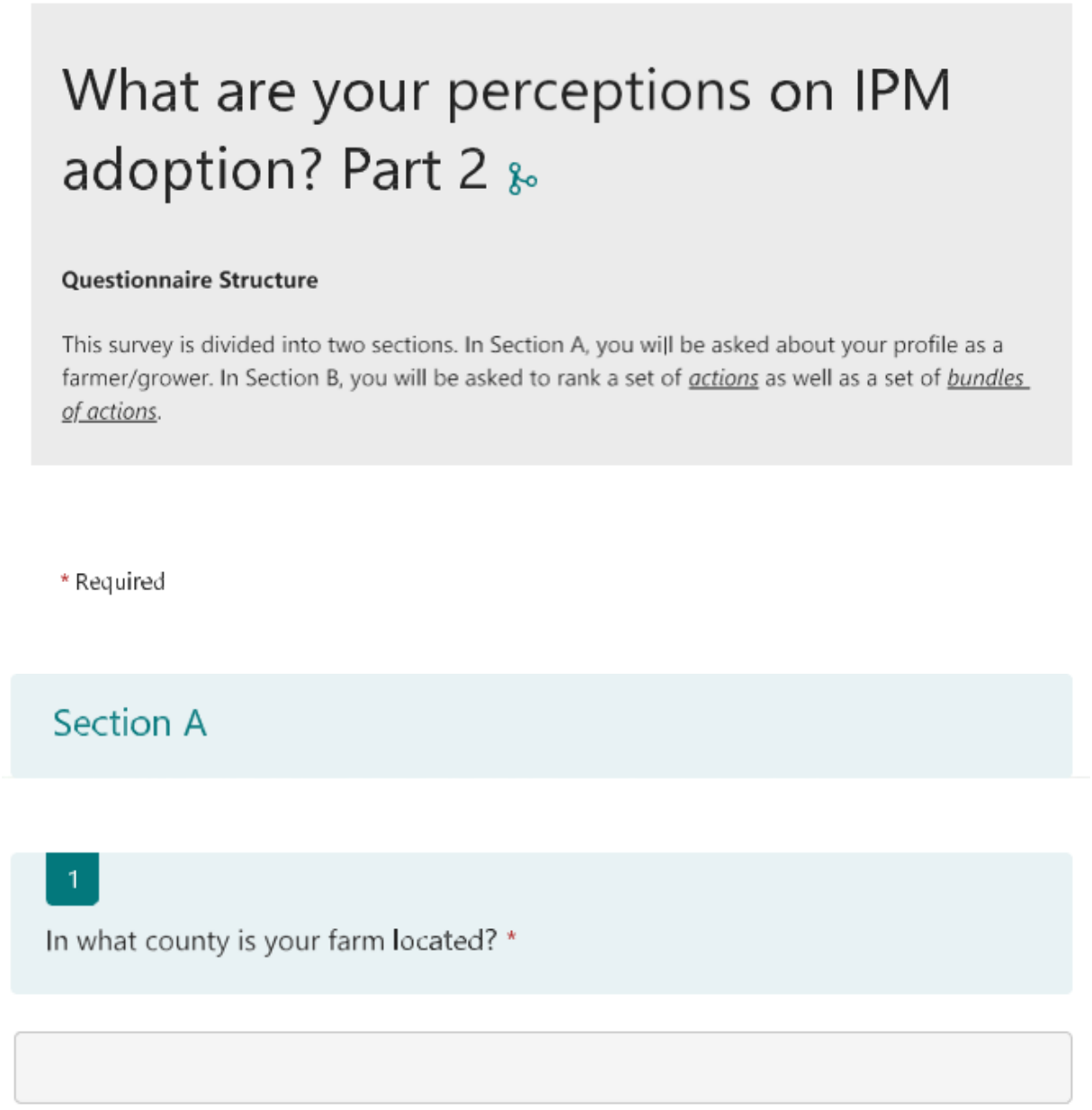
horticulturists. Incentive payments could increase adoption if they covered the potential economic losses due to reduced level and consistency of control.

- Most participants utilise disease/invertebrate pest resistant varieties where they are available and marketable. Smaller area, more niche, horticultural crops may not be able to grow resistant varieties for these reasons. Incentives to increase adoption amongst largely arable farmers received support from the group.

5.4 WP 4 Supplementary Material

Questionnaire used in the participants workshops

The following questionnaire is an example of those used in the arable and horticultural workshops. A full list of the questionnaires used is available from SRUC on request (see WP4 interim report).



What are your perceptions on IPM adoption? Part 2

Questionnaire Structure

This survey is divided into two sections. In Section A, you will be asked about your profile as a farmer/grower. In Section B, you will be asked to rank a set of *actions* as well as a set of *bundles of actions*.

* Required

Section A

1

In what county is your farm located? *

2

What is the size of your farm (in ha)? *

3

What is your farm type? (Tick all that apply) *

- [ ] Arable
- [ ] Horticulture
- [ ] Mixed arable and livestock
- [ ] Mixed horticulture and livestock

4

Which of the following crops do you grow? (Tick all that apply) *

- [ ] Bulbs and outdoor flowers
- [ ] Field vegetables
- [ ] Potato growers
- [ ] Salads and/or herbs
- [ ] Soft fruit
- [ ] Tree fruit
- [ ] Hops
- [ ] Other

13

Please, rank the following *actions* from most preferred to least preferred *

- Have a whole farm IPM plan
- Receive advice on IPM planning and Implementation from BASIS Qualified Adviser
- IPM training (workshops,webinars, events)
- Use of DSS/DST

14

Please, rank the following *actions* from most preferred to least preferred *

- Have a crop specific IPM plan
- Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm)
- Include at least one spring crop in the rotation within the standard (every 3 years)
- No second winter cereals grown in the rotation
- Variety resistance (to 2 or more important diseases/pests on farm)
- Bioprotectants and low risk PPPs where available

15

Please, rank the following *actions* from most preferred to least preferred *

- Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm) + Grow an in-field habitat of at least 1% of the land (such as beetle bank or planted strip)
- Include at least 3 different crop types (spring cereal,winter cereal, brassica, legume, root, tuber, maize, other) in a 4 year rotation
- Include a companion crop on at least 10% of the land (e.g. undersowing, intercropping, trap cropping)
- Insecticide/molluscicides not applied to all land in standard

16

Please, rank the following *bundle of actions* from most preferred to least preferred *

Actions	Bundle 1	Bundle 2	Bundle 3
Have a whole farm IPM plan	✓	✓	✓
Receive advice on IPM planning and Implementation from BASIS Qualified Adviser	✓	✓	✓
IPM training (workshops,webinars, events)	✓	✓	✓
Use of DSS/DST			
Have a crop specific IPM plan			
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm)		✓	✓
Include at least one spring crop in the rotation within the standard (every 3 years)		✓	✓
No second winter cereals grown in the rotation			
Variety resistance (to 2 or more important diseases/pests on farm)			
Bioprotectants and low risk PPPs where available			
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm) + Grow an in-field habitat of at least 1% of the land (such as beetle bank or planted strip)			✓
Include at least 3 different crop types (spring cereal,winter cereal, brassica, legume, root, tuber, maize, other) in a 4 year rotation			
Include a companion crop on at least 10% of the land (e.g., undersowing, intercroping, or tra cropping)			✓
Insecticide/molluscicides not applied to all land in standard			✓
Subsidy (£/ha)	87	134	251

Bundle 1

Bundle 2

Bundle 3

18

Could you please indicate us why you would or you would not adopt it?

19

Please, rank the following *bundle of actions* from most preferred to least preferred *

Actions	Bundle 1	Bundle 2	Bundle 3
Have a whole farm IPM plan	✓	✓	✓
Receive advice on IPM planning and Implementation from BASIS Qualified Adviser	✓	✓	✓
IPM training (workshops,webinars, events)	✓	✓	✓
Use of DSS/DST			
Have a crop specific IPM plan			
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm)		✓	✓
Include at least one spring crop in the rotation within the standard (every 3 years)		✓	✓
No second winter cereals grown in the rotation			
Variety resistance (to 2 or more important diseases/pests on farm)			
Bioprotectants and low risk PPPs where available			
Grow habitat for natural enemies insects on at least 4% of the land (distributed across farm) + Grow an in-field habitat of at least 1% of the land (such as beetle bank or planted strip)			✓
Include at least 3 different crop types (spring cereal,winter cereal, brassica, legume, root, tuber, maize, other) in a 4 year rotation			
Include a companion crop on at least 10% of the land (e.g., undersowing, intercroping, or tra cropping)			✓
Insecticide/molluscicides not applied to all land in standard			✓
Subsidy (£/ha)	44	67	125

Bundle 1

Bundle 2

Bundle 3

21

Could you please indicate us why you would or you would not adopt it?

APPENDIX 6 - WORK PACKAGE 5: USER FEEDBACK ON CLARITY AND STREAMLINING OF SFI IPM PROCESS AND USEFULNESS OF GUIDANCE.

6.1 WP 5 METHODOLOGY

6.1.1 Design, produce, and distribute an online questionnaire to elicit farmers understanding, views and experiences of going through the SFI IPM process and utilising the IPM Tool

All 113 registered users (farmers, agronomists and advisors) who completed the online IPM Tool were invited to undertake an online survey to gain insight into their views, understanding and experiences of using the web based tool. The structure of the questionnaire was designed in a way that was accessible, easy to understand and gave meaningful responses. It consisted of a set of qualitative and quantitative questions intended to capture robust responses from participants related to their online IPM Tool experience (see Section 6.4 for sample questionnaire). A link to the feedback was included at the end page of the online IPM Tool https://adas-survey.onlinesurveys.ac.uk/ipm-online-tool-participant-feedback and as participants completed the IPM Tool they were also sent an email at the start of each week inviting them to complete the feedback questionnaire.

Evaluation of questionnaire responses

Responses were compiled and uploaded to ADAS's secure SharePoint where an evaluation was undertaken using Excel and qualitative coding software NVivo[1]. Results were analysed to provide an overview of the key attitudes held by users in relation to the online IPM Tool, its functionality and the usefulness of the video and written guidance within the tool. The downloaded survey responses were checked, cleaned and analysed to provide high-level insight from a final sample of 82 users. The high-level results were graphed using bar charts for each quantitative question and these were inspected to identify interesting patterns by user type (e.g. farmer, agronomist, other). Various cross–tabulations were also run to explore correlations between selected questions.

6.1.2 Face-to-face and/or telephone behavioural insight interviews with representative sample of farmers

Development of Interview Script and Guide

A semi-structured interview guide was designed to include both open ended and closed questions for the interviews. A key feature of the approach was the ability of expert ADAS interviewers to follow up questions and probe for the drivers and attitudes that lie behind the responses.

The interviews were designed to elicit farmers understanding, views and experiences of utilising the online IPM Tool, including the video and written guidance. The key aim was to understand attitudinal and behavioural changes from using the online IPM Tool. This was done by asking questions in three sections:

- Opinions ***before*** using the tool: **Expectations of the tool**
- Experience ***during*** using the tool: **Useability and practicalities**
- Using the tool in the ***future***: **Motivations** for using the tool again or **barriers** to themselves and others using the tool.

[1] NVivo is a qualitative data analysis software that helps uncover research insights. See https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/about/nvivo

Sample Selection and Data Collection

Fifty interviewees who responded with 'yes' to follow-up contact in the online survey formed the basis for the behavioural insights interviews. A team of ADAS consultants were allocated farmers to contact. First contact was made through email or telephone call. When contacting the farmer, consultants clearly stated the aims of the project, the commitment needed from the participant and provided access to ADAS's data protection policy outlining relevant procedures. Response to initial contact was positive, with 44 interviewees agreeing to take part in a one-to-one interview. Interviewees were given a financial incentive to cover their time.

Interviews were recorded (with the interviewee's prior permission gained through a consent form shared before the interview) and interviewers took short notes to highlight key points, issues which triggered strong sentiments and other relevant (non-verbal) information. These notes formed the basis of the analysis. The team data manager ensured that data collected was stored in accordance with legal and our institutional requirements for the protection and storage of personal data.

All interviews were recorded, transcribed verbatim, anonymised and securely held under password protection. The electronic records from the interviews were then uploaded and analysed using NVivo Software. The data was analysed using the following steps:

1. **Data cleaning** – transcripts were cleaned and anonymised;
2. **Identifying a thematic framework and basic themes** – before the data was coded, a framework was set out in line with the research objectives. This included creating priori codes which were set out in response to the specific questions that were asked as part of the questionnaire;
3. **Data coding** – 44 transcripts were coded; and
4. **Themes identified** – after the transcripts had been coded, codes were retrieved and patterns identified.

6.2 WP 5 RESULTS

6.2.1 Online IPM Tool Participant Feedback

The feedback analysis presented here is a high-level reflection on user experiences of completing the online IPM Tool.

Participation and completion of crop plans using the IPM Tool

- Eighty two participants completed the survey questionnaire. This number represents a 73% response rate based on the 113 registered participants who had completed IPM planning using the online tool for at least one crop. The high response rate indicates a positive willingness to participate in IPM planning through the use of online IPM software.
- Of the 82 participants who completed the feedback survey, 65 were farmers, 16 were agronomists and one participant specified that they were an advisor.
- Most (91%) of the 65 farmers who completed the online IPM Tool indicated that they were able to complete the tool without requiring advice from their agronomist. One quarter (25%) of the farmer participants also indicated that they were BASIS qualified.
- Most (95%) of participants found the introductory page of the online IPM Tool helpful. One of the reasons cited for **not** finding the introductory page useful was: "*I didn't notice them but I didn't need any help*". Another reason cited was "*I didn't think the main page explained what the process included, nor what the outcome would be*".

- All 82 participants fully completed IPM crop plans using the online tool, with 68% of farmer participants and 87% of agronomist participants indicating that they fully completed plans for 2 or more crops. The breakdown of completions by number of crops and participant type are shown in Table 6.1.

Table 6.1: Participant responses to question - "How many crops did you complete the online IPM Tool for?"

How many crops did you complete the online IPM tool for?	Farmer	Agronomist
1	32%	13%
2	25%	37%
3	34%	50%
More than 3	9%	
Totals	**100%**	**100%**

- Just under 80% (64/82) of survey participants completed IPM planning in under an hour. The time taken to complete plans for second and subsequent crops was less than 30 minutes for 81% (49/60) of participants who entered more than one crop (Figure 6.1).

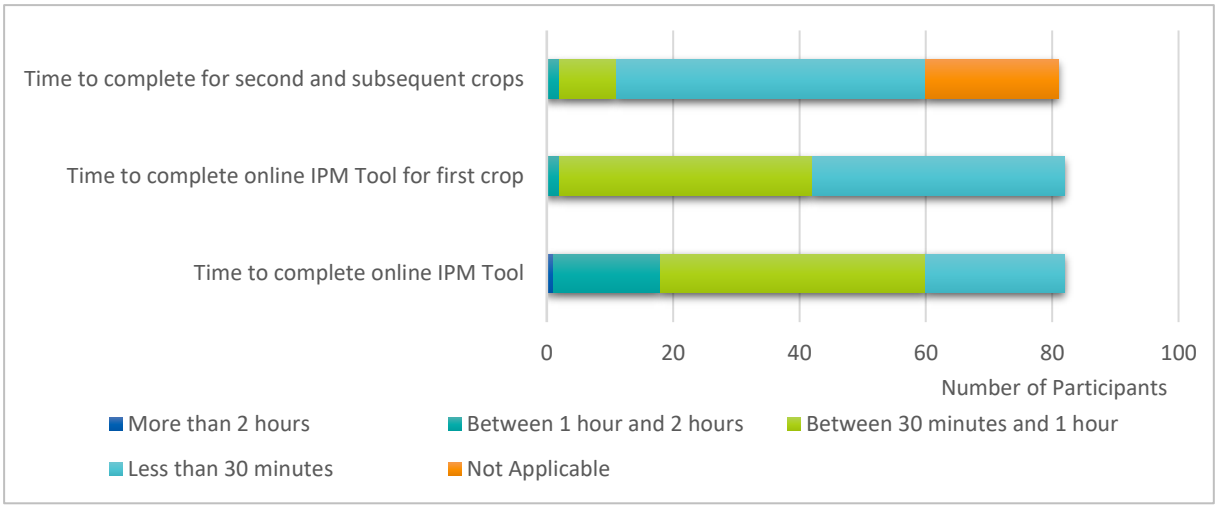


Figure 6.1: Time spent completing the online IPM Tool, including time taken to complete first crop and time taken to complete second and subsequent crops.

- Participants mostly felt that using the IPM Tool took significantly less time for each crop type after the first (Figure 6.2).

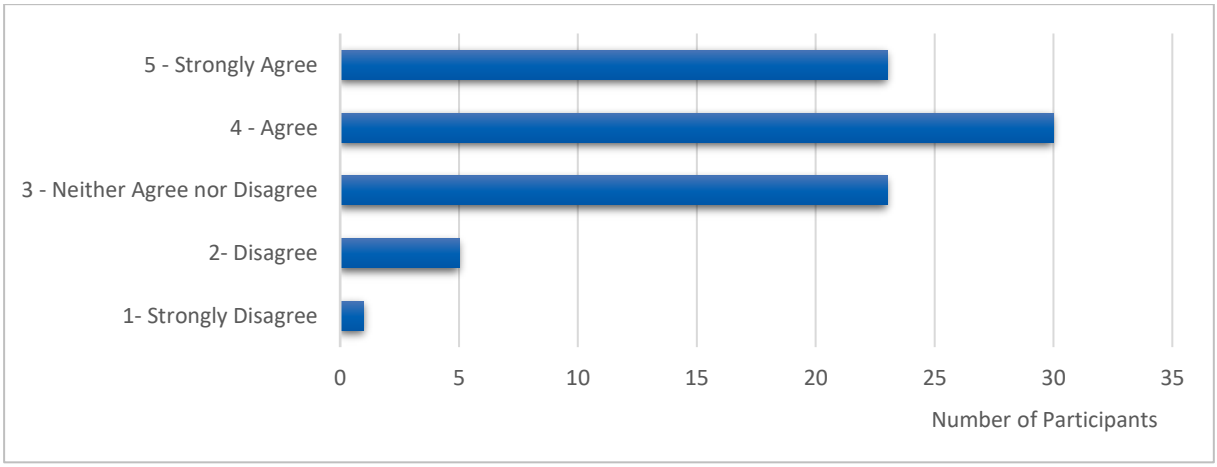


Figure 6.2: Scores given by participants to the statement '*the online tool took significantly less time to complete for each crop type after the first*'.

IPM Tool Usability and Functionality

Participants were asked a number of questions related to how they found the online process of completing crop plans using the IPM Tool and their level of satisfaction with different aspects of the online IPM Tool.

- Overall, feedback related to the online IPM Tool usability and functionality was extremely positive.
- Farmer participants mostly found the online process of using the IPM Tool easy or very easy (Table 6.2). Likewise, agronomists who completed the online IPM Tool found the process easy or very easy.

Table 6.2: Participant responses to the question - ˜How did you find the online tool took significantly less time to complete for each crop type after the first"

How did you find the online process of completing the IPM Tool?	Farmer	Agronomist
Very Easy	11%	6%
Easy	51%	56%
Neither Easy nor Difficult	37%	38%
Difficult	2%	0%
Very Difficult	0%	0%
Totals	**100%**	**100%**

- Participants were overwhelmingly satisfied with the ease of registration and use, as well as the links to guidance in the online IPM Tool (Figure 6.3). Cited reasons included: *"Links and guidance were very good. Helped provide background to the questions and understanding of what they were asking"* and *"The in-tool info was very useful in ensuring you could understand and answer the question fully. Links to guidance very helpful and provided comprehensive research if needed".*
- Layout and questions in the online IPM Tool where less satisfying to participants with some of the reasons cited as: *"In tool information - It would be much easier to enter all fields and crops before completing the questions"*; *"There is a lot of repetition/overlap between similar crops. The layout suggests that the plan for the future may be for field by field assessment. This would be a very tedious process as IPM actions are generally adopted at a farm level, albeit level of risk may differ between fields"* and *"Dashboard layout".*

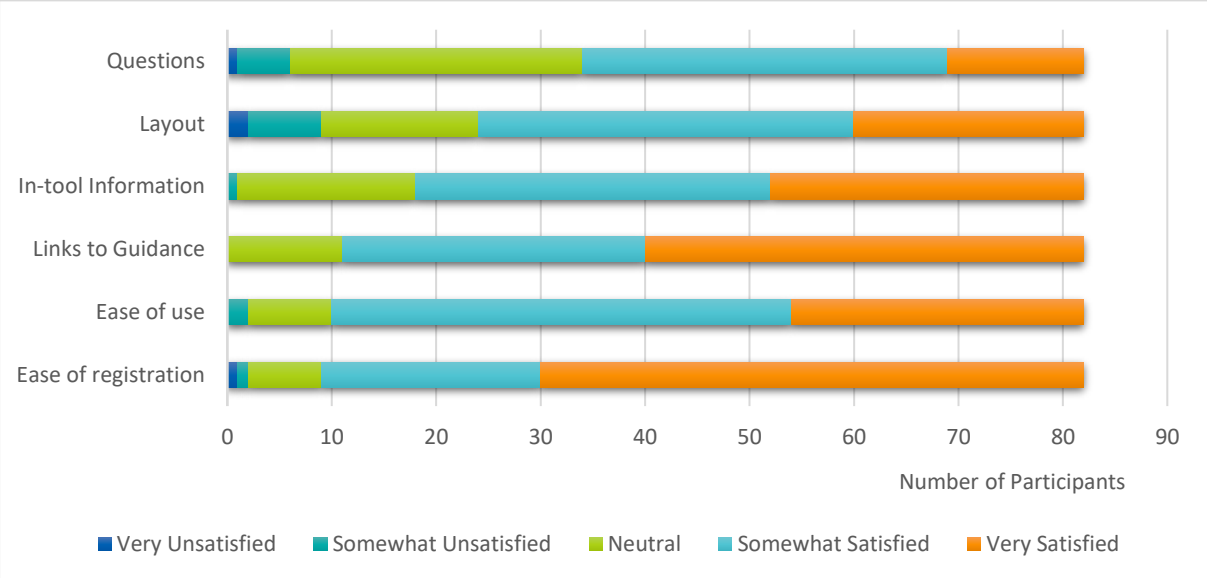


Figure 6.3: Satisfying aspects of the online IPM Tool as scored by participants who completed the tool – noting how satisfied (on a scale of Very Unsatisfied to Very Satisfied) they were with each aspect as stated in the survey questionnaire.

Video and Written Guidance

Participants were asked a number of questions related to the video and written guidance provided within the online IPM Tool. In general, feedback was positive, however there were a number of participants who stated that they did not find or use the video or written guidance. Some of the cited responses are provided below.

Video Guidance

- Participants mostly found that the **introductory video** contained relevant information, was engaging and was a good length. Just under a half of all participants (40/82) felt that they learnt something new from watching the introductory video (Figure 6.4).

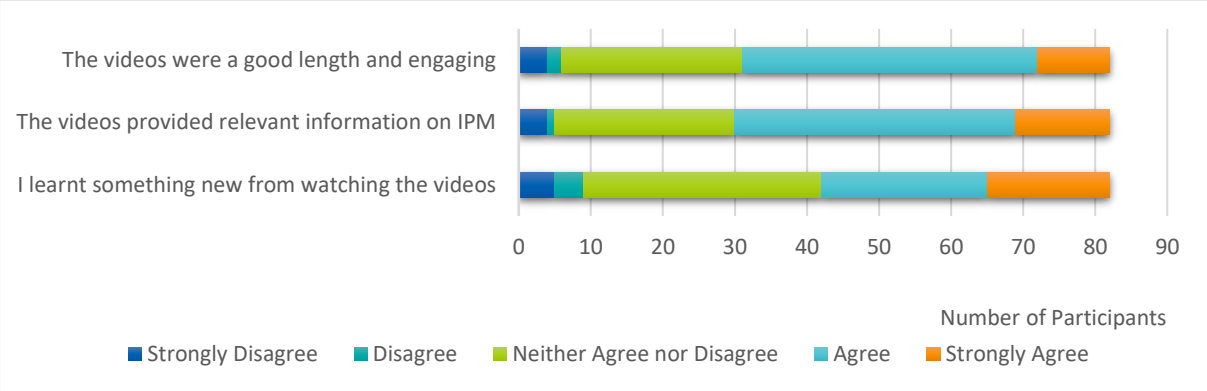


Figure 6.4: Responses to introductory video guidance statements as scored by participants who completed the tool – noting their level of agreement (on a scale of Strongly Disagree to Strongly Agree) with the statements provided.

- Participants mostly found that the **guidance videos** were easy to understand and follow, as well as being both engaging and a good length. More than half of all participants (61%, 50/82) felt that the videos helped then complete the IPM Tool without additional support (Figure 6.5).
- Some participants stated that they did not view or could not find the videos within the tool at first: *"didn't spot the videos = were they obvious?", "Have not seen the video yet and did not seem to be a way to get back to it", "I didn't see where the videos or written guidance were as I didn't see that I needed to scroll down the home page to see them. Maybe link them on some of the question pages?".*

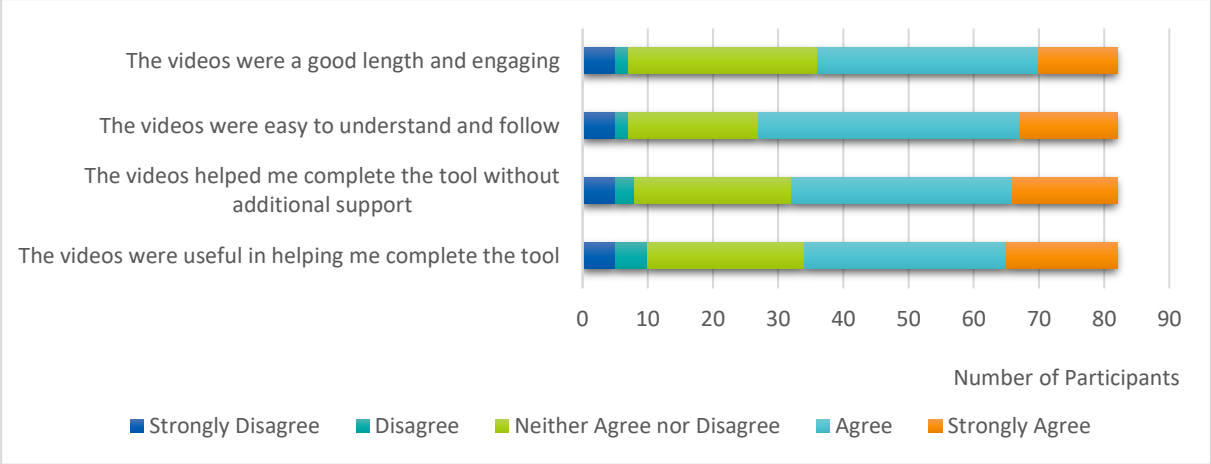


Figure 6.5: Responses to general video guidance statements as scored by participants who completed the tool – noting their level of agreement (on a scale of Strongly Disagree to Strongly Agree) with the statements provided.

Written Guidance

- Participants largely felt that the **written guidance** helped them learn something new, including learning about different aspects of IPM. More than half of all participants (57%, 47/82) also felt that the written guidance would be a valuable ongoing source of information (Figure 6.6).
- Some additional feedback provided by participants related to both video and written guidance included: "*I didn't use either videos or written guidance*", "*Video and written guidance more useful for novice farmers*", and *"I carried out the IPM plan without watching the videos or reading the guidance first. I only went back and read it after being made aware of it because of this questionnaire! I found it useful but when you go on the first screen, it doesn't appear and you have to scroll".*

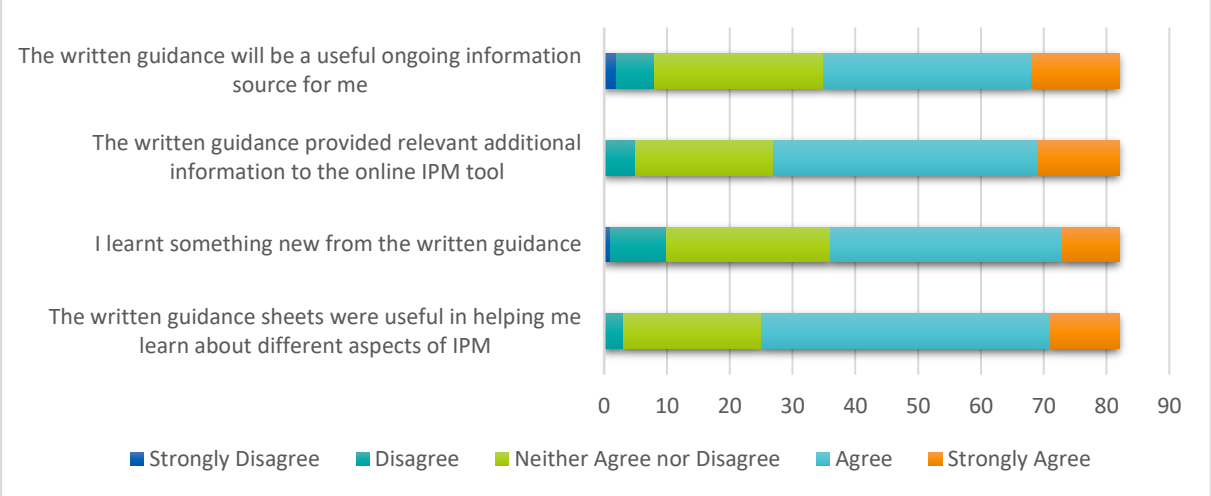


Figure 6.6: Responses to written guidance statements as scored by participants who completed the IPM Tool – noting their level of agreement (on a scale of Strongly Disagree to Strongly Agree) with the statements provided.

Complete Experience

Considering their overall complete experience of using the online IPM Tool, participants were asked to rate a number of statements related to how likely it would be that they would do what was suggested in the statements. Figure 6.7 highlights the responses provided for each statement.

- Participants overwhelmingly indicated that they would recommend the online IPM Tool to others, with 76% (62/82) likely or very likely to recommend it. Likewise, 80% (66/82) of all participants indicated that they were likely or very likely to use the tool to create a new plan for the following harvest year.
- Just over a third of all participants (29/82) indicated that it was unlikely or very unlikely that they would use the **video guidance** again. However, 60% (49/82) of participants indicated that they were likely or very likely to use the **written guidance** again.

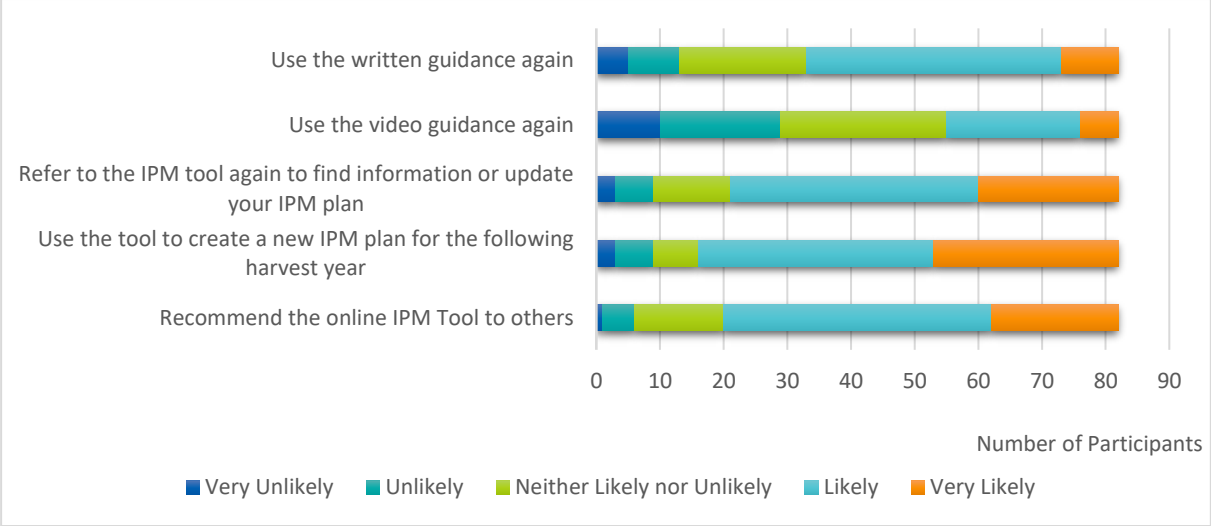


Figure 6.7: Responses to complete experience statements as scored by participants who completed the tool – noting level of likelihood (on a scale of Very Unlikely to Very Likely) with the statements provided.

6.2.2 Behavioural Insight Interviews

The results below take a qualitative thematic approach and are presented on the basis of evidence from the in-depth interviews. The approach provides a description of the evidence collected and identifies references made by interviewees to different themes determined through thematic coding of the 44 interview transcripts.

Data was analysed in Nvivo 12 software. The number of interviewees who were categorised under a theme are used for the results, rather than number of times a theme is referred to. This data was chosen to understand popular themes, rather than be weighted for some points which were deemed more relevant to interviewees.

Expectations of the online IPM Tool

- Interviewees had varying expectations of the online IPM Tool, including the tool being an aid to assist memory or as a more formal framework to organise and capture thought processes. Cited responses included:

  "I think what all these do is act as a bit of a memoir at times, but also probably confirm what you're finding in the field."

  "I haven't had a framework before I think."

- Expectations of using the online IPM Tool were exceeded with positive perceptions of the tool being more comprehensive than interviewees had expected. Interviewees reported that the tool made them consider and question their thought process, actions and potential changes they could enact. The tool was also deemed to be quicker and easier to complete than they expected.

"I didn't expect it to be a source of information like it was."

"No, I thought it was quite comprehensive in terms of you know, all the disease pests and covered like say you know good links to all the tools and data that are currently available."

- There was a general perception that the online IPM Tool was too broad compared to what interviewees were expecting. Including that it lacked detail to move from being just a record of data input to a plan to develop a strategy for integrated pest management.

  "… for us it was very broad. So yes, the tool was not difficult at all to use it talked you through it. One thing led to another. So there was, there was a very logical path to it. So that was very nice. But we by purely putting in what applied to us, we weren't able to go much into depth."

- It was expressed that the tool was not as helpful as expected for organic farmers. Although, there was a counter argument that it could be useful as a data collection tool for organic farmers.

  "It would be good for organic farmers to have to do it as part of their [data recording]."

- Interviewees noted that the type of feedback compared to other available tools was more relevant to farmers. Furthermore, the language used was seen as more farmer friendly than academic.

- Interviewees felt they were able to use the information from the tool in discussions with their agronomists or other advisors, which they had not expected as an outcome from using the IPM Tool. Additionally, it was generally perceived that the online IPM Tool aided farmers in understanding their agronomist more as they felt further informed.

  "I'm a dairy farmer so I'm not like a Land Management expert. So somethings I didn't understand and because I could then cross reference it with the videos and the explanations…I might have known that's what it was, but maybe I didn't know the proper word for it…to what is more of a layman's farmer term for it."

  "And we've certainly had good discussions about insecticide usage, for instance and… methods of control"

Confidence in IPM decision-making from using the IPM Tool

- Interviewees had mixed views regarding how using the online IPM Tool affected their confidence for IPM. Similar to the idea of being an "*aid memoir*", the tool also offered reassurance and confidence that farmers were already implementing appropriate IPM actions.

  "…it sort of refreshes our knowledge, so yes, it does add to your confidence."

  "I realised that I don't need to do anything special that I'm not already doing. So it gives me more confidence."

- Interviewees also indicated that the tool offered support for their decision-making, which in turn made them feel more confident. While farmers often have a lot of the data and decisions in their head, some interviewees felt that the tool offered them the chance to consider more ideas and solutions.

  "…I don't feel I need to do this plan to farm well. It does just help me…check I'm not missing the point. Sometimes you provoke something by writing things down…"

  "It helps you realise what you know, do well already and…You can see that there are things you could do better and therefore that gives you more confidence."

- Interviewees gained confidence from using the tool knowing it was connected to reputable organisations, including AHDB and ADAS. They noted the links to AHDB as being particularly useful and insightful;

"I just got stuck in…and then to have it sort of rubber stamped by ADAS or AHDB…an organisation just gives you that bit more confidence."

"I thought it was excellent actually the links to the AHDB….You know the reminder of what the thresholds might be or what you should be thinking about at that time."

Functionality of the IPM Tool (useability and practicalities)

Video and Written Guidance

- The written guidance was well-received, particularly the links to further information, with AHDB gaining particular mention. Interviewees explained they predominantly utilised the videos to understand how to use the tool and stated they would be unlikely to watch videos again, except they thought a refresher would be useful. The written guidance was also perceived as being helpful for those who had poor internet access.

  "…something I can scan and read is often more helpful than a video to watch."

  "Written was useful. We have such a poor internet supply that couldn't get the visual. We're under 0.5 of a meg download speed and it wasn't suitable, so I ignored that."

- The videos and written guidance were not utilised by all interviewees. This was based on their preference, when engaging with something new, to just get started and not read instructions. Even so, those who were unable or chose not to access the videos indicated that they would be keen on a refresher video being available.

  "Didn't use it, just went straight in and tried it."

  "I probably went this the wrong way about it. I just sat down, opened the tool and started. Then when I'd got a problem, I looked at your guidance notes which is probably not the way you are wanting us to do it."

- Two prominent drawbacks emerged from the in-depth interviews: time to input data; and duplication of data inputting. These two factors made the tool feel repetitive. While there was acceptance that repetitiveness would be normal in any formalised system, interviewees were keen to provide ideas to reduce these perceived disadvantages, including linking crops instead of having them classed by field. Another idea was for parts of the tool to be automatically filled where there are similarities across fields or crops. However, warning was provided that users may not fully concentrate and absorb the information or findings. There was concern that users could just write "*not applicable*" or "*no response*". Interviewees felt that in an effort to combat the risk of many negative responses, questions could be raised to avoid the tool being passively answered and decisions therefore not being considered.

  "To come up with an option saying,…seeing you answered no to this thing yourself here are the options that are available…you might want to consider."

- Suggestions were also provided on how the online IPM Tool could look to aid user experience. These suggestions ranged from an indicator to show how much the user had left to complete to the software automatically copying more information from the current season to start next season's plan. Other suggestions included highlighting areas the farmer wanted to improve in the future or colour coding different crops so they did not look the same to reduce risk of confusion.

  "I just felt it needed was maybe colour coding so I knew, "Now I'm looking at wheat. Now I'm looking at barley. Now I'm looking at seed rape." The screens were very samey."

  "…whether you can have like a traffic light system saying actually this side green great, this side's red. You know these are your areas you need to work on as a farm business."

"I think you want to have something which can show the areas you've marked off as the worst situation, the highest priority so that you can then look at that…You can then look at measures that you're not doing already to try to reduce that risk."

- Other data recording tools (which were predominantly software based) used by interviewees were identified as having similarities in data requirements as the online IPM Tool. These included Red Tractor, Gatekeeper and Muddy Boots. Although interviewees stated not all these tools collected similar data, they believed that they would in the future with the growth of data collection for environmental measures. Interviewees felt that working with these other data recording tools could reduce data inputting duplication, as well as the number of different recording and farm management databases.

  "I think it could be if we could integrate it into systems or link back from systems-- I worry how many databases we end up keeping..."

  "Probably not so much record keeping, more of a management tool, as to remind me of the thought process I went through and whether I needed to adapt it for next year…Probably I'd record all my activity through Gatekeeper, but I don't recall my thinking process through Gatekeeper. I have to go and remind myself why I did that high-seed rate and why I did this, why I did that."

- Some interviewees felt that while aligning or working with another organisation may reduce duplication of data-inputting and therefore time, there was an issue of trust and concern around data sharing. There was a concern that other organisations with a commercial focus may sell the data to other organisations or that the data collected may be used against the farmer.

  "I'm very uncomfortable about Red Tractor being linked to these things. Because I don't think they should have access to your farm data like this."

  "[Data] should remain between me and whoever runs the IPM tool. I don't think it should be shared with anyone else."

- Other interviewees commented that being run independently from a commercial or government organisation may provide farmers with more confidence in its validity.

  "It has certain independence to it, and that has value it's standalone. And if it stand alone, it has validity…It has that independence of the other software it is more respected."

- Interviewees had differing viewpoints on grouping information to reduce the time spent on the online IPM Tool. Some interviewees felt grouping could be done by cropping or infestation. Others raised whether the tool should be set up to allow for data input on a field or crops basis.

  "I think for the tool to work properly, you've gotta do it on a field-by-field basis…You've gotta go through the thought process for each individual one, cause you might just pick up a spot, a slight difference which will give you a different outcome"

  "You've got to learn and every year is a new year and every year the challenge is different, so copy and paste plan doesn't really work."

- There was a general perception of the online IPM Tool being a planning and management tool, and so a function to be able to print the guidance and recommendations was suggested. It was felt that this would allow the information generated from the tool to be shared with an advisor to get their insights as well as to use as a reminder of tasks and ambitious goals for the future. Moreover, it was felt that this would also allow the information to be shared with relevant stakeholders as evidence of action.

  "Provide a printed document that we could put to one side and tick the boxes for the IPM SFI… Farmers are going to be targeted by land agents, agronomists to get that bit of paper to satisfy SFI IPM. Did it to get ahead of the game"

"...it gives you a record to show SFI if they did come out or do an inspection…"

"We can tell a story and back it up with…This is where we were. This is what we've done. And we're now here. We're in a better place."

Perceived barriers to other farmers using the IPM Tool

- Sentiments were expressed regarding the need for other farmers to have assistance to complete the online IPM Tool. Suggestions were provided in the form of administration support, such as a helpline or webinars, as well as technical advisory services, such as from an agronomist.

  "I think if I was going to sit down and do this really thoroughly,…I think you'd probably need to have your agronomist with you…"

- Interviewees believed that they knew about the online IPM Tool because they are on certain mailing lists or linked to some organisations who are connected or advertised the tool. Whereas, as they felt other farmers who are not engaged with these organisations or on mailing lists may be less likely to use the tool. Interviewees also felt that many other farmers would be fearful of the unknown. This was described as fear of how to use the tool and utilise the findings as well as fear of consequences if they implemented something incorrectly. The latter was a cause for concern due to external factors, such as climatic conditions, which may hinder the farmer's IPM intentions.

  "People are scared of the unknown or scared of making a commitment."

  "Hopefully, it'll be used as a means of rewarding us for good practice…not dictating practice."

- The amount of time users believed the tool should take to complete ranged from five minutes to one hour for each crop. From those who inputted more than one crop, they explained that subsequent crops were much quicker to input and would take less than half an hour to complete after the initial learning curve.

  "I think once I got into it properly, it was quite quick and easy to use. Having worked through one crop, the next one took about half the time."

- Interviewees also stated however, that it would be challenging to give up the time to complete the online IPM Tool because farms may not have labour assistance. Therefore, the farmer would not want to give up their time on this task if there were others to be done, without an incentive.

  "…the big farming companies,…they'll be all over this. I guess it'll be harder for the sort of smaller mixed farm…they're just working their socks off. Don't probably get the time they need to do this sort of thing."

  "…there are some big agribusinesses, big farms…the secretary or whoever will do that. But there's a lot of us who are small businesses who have to do absolutely everything and you know, making that bit easier is definitely important."

Motivations and Barriers to use the IPM Tool in the future

- Continual education from the online IPM Tool was as important motivation and matched many interviewees initial expectation of curiosity in testing a new tool.

  "The industry wants a standard. People get behind it and they use it and you can then compare what you're doing in the business to business because you're using the same method of assessment."

- Perceived advantages of using the tool which interviewees felt would keep them motivated to use it were: if it assisted in their future planning, improved their performance (especially in crops and

financially) and would make their processes more efficient. Another motivator was the influence of the market and how the tool would help in that respect.

- Potential reasons to stop using the tool were based around the tool changing. For example, if changes to the tool made it too time consuming to complete or the tool became more complicated as it was rolled out wider. Alternative views included if the tool become more of a data record than a useful plan which aided their decision-making and planning or if the user stopped learning anything new as this was perceived to be a valuable attribute for investing time in the tool or a better tool became available.

  "The main one is time, because…it's just me on this farm. I've got a young family and if I'm not at work…That would mean I'd need to pay somebody to complete it. At that point I start getting quite cross because- in some ways that might be a good thing so I get an independent view of what somebody else writes."

  "But if the tool works I will use it whether I get paid or not. You know, if I if I see a benefit to me in time management and making recommendations, then I will use it."

  "…in IPM…we're learning new things all the time and my concern was the model or the tool. It's good. Just keep being updated so you've got the very latest."

- Organic farmers in the interviewee cohort had mixed views of the usefulness of the online IPM Tool as they perceived that they implemented most of the recommendations already or the recommendations were not relevant to them.

  "I wouldn't bother doing an IPM Tool because it's not. It's not relevant to organic as much."

6.3 WP 5 CONCLUSIONS

- The overall number of completed responses to the online survey (n=82) was high and represented a 73% response rate, indicating a positive willingness to engage in IPM planning through the use of online IPM tools.

- Response rate for follow-up one-to-one interviews, from amongst the 82 completed survey responses, was also high at 61%, indicating further willingness to engage with IPM through online IPM tools.

- The majority of participants completed crop plans using the online IPM Tool in under two hours, with many participants completing plans for the first crop in less than one hour and the second and subsequent crops in less than 30 minutes.

- The feedback regarding the video and written guidance was positive across the majority of participants, with most reporting agreement with the statements presented.

- Participants overwhelmingly indicated that they would recommend to other farmers to consider using the online IPM Tool and would use the tool again to create a new plan for the following harvest year.

- Barriers to using the online IPM Tool were acknowledged as: awareness of the tool; computer literacy; fear (of consequences if they implement something incorrectly); lack of financial incentive for the time input and if the tool became the industry standard or mandatory.

- The online IPM Tool was complimented for its ease of use, suitable language for a farmer audience and logical flow. Participants also perceived the tool to be useful for IPM because of the questions it raised which made them consider inputs and decisions.

- Strengths of the online IPM Tool are particularly based on the guidance, links to up-to-date data, thresholds and respected organisations were popular.
- The main motivation to continue using the IPM Tool was continued learning. Therefore, the tool will need to be regularly updated with robust data from respected organisations.

6.4 WP 5 Supplementary Material

6.4.1 IPM Online Tool Participant Feedback Survey

IPM Online Tool Participant Feedback Survey [transcript of the online survey text]

Introduction

Thank you for testing the IPM Tool. We would like to hear how you found the process.

This questionnaire should take less than 15 minutes to complete.

Please read before you start the survey.

Consent to Participate:

All answers you provide in the survey will be treated confidentially. Your anonymity will be maintained throughout the research, with each participant assigned a unique participant identification number, which will be used in answer responses and analysis. Your contact details will only be used for the purpose of carrying out this project. Data will be stored in accordance with General Data Protection Regulations (GDPR) and will not be shared outside of the research team. Following project completion all personal data will be securely destroyed. You are free to withdraw from completing the survey at any point.

1. Please confirm: I have read and understand the information above and I consent to participate in the survey: Yes No

Further information: Should you have any concerns or queries about participation in the survey, the storage and processing of your personal data or any other aspect of this research, please contact [ADAS contact email].

General Questions

2. What best describes your role? * Required

Farmer

Agronomist

Other

2.a. If you selected Other, please specify:

3. Did you require advice from your Agronomist to complete the online IPM tool? * Required

Yes No Not applicable

4. Are you BASIS qualified? * Required

Yes No

5. Please indicate how much of the online IPM Tool you completed * Required

Fully completed for one crop only

Fully completed for 2 or more crops

Partially completed

Did not start at all

5.a. You have indicated that you only 'partially completed' the online IPM tool, please tell us the reason(s) why you didn't continue using the tool to complete an IPM plan.

5.b. You have indicated that you did not start the online IPM tool at all, please tell us the reason(s) for this.

Online IPM Tool and Functionality

6. Did you find the introductory page helpful? * Required

Yes No

6.a. You have indicated that you did not find the introductory page helpful. Please provide the main reason for your response.

7. How many crops did you complete the online IPM tool for? * Required

1

2

3

More than 3

8. How long did it take you to complete the online IPM Tool? * Required

Less than 30 minutes

Between 30 minutes and 1 hour

Between 1 hour and 2 hours

More than 2 hours

9. How long did it take you to complete the online IPM Tool for the first crop type? * Required

Less than 30 minutes

Between 30 minutes and 1 hour

Between 1 hour and 2 hours

More than 2 hours

10. How long did it take you to complete the online IPM Tool for the second and subsequent crop types?

Less than 30 minutes for each crop type

Between 30 minutes and 1 hour for each crop type

Between 1 hour and 2 hours for each crop type

11. Please rate the following statement 'the online tool took significantly less time to complete for each crop type after the first' * Required

Strongly Agree

Agree

Neither Agree nor Disagree

Disagree

Strongly Disagree

12. How did you find the online process of completing the IPM Tool? * Required

Very Easy

Easy

Neither Easy nor Difficult

Difficult

Very Difficult

13. Please rate your level of satisfaction with the following aspects of the IPM Tool * Required

Please don't select more than 1 answer(s) per row. Please select at least 6 answer(s).

	Very Satisfied	Somewhat Satisfied	Neutral	Somewhat Unsatisfied	Very Unsatisfied
Ease of registration					
Ease of use					
Links to guidance					
In-tool information					
Questions					
Layout					

14. Which aspect of the online IPM tool were you MOST satisfied with and why? * Required

15. Which aspect of the online IPM tool were you LEAST satisfied with and why? * Required

Video and Written Guidance

Introductory Videos

16. Please rate the following statements about the introductory videos provided on IPM * Required

	Strongly Agree	Agree	Neither Agree of Disagree	Disagree	Strongly Disagree
I learnt something new from watching the videos					
The videos provided relevant information on IPM					
The videos were a good length and engaging					

17. Please rate the following statements about the video guidance provided on using the tool * Required

	Strongly Agree	Agree	Neither Agree of Disagree	Disagree	Strongly Disagree
The videos were useful in helping me complete the tool					
The videos helped me complete the tool without additional support					
The videos were easy to understand and follow					
The videos were a good length and engaging					

Written Guidance

18. Please rate the following statements about the written guidance provided as part of the online IPM tool * Required

Please don't select more than 1 answer(s) per row. Please select at least 4 answer(s).

	Strongly Agree	Agree	Neither Agree of Disagree	Disagree	Strongly Disagree
The written guidance sheets were useful in helping me learn about different asepcts of IPM					
I learnt something new from the written guidance					
The written guidance provided relevant additional information to the online IPM Tool					
The written guidance will be a useful ongoing information source for me					

19. Considering your COMPLETE EXPERIENCE using the online IPM Tool, how likely are you to do the following? * Required

Please don't select more than 1 answer(s) per row. Please select at least 5 answer(s).

	Very Likely	Likely	Neither Likely or Unlikely	Unlikely	Very Unlikely
Recommend the online IPM Tool to others					
Use the tool to create a new IPM plan for the following harvest year					
Refer to the IPM tool again to find					

information or update your IPM plan					
Use the video guidance again					
Use the written guidance again					

20. Is there anything else you think is important for us to consider in relation to improving the online IPM tool? * Required

Follow-up Participation

A telephone or in-person interview would help us gain detailed feedback from you on how to improve the online IPM Tool and the IPM SFI.

21. Can we invite you to participate in a 1-to-1 interview with an ADAS researcher at a later date? * Required

Yes No

21.a. You have indicated that you would be happy to participate in a 1-2-1 interview at a later date. Please provide the best contact details (email or phone number) that an ADAS researcher can use to contact you.

Thank you for Participating. Thank you for taking the time to complete this online survey. If you have further comments or wish to discuss the use of data in this survey, please contact Kath.Behrendt@adas.co.uk

REFERENCES

Blake B, Cook S, Godfrey K, Tatnell L, White S, Pickering P, Ritchie F, Smallwood IL, Young C, Ellis S, Paveley N, Wright P. (2021) Research Review No.98. Enabling the uptake of integrated pest management (IPM) in UK arable rotations (a review of the evidence). AHDB, UK.

Cook S, Godfrey G, Telling S, Bartel E, Tatnell L. Burn A, Ellis S. (2023) Integrated Pest Management (IPM) for Biodiversity Enhancement. Natural England, UK.

Twining S, Elliott J, Watson S, Cook S, Everit R, Clarke J, Proctor P, McChesney D. (2007) The potential for increasing the area of spring cropping to enhance biodiversity (IFO130). Defra, UK.

Young C, Cook S, Wedgewood E, Bennison J, Bartel E, Blake J, Huckle A, Allen J, Godfrey K, Eyre C, Butters L, Ree H, Bowsher-Gibbs M, Creissen H. (2022) Review and guidance for integrated management of economically significant weeds, pests and diseases in a range of horticultural and other edible field crops. AHDB, UK.