

Potential Impacts Arising from Pesticide Withdrawals to Scotland's Plant Health

PHC2018/15 - Project Final Report



This report should be used and interpreted in conjunction with report PHC2020/09

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This report should be used and interpreted in conjunction with report [PHC2020/09: Economic Impact of Pesticide Withdrawals to Scotland, with case studies](#).

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1 Executive summary

This report was prepared using detailed industry-generated evidence of upper-bound impacts on total value of output for Scottish crops. These are commonly mitigated by adaptations in practice which are explored in a linked report on economic impacts with case studies (PHC2020/09). The findings of report PHC2018/15 below should therefore be used and interpreted in the context of the second report which identifies the mitigating adaptations taken up by Scottish growers.

The key research questions addressed in this report are the risks posed to Scottish plant health from the potential withdrawal of some of the key active substances in pesticides used in Scotland for pest, weed and disease management across agriculture (including production horticulture), forestry, and the natural environment & horticulture (including amenity) sectors. An assessment of the impact of withdrawals of key active substances in each sector has also been undertaken based on a worst case scenario.

Adopting a worst case scenario approach, for all sectors, the withdrawal of active substances identified as at risk of withdrawal would have a significant impact on the ability to manage pests, weeds and diseases effectively and economically and the total value of output for all sectors would be affected. The sectors for forestry and environment would be moderately affected as their reliance on pesticides is currently lower than in the horticulture and agriculture sectors. Of these latter sectors, there would be significant economic loss and a necessity to rapidly implement alternative Integrated Pest Management (IPM) options. For soft fruit and vegetable production, losses may be sufficiently severe as to make production uneconomic if no adaptations are made. Across all sectors, where alternatives to pesticide active substances are available this may add to complexity and cost of production for producers and land managers.

1.1 Recommendations

- Increased promotion of IPM across all sectors is necessary to mitigate the potential withdrawal of active substances.
- Particular consideration of soft fruit, vegetable and ornamental production sectors should be integral in future support and policies from Scottish Government.
- There will be a need to steward and conserve the active substances that currently have approval and any new active substances made available in the future.
- There will be an increased requirement for training, knowledge exchange and advice to mitigate increased plant health losses and facilitate the rapid uptake of alternative and integrated solutions across all sectors. Provision of training, knowledge exchange and advice should be provided by NGO's and industry.

1.2 Main findings

The key outcomes from the assessment of the risk of active substance withdrawals to Scottish plant health are that for all the plant health sectors (agriculture/horticulture, forestry and natural environment), the withdrawal of key substances would have a significant impact on the ability to manage pests, weeds and diseases effectively and economically. The Total Value of Output for all sectors would be affected. For the soft fruit and field vegetable sectors in particular, production will be significantly affected and may become uneconomic.

A summary of the withdrawal risk of the most commonly applied active substances in Scotland in each sector is summarised in the Table below.

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Sector	No of most applied principal active substances considered	No of active substances and level of risk of withdrawal		
		High	Medium	Low
Arable	50	12	16	22
Soft Fruit	20	3	9	8
Grass & Fodder	30	14	7	9
Field Vegetables	30	13	13	4
Forest Nursery/Plantations	16	5	9	2
Amenity vegetation & grass	23	6	5	12
Natural Environment & Ornamental Horticulture	18	8	4	6
Amateur use	20	9	8	3

The upper-bound Total Value of Scottish Output (£M) for the Arable sector and its sub-sectors and the potential reduction in Value (£M and %) if active substances at High and Medium risk are lost.

<i>Arable Sector</i>	<i>Total Value of Scottish Output (£M)</i>	<i>Potential reduction in Value of Scottish Output due to loss of active substances at risk (£M)</i>	<i>% reduction in Value of Scottish Output</i>
Whole sector	717.6	102.2	14.2
Cereals	441.5	59.2	13.4
Oilseed rape	44.8	9.4	21.0
Legumes	16.7	7.5	44.9
Potatoes	214.7	33.3	15.5

The upper-bound Total Value of Scottish Output (£M) for the Soft Fruit sector (Strawberries and Raspberries) and the potential reduction in Value (£M and %) if active substances at High and Medium risk are lost.

Soft Fruit Sector	Total Value of Scottish Output (£M)	Potential reduction in Value of Scottish Output due to loss of active substances at risk (£M)	% reduction in Value of Scottish Output
Strawberries	88.6	61.1	69.0
Raspberries	20.2	16.1	79.7

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The upper-bound Total Value of Scottish Output (£M) for the Field Vegetable sector (Brassica field crops and Carrots) and the potential reduction in Value (£M and %) if active substances at High and Medium risk are lost.

Field Vegetable Sector	Total Value of Scottish Output (£M)	Potential reduction in Value of Scottish Output due to loss of active substances at risk (£M)	% reduction in Value of Scottish Output
Turnips/swedes and Brussels sprouts	30.4	13.4	44.1
Carrots	42.2	22.4	53.1

In some cases no chemical alternatives are currently available, or alternatives may be less efficacious, requiring a greater shift into the use of biological pesticides and increased adoption of integrated approaches to achieve effective pest, weed and disease management.

Targeted pesticide use within an integrated pest management (IPM) system is recommended within all sectors to maintain effective management of pest and disease burdens, and to conserve the remaining pesticide active substances though reducing risk of resistance and insensitivity.

Pesticide use in forestry, amenity and ornamental horticulture is very reliant on Extension of Authorisations for Minor Use (EAMUs), with fewer on-label approved active substances compared to those approved for use on agricultural and food crop systems. Weed control is the most substantive current usage and where greatest impact from pesticide withdrawals is anticipated. Pesticide use in the natural environment is largely around the control of invasive species so potential withdrawal of herbicide active substances like glyphosate would have the greatest impact.

Pesticides with approval for amateur use (i.e. gardeners) are already restricted with few of the actives at risk of withdrawal likely to have significant impact on the health of garden plants. Glyphosate and metaldehyde are the more commonly used actives at risk, with the insecticide thiacloprid already withdrawn and the pyrethroid insecticides deltamethrin and cypermethrin likely to be lost in 2023. Ferric phosphate provides an alternative to metaldehyde and for glyphosate there is more likely a need to apply alternative methods of control such as hand weeding, which is not applicable to commercial settings. There has been an uptake of alternative solutions such as the use of fatty acids and acetamiprid in place of insecticide products already withdrawn, and this is likely to continue as insecticide active substances such as deltamethrin and cypermethrin are withdrawn.

2 Introduction

The Scottish agricultural, horticultural, natural environment, ornamental horticulture, forestry and amenity sectors face a significant threat to their plant health and/or productivity through the withdrawal of key plant protection active substances and products. This threat is primarily due to the withdrawal of existing active substances (by agrochemical companies or through regulation), limitations on the development of new active substances, an increase in pesticide resistance in pests, weeds and diseases, increased concern over health and environmental impacts arising from pesticide usage and hence increased political and public pressure against specific pesticides and pesticide groups.

The EU definition of the term ‘pesticide’ is an agent (i.e. a plant protection product) that prevents, destroys, or controls a harmful organism (‘pest’) or disease, or protects plants or plant products during production, storage and transport. The term includes, amongst others: herbicides, fungicides, insecticides, acaricides, nematocides, molluscicides, growth regulators, repellents, rodenticides and other biocides. Note that this report does not consider the impact of the loss of rodenticides and other biocides. Pesticides contain at least one active substance and may also contain other components including safeners and synergists. (https://ec.europa.eu/food/plant/pesticides_en)

Use of pesticides is just one of the options within the integrated pest management programmes that are promoted as part of the Scottish Government Integrated Pest Management (IPM) Plan (<https://consult.gov.scot/cap-reform-and-crop-policy/9a1bb2d9/>). However, current Scottish agricultural and production horticulture pest management practices rely heavily on chemical pesticides. Reliance across other sectors is proportionally lower.

Current Scottish and UK government rhetoric is around more environmentally sustainable systems of production, and indications are that pesticide regulation in the UK will be as stringent, if not more so, than EU rulings.

This report assesses the risk of withdrawal of the main active substances used in Scotland across the agriculture, production horticulture (vegetables and soft fruit), forestry, amenity and environment, and ornamental horticulture sectors, and where possible provides an assessment of the impact of potential key active substance withdrawals in the relevant Scottish sectors. Use in the natural environment is very limited and any impact is likely to be around the management of invasive species.

3 Approach

This report uses detailed industry-generated evidence of upper-bound impacts on total value of output for Scottish crops to frame the impact of pesticide losses. These are commonly mitigated by adaptations in practice but evidence on what these are and how they have been taken up on practice was not available. This evidence gap has been addressed in a linked report on economic impacts with case studies (PHC 2020_09) which discusses the mitigating practices taken up by Scottish growers. The findings of the report below should therefore be used and interpreted in the context of the second report which captures the mitigations possible.

The approach adopted in this assessment of at-risk active substances used Scottish pesticide use data gathered from the most recent Pesticide Usage Survey Reports (<http://www.sasa.gov.uk/pesticides/pesticide-usage/pesticide-usage-survey-reports>) to

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identify the most frequently used active substances in Scottish agricultural and horticultural sectors (where available). This means that active substances of greatest importance to each sector are assessed and discussed in descending order of usage in the concluding tables to this report.

This data was cross-referenced with an analysis of active substances at risk provided by SASA (a Division of the Scottish Government Agriculture and Rural Economy Directorate) and a database maintained by the Agriculture and Horticulture Development Board (AHDB) that tracks and assesses the risk of withdrawal of active substances currently approved in the UK and in the EU. To weight these impacts to Scottish risks we have consulted with key stakeholders listed in the acknowledgement section to amend economic loss estimated accordingly.

In addition, information and data from the following were taken into account when identifying active substances that are at risk of withdrawal:

Healthy Harvest: The impact of losing plant protection products on UK food and plant production (<https://www.nfuonline.com/healthy-harvest-report/>), Steward Redqueen (2014).

Broader impact of criteria for endocrine disrupting properties for crop protection products in Europe (http://www.ecpa.eu/sites/default/files/documents/ED%20Report_20March.pdf).

The Effect of the Withdrawal of Plant Protection Products on UK Agriculture and Horticulture and the Wider Economy (<https://www.nfuonline.com/andersons-final-report/>).

The Pesticide User Habits Survey 2016: Public purchasing, use, storage and disposal of pesticides in plant protection products http://www.hse.gov.uk/pesticides/resources/G/Garden_User_Habits_Survey_Report_2016.pdf

The data is presented for each sector: agriculture/production horticulture, forestry, amenity, natural environment and ornamental horticulture. As there are no equivalent usage statistics for amateur use, information gathered is from the HSE Pesticide Database and from the 2016 usage survey published by HSE and a descriptive analysis only given.

For large sectors such as agriculture/production horticulture, the data is sub-divided into: Agriculture: arable crops (cereals, potatoes, oilseeds and legumes); Production horticulture: soft fruit crops (strawberries, raspberries and other soft fruit); grass and fodder crops (fodder crops are those to be fed to livestock); and field vegetable crops (carrots, turnips/swedes, Brussels sprouts and other crops).

The criteria that was used to get to a 'traffic light' rating of either:

High risk of withdrawal, **Medium risk of withdrawal**, **No/low risk of withdrawal**,

in this report was based on European Union Regulation EC 1107/2009, which covers both the approval of new active substances and the renewal of existing substances within the EU.

Specifically, active substances that receive classifications of 1A & 1B – for Reproduction, Carcinogenic and Mutagenic hazards all warrant a non-renewal from the European Food Standards Agency (EFSA), and as such all of these active substances receive a High risk of withdrawal rating in this report. If a substance is given a classification of 2 in more than one

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of these categories: Reproduction, Carcinogenic or Mutagenic, this gives the risk as Medium risk of withdrawal, as this is often stated as a reason for non-renewal. Active substances with a classification of 2 in all three categories (Reproduction, Carcinogenic or Mutagenic) receive a High risk of withdrawal rating.

Active substances determined to be endocrine disruptors are given a non-renewal, and subsequently a High risk of withdrawal rating.

Pesticides where there are specific reviews underway or pending for renewal of approvals by EFSA were considered. 'No Safe Use' suggested by EFSA early in the review process are given either a Medium risk of withdrawal or High risk of withdrawal rating depending on areas of concern. Critical areas of concern are given a High risk of withdrawal rating. Determining whether a non-safe use is given a Medium risk of withdrawal rating depends on the nature of the concern and the number of areas of concern. If the area of concern is simply overcome by filling a data gap the risk of withdrawal is downgraded (e.g. if based on one data gap, or a simple data gap).

The political environment is also taken into consideration. For example, the active substance glyphosate would have few problems going through the renewal process and would consequently receive a No/Low risk of withdrawal rating. However, pressure for non-renewal comes from increased concerns over health and environmental impacts arising from pesticide usage, the political and public perceptions and concerns that raise the risk of withdrawal.

To derive conclusions on the impact of withdrawals in the Scottish context we have first gather data on the value of the sectors in Scotland where this was available. The potential economic impacts of yield impact for the withdrawal of key active substances on Scottish crops were estimated based on the Total Value of Output data for each commodity from the Scottish Government Economic Report on Scottish Agriculture 2018 (<https://www2.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/PubEconomicReport/ERSA2018>). Additional data was obtained for the breakdown of cereals into winter barley, spring barley and winter wheat derived from a combination of data from DEFRA, Scottish Government, AHDB Cereals, the Maltsters' Association of Great Britain (MAGB) and SRUC (compiled by Julian Bell, SAC Consulting). Data on the Scottish forestry sector was obtained from Forestry Research (<https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/>).

Derivation of the potential financial impact (£) of the withdrawal of active substances on the Scottish Total Value of Output, utilised the estimated percentage impact of withdrawal specified by Wynn (2014) in the AHDB review of the impacts of the withdrawal of active substances on crop sectors in the UK. This approach using the Total Value of Output (where known) was adopted for all sectors to provide an estimate of the economic impact of the withdrawal of a specific active substance. This also takes into account the potential increased cost of production for adopting other more expensive active substances or other IPM approaches. A caveat here is that for the Scottish (as opposed to the UK) situation, pest/weed/disease pressure could be different (higher or lower), and the financial impact of these could also be higher or lower. We have therefore consulted with stakeholders and amended the economic impact assessment (Total Value of Output) where expert opinion held that this deviated from UK sourced data.

For example, the Total Value of Output of Scottish winter wheat is £120.01M (Julian Bell, SAC Consulting). Wynn (2014) estimated that the withdrawal of the active substance prothioconazole would lead to a withdrawal of 2% of the UK farmgate value of winter wheat.

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So, assuming this 2% reduction to Total Value of Output of Scottish winter wheat, withdrawal of prothioconazole would reduce the Total Value of Output of Scottish wheat (£120.10M) by £2.40M (2%). Most of the major wheat pathogens managed by prothioconazole are of similar importance to the UK calculated losses so this 2% value was regarded by stakeholders as representative for Scotland and retained in this report. The impact on barley was moderated downwards because of resistance problems in ramularia which have rendered the active less effective anyway.

In England the cabbage stem flea beetle has been the cause of significant damage to winter oilseed rape, exacerbated by the fact that the beetle is resistant to the pyrethroid insecticide approved for its management. In Scotland cabbage stem flea beetle is not currently a serious issue as stem damage is not often reported. Consequently, we have not attributed any loss of Total Value of Output to cabbage stem flea beetle.

The approach using the Total Value of Output (where known) and the views of the consulted stakeholders were adopted for all of the sectors to provide an estimate of the economic impact of the withdrawal of an active substance in a Scottish context.

Additionally, comments on early drafts of this report from policy stakeholders in the plant health sector were incorporated in the final version and are acknowledged at the end of this document.

3.1 Agriculture/Production Horticulture sector

As this sector covers a wide range of crops, the data is sub-divided into the following:

Most frequently used active substances (n=50) on arable crops (cereals, potatoes, oilseeds and legumes) (Table 1 – in Appendix)

Most frequently used active substances (n=20) on soft fruit crops (strawberries, raspberries, blackcurrants, blueberry) (Table 2 – in Appendix)

Most frequently used active substances (n=30) on grass and fodder crops (fodder crops are those to be fed to livestock) (Table 3 – in Appendix)

Most frequently used active substances (n=30) on field vegetable crops (Table 4 – in Appendix).

3.1.1 Arable crops

Table 1 (in Appendix) lists the 50 most frequently used active substances on arable crops (cereals, potatoes, oilseeds and legumes) by area treated (from the 2018 Scottish Pesticide Use Survey). The table has the ‘traffic light’ colour code to highlight the risk of withdrawal. The table also identifies the type of active substance (Fungicide, Herbicide, Insecticide, Seed treatment, Growth regulator, Molluscicide), the current scheduled UK expiry date for that active substance (from the CRD Pesticides Register Database <https://secure.pesticides.gov.uk/pestreg/>) and Comments regarding that specific active substance in terms of its Scottish use, importance, availability of alternatives and other salient points.

For example, from Table 1, the fungicide/seed treatment (F/S) prothioconazole is the most frequently used active substance on Scottish cereal and oilseed crops, it has a scheduled UK expiry date of 31st January 2024. It is rated Medium risk of withdrawal and is very widely used

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on Scottish cereal and oilseed crops, on its own and in a range of formulations for a range of diseases. It is also used as a seed treatment in cereals in partnership with other fungicides. It is one of the most effective azole fungicides against *Septoria* in wheat, although reduced sensitivity to several pathogens is occurring in Scotland. This and other azole fungicides are at risk of withdrawal and would reduce the options available for *Septoria* management. New fungicides, including new azoles are in the pipeline and may mitigate some of the withdrawals but are likely to come at enhanced financial cost and will also be at risk of similar fungicide resistance pressures.

Key points to note from Table 1 are that 12 active substances that are rated as at high risk of withdrawal either through being withdrawn already (e.g. chlorothalonil, 2-chloroethylphosphonic acid, diquat) or are scheduled for withdrawal (e.g. metaldehyde, fenpropimorph), have dossiers under review by CRD (e.g. pendimethalin, mancozeb) or are under political/public pressure (e.g. glyphosate). Several of these active substances are also widely used, and whilst there may currently be alternatives for some, their withdrawal will impact directly on management of cereal disease in particular due to not having any direct replacements (e.g. chlorothalonil for *Ramularia* management). Similarly, there are no direct replacements for glyphosate and diquat for weed management and crop desiccation. Folpet will provide a partial mitigation for chlorothalonil withdrawal in some scenarios but will come at additional cost and for some key diseases such as *Ramularia* in barley and *Septoria* in wheat, efficacy is lower. As folpet is also a multisite, there remains some residual risk that its risk rating changes and is ultimately withdrawn.

It has been estimated that without glyphosate, over time, a build-up of perennial weeds will affect all land within the arable rotation (Oxford Economics, 2017). Consequently, losses can be expected to apply across the entire crop area, not just the field receiving a glyphosate application in any one year.

There are 16 active substances rated medium risk of withdrawal, some of which have short expiry dates and may be under review for re-registration (e.g. thifensulfuron methyl – 2020; cyprodinil, trinexapac-methyl – 2023; spiroxamine, diflufenican, prothioconazole, mecoprop-p, flufenacet – 2024), so the future availability of these active substances is unclear, but consequently are considered in this report as being under threat.

There are 22 active substances rated No/low risk of withdrawal – less than half of the active substances in the list of 50 most frequently used in 2018. It is anticipated that these active substances will be re-registered prior to their expiry dates and continue to be available.

3.1.2 Cereals

Cereal seed treatments are at risk of active substance withdrawal. The combined insecticide/fungicide seed treatment clothianidin/prothioconazole is no longer available due to revocation of the neonicotinoid clothianidin in 2018. Prothioconazole is at medium risk of withdrawal and its approval is due to expire in 2024. Prothioconazole is a key active substance in other cereal seed treatments with other actives substances such as tebuconazole, which is at high risk of withdrawal in 2023. There are other seed treatments available utilising active substances such as prochloraz (medium risk of withdrawal) and fluopyram (low risk of withdrawal), so in the short term there will be cereal seed treatment options available, although they may be more expensive.

There are a wide range of fungicide active substances applied to Scottish cereal crops as foliar treatments. The multisite fungicide chlorothalonil is widely used on Scottish cereals, and a decision was taken at a meeting of the European Standing Committee on Plants, Animals,

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Food and Feed on 22 March 2019 not to renew the approval of chlorothalonil. The final use of chlorothalonil (as a single product and co-formulated with other fungicides) was in May 2020.

The withdrawal of chlorothalonil, coupled with the potential withdrawal of some azole fungicides which include epoxiconazole (October 2021) and tebuconazole (both high risk of withdrawal), and prothioconazole (medium risk of withdrawal) would make the management of diseases such as Septoria leaf blotch on Scottish winter wheat crops more difficult, and in the case of Ramularia on barley crops virtually impossible. Mancozeb and folpet are multisite alternatives to chlorothalonil, however, mancozeb is also at high risk of withdrawal, and folpet has very limited activity against Ramularia and lower efficacy relative to chlorothalonil against Septoria in wheat. The SDHI group of fungicides are often mixed (as products or as tank-mixes) with azoles as a resistance management strategy for Septoria. The withdrawal of azoles and multisite fungicides will put pressure on the SDHI's in terms of developing resistance. As it stands several of the SDHIs are rated at a medium risk of withdrawal (boscalid, isopyrazam).

It has been estimated that the withdrawal of prothioconazole would reduce the annual Scottish Total Value of Output of winter wheat (£120.01M) by 2% (Wynn, 2014) - £2.40M. The additional withdrawal of chlorothalonil (2%) in May 2020, and epoxiconazole (0.4%) would overall reduce Scottish Total Value of Output of Scottish wheat by £2.88M. The withdrawal of these active substances may be partially mitigated by the introduction of new azoles such as mefentrifluconazole, but this is likely to come at additional cost and be subject to similar resistance issues to other azoles, so mitigation of the withdrawals described here will be only partial. Similarly, other new actives such as new active groups (i.e. fenpicoxamid) and new generation SDHI and strobilurin fungicides will provide some mitigation but at an additional cost.

A recent study by Kildea *et al* (2018) suggested that the withdrawal of chlorothalonil in Ireland would lead to cereal production only being economic on the highest yielding sites with low costs of production, as the risks of economic withdrawal will increase dramatically on other sites. Should this also be the case in Scotland, then the withdrawal of chlorothalonil will also be significant in terms of economic impact on cereals, particularly winter and spring barley where Ramularia is a disease primarily managed through the use of chlorothalonil, due to resistance in Scotland to SDHIs and azoles. For other cereal diseases the impact of the loss of chlorothalonil both as an effective fungicide, and also as a tool to reduce the risk of resistance to other fungicides such as the SDHIs and azoles will be significant.

Winter barley (Scottish Total Value of Output of £46.54M) and spring barley (Scottish Total Value of Output of £274.83M) will also be impacted by the withdrawal of prothioconazole (both 1% of Total Value of Output), resulting in £0.46M and £2.75M losses respectively. However, there are new active substances in the pipeline that would mitigate the withdrawal of prothioconazole and resistance issues have already reduced its efficacy against ramularia in Scotland.

In terms of insecticide withdrawals in cereals, there have already been withdrawals in insecticides such as chlorpyrifos which raises the risk of leatherjacket damage in spring barley (estimated as 0.5% - £1.37M), as there are no pesticide options available to manage this pest. This is an upper-bound estimate and avoiding fields at risk and rolling may partially mitigate. The insecticide lambda-cyhalothrin is primarily used to manage aphids and barley yellow dwarf virus (BYDV) in cereals. Its use is likely to rise due to the revocation of the neonicotinoid cereal seed treatments at the end of 2018. Potential withdrawal of lambda-cyhalothrin (and other pyrethroid insecticides) coupled with limited alternatives could see a resurgence of BYDV and significant yield losses – estimated to be in the region of 1% (£0.47M for winter

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barley, £1.2M for winter wheat and £2.75M for spring barley). These estimates will be partially mitigated through the use of foliar sprays.

The withdrawal of metaldehyde for use on outdoor crops by March 2022 is mitigated by the availability of ferric phosphate as a straight alternative at a similar cost.

Whilst some herbicides used in cereals are at high or medium risk of withdrawal, there are several alternatives available and economic impact on cereals is likely to be minimal. However, the loss of glyphosate will have an impact on cereal production, particularly winter wheat where glyphosate is widely used to lower the overall weed burden and for pre-harvest desiccation to avoid uneven ripening, and to allow harvesting at the optimum time to maintain quality. It has been estimated (Oxford Economics, 2017) that loss of glyphosate will reduce the yields of winter wheat by 12%, winter barley by 12.5% and spring barley by 9%, equivalent to a Scottish loss in Total Value of Output of £14.4M, £5.8M and £24.7M respectively.

3.1.3 Oilseed rape

The oilseed rape seed treatment thiram was withdrawn in January 2020 and this will leave oilseed rape at risk of diseases at crop emergence such as damping off. New fungicide seed treatment options are in the pipeline and may be available for autumn 2020 sowing.

The withdrawal of the neonicotinoid seed treatments on oilseed rape in 2013 meant that the only options available to growers for protection of the crop from flea beetles and cabbage stem flea beetle were the use of insecticides as a foliar treatment. There is an insecticide seed treatment available in some European countries with the active ingredient cyantraniliprole, which has activity against cabbage stem flea beetle and flea beetles. This seed treatment is not yet approved for use in the UK, however, some growers, particularly in SE England (where cabbage stem flea beetle is a major problem) were getting treated seed imported from countries such as Poland for planting in autumn 2019.

In winter oilseed rape (Scottish Total Value of Output of £44.75M), the withdrawal of the azole fungicides in particular; prothioconazole (6% - £2.69M), metconazole and tebuconazole (both 0.5% - £0.22M each) would increase the risk of light leaf spot and sclerotinia, and the incidental plant growth regulator activity of the latter two azoles will not have any alternatives available.

Currently the only foliar applied active substances approved against flea beetles and cabbage stem flea beetle are the pyrethroid insecticides; alphacypermethrin, beta-cyfluthrin, cypermethrin, deltamethrin, lambda-cyhalothrin, tau-fluvalinate and zeta-cypermethrin. The use of the pyrethroids is problematic due to the issue of widespread pyrethroid resistance in the cabbage stem flea beetle, which, whilst not currently a serious issue in Scottish oilseed rape crops, has caused serious issues in English rape crops where resistance is rife. We do not currently have a good handle on the resistance status of cabbage stem flea beetle in Scotland. Whilst cabbage stem flea beetle is present in Scotland, most of the crop damage can be attributed to the smaller flea beetle. Peach-potato aphids are a vector of turnip yellows virus, and the use of the neonicotinoid seed treatments kept this pest (and virus) at bay, as the aphid is resistant to the pyrethroid insecticides. The revocation of the neonicotinoid seed treatments in 2013 led to approvals for the active substance pymetrozine (withdrawn in January 2020), flonicamid, and the neonicotinoid active thiacloprid (which ends in Feb 2021) specifically focused on managing peach-potato aphid and reducing virus transmission. After thiacloprid is withdrawn in early 2021 only flonicamid will be available for managing peach-potato aphid/turnip yellows virus.

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In the spring pollen beetles are a potential issue on oilseed rape, and because of resistance to the pyrethroid insecticides, the use of the neonicotinoids thiacloprid and acetamiprid to target resistant pollen beetles has been the recommendation for the last few years, along with other insecticide options such as pymetrozine and indoxacarb. With thiacloprid being withdrawn and pymetrozine no longer available, the neonicotinoid acetamiprid and indoxacarb will be the only alternatives to pyrethroids for the control of pollen beetle. Indoxacarb is at high risk of withdrawal and may well be unavailable after 2023. Several of the pyrethroid active substances are at medium risk of withdrawal.

As with cereals, growers have an alternative molluscicide available to metaldehyde in the form of ferric phosphate.

Whilst some herbicides used in oilseed rape are at high or medium risk of withdrawal such as glyphosate, clomazone and propyzamide, there are several alternatives available and economic impact is likely to be minimal. The loss of glyphosate would impact oilseed rape by reducing yields of around 14% (Oxford Economics, 2017), equivalent to a reduction in Scottish Total Value of Output of £6.3M.

3.1.4 Legumes

Scottish legume crops are already suffering from some significant active substance withdrawals, with the likes of the fungicide iprodione and thiram already withdrawn. Alternative fungicide seed treatments in particular are limited, with just one option for peas.

There are several fungicides at medium or high risk of withdrawal which are key foliar applied active substances in the management of diseases such as botrytis, sclerotinia, damping off, chocolate spot and downy mildew. These include metconazole, tebuconazole, cymoxanil and chlorothalonil. The withdrawal of chlorothalonil alone has been estimated by Wynn (2014) to potentially reduce farm gate values by 18% (£3.01M for Scottish peas), with the other fungicides an estimated reduction of 16% (£2.67M for Scottish peas).

The withdrawal of the herbicide active substance linuron is estimated by Wynn (2014) to reduce farmgate value of combining peas and beans by 4% (£0.67M of Scottish Total Value of Output). Alternatives such as glyphosate (equivalent to £1.17M of Scottish Total Value of Output), pendimethalin and clomazone are all at high risk of withdrawal. There will be a need for growers to look to Extensions of Authorisation for Minor Use (EAMUs) rather than on-label approvals for weed management in the short term.

3.1.5 Potatoes

In Scottish potatoes, both seed and ware crops have seed treatments applied to the tubers prior to or at planting. Currently these seed treatments (primarily fludioxonil, penflufen and flutolanil) are at low risk of withdrawal.

Other active substances applied at planting include nematicides for the management of Potato Cyst Nematode (PCN) and Free-Living Nematodes (FLN). The nematicide ethoprophos is no longer available and the nematicide oxamyl is currently on a yearly renewal in the UK and at medium risk of withdrawal. The introduction of a new nematicide active substance (fluopyram) from the 2019 season leaves fluopyram, fosthiazate (low risk of withdrawal) and oxamyl as the only effective nematicides currently available.

Managing potato blight resistance has become reliant on the use of mancozeb (high risk of withdrawal) to help manage resistance to other fungicide groups. The introduction of the

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active substance oxathiapiprolin in 2018 mitigates to some extent the risk of resistance and the impact of the impending withdrawal of mancozeb. The withdrawal of mancozeb will put pressure on other active substances and the cost of production would increase through the use of more expensive products to maintain yields. Chlorothalonil was also used in a mix with cymoxanil and is now no longer available. Wynn *et al.* (2014) estimated that the extra costs incurred from mancozeb withdrawal would be in the region of £3.4M on the UK scale – equivalent to £0.66M for Scottish potato crops. The additional issue regarding fluazinam resistance in blight has been estimated by Wynn *et al.* (2014) to lead to an extra £2.1M in UK costs to address the issue through the use of more expensive active substances in the blight management programme. This equates to £0.41M for Scottish potato crops.

The withdrawal of diquat in Feb 2020 to ‘burn off’ and desiccate potatoes in order to reduce the risk of foliar diseases getting into potato tubers (e.g. tuber blight) and also to stop bulking when tubers reach the desired marketable size, will have a significant impact. Alternatives such as flailing and other desiccants are only around 60% as effective as diquat in burning down crops. Flailing and spraying is an effective ‘burn-off’ strategy in dry seasons like 2018 and on lighter soil types. However, it may be problematic in wetter conditions which are more typical in Scotland. Increased risk of blackleg is a concern in these scenarios and would lead to yield and quality losses and might also impact on the marketability of the Scottish crop. The range of varieties being grown in Scotland makes the efficacy of burning down more critical, especially in a moist season.

Neonicotinoid insecticides have played a key role in the management of aphid-borne potato viruses in Scottish seed potato crops for several years. The peach-potato aphid is the main virus vector species and is resistant to pyrethroid insecticides. Consequently, advice provided by the Scottish Aphid-Virus Working Group has been to use non-pyrethroid insecticides every two weeks to specifically target this aphid, with a maximum of two neonicotinoid treatments a season. The withdrawal of the neonicotinoids thiamethoxam and the impending withdrawal of thiacloprid (February 2021) has now limited the neonicotinoid choice to acetamiprid only. Consequently, there will be just the one neonicotinoid active (acetamiprid – medium risk of withdrawal) available for use on potatoes, with the alternatives being spirotetramat (medium risk of withdrawal) and flonicamid (low risk of withdrawal) being the only other options currently available.

Reliance on acetamiprid, spirotetramat (which can only be applied when the crop is not in flower) and flonicamid will increase the risk of resistance to these actives in the peach-potato aphid and restrict the number of applications on the crop to 8 in total; 2 of acetamiprid, 4 of spirotetramat and 2 of flonicamid. This poses a risk of increased virus levels in the Scottish seed potato crop which would have a significant impact on seed health and seed exports.

The withdrawal of key herbicides in potatoes such as linuron (already withdrawn) and potentially metribuzin (15% of the Scottish Total Value of Output of £214.7M - £32.21M) would have left a significant ‘hole’ in weed management in Scottish potatoes, especially with other herbicides also at risk or being withdrawn such as diquat, glyphosate and pendimethalin. However, in March 2019 a new active substance, aclonifen, was granted approval for use on potatoes, and may well ‘plug the gap’ when metribuzin and other herbicides are unavailable.

Note that the additional loss of the potato sprout suppressant chlorpropham (CIPC) from October 2020 has been estimated to lead to a 25% loss in the Total Value of Output for potatoes in UK reference data. This is primarily due to the issues associated with the transfer of CIPC residues in the store structure into the stored potatoes leading to rejection due to residues exceeding the legal limit. Scottish use of CIPC is relatively low compared to English use,

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consequently, the loss of CIPC will not significantly impact the Scottish potato sector and no Total Value of Output cost has been included in our calculations.

3.1.6 Soft fruit

The Scottish soft fruit sector (Table 2 – in Appendix) is particularly at risk of active substance withdrawals over the next few years, with many of them having Extensions of Authorisation for Minor Use (EAMUs) rather than on-label approvals for use on soft fruit crops. Of concern is that the current alternatives to the at-risk active substances are themselves at-risk or are EAMUs rather than full on-label approvals. For example, botrytis and mildew management in soft fruit has already been affected by the withdrawal of myclobutanil and iprodione, and the alternatives such as fludioxonil, cyprodinil, pyraclostrobin, boscalid and azoxystrobin are all at high or medium risk of withdrawal.

With the withdrawal of abamectin for use in protected raspberries, soft fruit growers are left with no chemical alternatives for spider mite management and, even though most growers are looking to establish biocontrol for management of mites and other pests such as aphids in crops, particularly protected crops, the climate in Scotland in the spring is often restrictive to the establishment of the biocontrols. Certain active substances widely used in soft fruit production have also had a change in approval conditions (e.g. bupirimate) to restrict their use to ‘permanent protection’ situations which provide full enclosure (including continuous top and side barriers down to below ground level) and which are present and maintained over a number of years. The “permanent protection with full enclosure” (PPFE) definition excludes Seaton tunnels which are commonly used in Scottish soft fruit production. Seaton tunnels do not have side barriers down to ground level and are defined as “protected” and not PPFE therefore, this restricts further a range of active substances from being applied. Consequently, there is now no chemical option for spider mite control in polytunnel raspberries in Scotland, and limited options for strawberries. The active substances available for aphid control at the moment are limited at best and, with thiacloprid being withdrawn and lambda-cyhalothrin at medium risk of withdrawal, there will be no chemical active substance management options for strawberry, shallot and potato aphids.

Key points to note from Table 2 (in Appendix) are that 3 active substances are rated as high risk of withdrawal through being withdrawn already (e.g. diquat, quinoxifen), or scheduled for withdrawal (e.g. thiacloprid).

There are 9 active substances rated medium risk of withdrawal, (e.g. fludioxonil, cyprodinil, pyraclostrobin, abamectin – 2023; lambda-cyhalothrin, boscalid – 2022), so their future availability is in doubt.

Only 8 active substances are rated No/low risk of withdrawal – less than a third of the active substances in the list of 20 most frequently used in 2018. However, three of these have UK expiry dates in 2023 (*Bacillus subtilis*, pyrimethanil and sulphur) and their renewal is pending. For some active substances, dossiers for renewal of approvals are currently under review, and rated as No/low risk of withdrawal.

In Scottish blackcurrants, withdrawal of fungicides such as fludioxonil, cyprodinil, pyraclostrobin and boscalid (all at medium risk of withdrawal) would leave the management of botrytis and powdery mildew with alternatives such as kresoxim-methyl, sulphur, fenhexamid, *Bacillus subtilis* and azoxystrobin, many of which are EAMUs.

The withdrawal of the insecticide thiacloprid (impact of 2% of Total Value of Output) and potentially lambda-cyhalothrin (7% of Total Value of Output) coupled with the recent

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withdrawal of chlorpyrifos in 2016 (21% of Total Value of Output) leaves just one active substance with broad-spectrum activity – spinosad. However, spinosad itself is also at high risk of withdrawal and has a UK expiry date of October 2023.

The withdrawal of the herbicide diquat along with the alternatives metribuzin (potentially to be lost in 2023) and propyzamide (under review), coupled with doubts over the future availability of glyphosate, will leave weed management in blackcurrants (and other soft fruit crops) with few or no alternatives. Wynn (2014) estimated that the withdrawal of metribuzin and propyzamide would reduce the farmgate value of blackcurrants by 18%.

Blueberry is an increasing Scottish crop and the withdrawal of the insecticides thiacloprid (11% withdrawal of Total Value of Output) and the medium at risk lambda-cyhalothrin (19%) would have a significant impact on the ability to manage pests such as aphids, vine weevil and caterpillars.

Scottish raspberries have a Scottish Total Value of Output of £20.2M. The withdrawal of key fungicides such as myclobutanil (3%), tebuconazole (10%), bupirimate (2%) and fluazinam (10%), totalling an estimated £5.05M in Total Value of Output losses, will put pressure on the few alternatives available, and likely lead to more expensive treatments for powdery mildew and increased use of fenhexamid and biopesticides such as *Bacillus subtilis*.

The withdrawal of the insecticide chlorpyrifos in 2016, which was estimated to contribute to a 20% Total Value of Output withdrawal (£4.04M), will be exacerbated by the potential withdrawal of the insecticides abamectin (7%), thiacloprid (15%), deltamethrin (15%) and spinosad (3%), and will leave growers with no active substances for the management of capsids, raspberry beetle, clay-coloured weevil, raspberry cane midge, small raspberry sawfly and substantially reduced options for aphid control. Wynn (2014) estimates that the withdrawal of these insecticides would reduce the farmgate value of raspberries by up to 50% (£10.1M for Scotland). The neonicotinoid acetamiprid has been approved at the EU level until 2033, but is at medium risk of withdrawal in the UK due to it being a neonicotinoid and the political and public pressure associated with this insecticide group.

The withdrawal of the herbicides diquat and glufosinate-ammonium in 2020 and potentially propyzamide (under review) would leave a significant gap in the management of weeds, estimated to be 8% of the Scottish Total Value of Output (£1.62M), putting pressure on active substances currently at low risk of withdrawal such as isoxaben.

Scottish strawberries (Scottish Total Value of Output of £88.6M) will be significantly affected by the withdrawal of the fungicides iprodione (8% of the Total Value of Output), and potentially bupirimate (13%), leading to more expensive or difficult management of botrytis and powdery mildew. Alternatives are limited to other at risk active substances such as boscalid, pyraclostrobin, and a few fungicides with short UK expiry dates or dossiers under review such as kresoxim-methyl, sulphur, fenhexamid, *Bacillus subtilis* and azoxystrobin. Wynn (2014) estimated that the withdrawal of myclobutanil along with bupirimate and iprodione could reduce the farmgate value of strawberries by 26% (£23.04M for Scottish crops). As with raspberries, the withdrawal of the insecticides abamectin (13%), thiacloprid (19%) and deltamethrin (11%) will severely compromise the management of aphids, weevils, mites, and spotted wing drosophila, potentially reducing the Total Value of Output by 43% (£38.1M).

The worst-case scenario is that Scottish raspberry and strawberry production could potentially become uneconomic if all the possible pesticide withdrawals outlined above occur and

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alternative chemical or non-chemical control strategies are not available. Many growers are already utilising biopesticides and other alternatives to mitigate these pesticide losses.

3.1.7 Grass and fodder

There are a high number of active substances at high risk of withdrawal in the grass and fodder sector (Table 3 – in Appendix). Fourteen out of the 30 most applied active substances in 2017 are at high risk of withdrawal, with a further 7 active substances at medium risk of withdrawal. Most active substance use tends to be on fodder crops rather than grass. Herbicides in particular are at risk of withdrawal, with active substances such as 2,4-D, lenacil, pendimethalin, desmedipham (lost in 2020), phenmedipham, dimethenamid-P, and glyphosate at high risk of withdrawal, and tribenuron-methyl, aminopyralid, triclopyr and clopyralid at medium risk of withdrawal. Of the remaining herbicides at low risk of withdrawal such as dicamba, amidosulfuron, metamitron, ethofumesate, metazachlor, 2,4-DB, MCPA and fluroxypyr, several have relatively short UK expiry dates or have Extension of Authorisation for Minor Use (EAMUs).

The withdrawal of the insecticide chlorpyrifos in 2016 has meant that pests such as leatherjackets and fruit fly in grass now have no chemical control options. In the last few seasons, growers have had to absorb the losses incurred through the damage caused by leatherjackets which, in some part, has led to an increased demand (and price) for animal feed and silage. On fodder brassicas, the withdrawal of pymetrozine and thiacloprid, coupled with risks to indoxacarb, spinosad and deltamethrin will reduce the options available for pest management on crops, leaving expensive active substances such as spirotetramat and *Bacillus thuringiensis* to replace them.

Fodder crops such as turnips, swedes and beet have to contend with the withdrawal of the fungicide seed treatment thiram and tebuconazole, the insecticide seed treatment thiamethoxam and the foliar fungicides tebuconazole, chlorothalonil, epoxiconazole, fenpropimorph and potentially prothioconazole. Alternatives (including EAMUs) are also at risk, such as azoxystrobin, cyprodinil, fludioxonil, metalaxyl-M, difenoconazole, boscalid and pyraclostrobin. If these active substances have their on-label approvals withdrawn over the next few years, their EAMUs will also disappear, leaving few options for disease control beyond biopesticides such as *Bacillus subtilis*.

Pesticide inputs tend to be less on grass and fodder crops, and with the potential restriction on the availability of relatively cheap herbicides, fungicides and insecticides, cost of production and consequently end price is likely to rise.

3.1.8 Field vegetables

There are a significant proportion of active substances applied to Scottish field vegetable crops that are at high risk of withdrawal, have been lost already or have short expiry dates (Table 4 – in Appendix). These include the fungicides fenpropimorph, thiram and tebuconazole, the herbicides metribuzin, glyphosate, linuron, pendimethalin and clomazone, and the insecticides pymetrozine, thiacloprid, indoxacarb and the molluscicide metaldehyde. Additionally, there are several active substances applied to Scottish field vegetable crops that are at medium risk of withdrawal, which would exacerbate the impact on pest, weed and disease management.

Four fungicide seed treatment active substances; thiram, cymoxanil, fludioxonil and metalaxyl-M, have been lost already or are at high or medium risk of withdrawal, potentially leaving brassicas and carrots with few or no options against establishment diseases such as

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damping off and Pythium. The withdrawal of foliar applied fungicides such as tebuconazole, difenoconazole, prothioconazole, fenpropimorph, trifloxystrobin, azoxystrobin, cyprodonil, copper oxychloride, boscalid and pyraclostrobin would severely hamper the management of diseases such as downy mildew, powdery mildew, sclerotinia, botrytis and stem canker in Scottish field vegetables. Growers would need to increasingly turn to using biopesticides such as *Bacillus subtilis* and *Gliocladium catenulatum* alongside the few active substances left available (isopyrazam, sulphur, fluopicolide and propamocarb), which are primarily EAMUs rather than fully approved substances.

The list of herbicides at high or medium risk of withdrawal is a particular cause for concern as alternative options have EAMUs. Reliance on active substances with limited on-label approvals and/or EAMUs such as isoxaben, s-metolachlor, prosulfocarb, cycloxdim, flumioxazine, metamitron and propaquizafop may suffice in the short-term.

The Scottish Total Value of Output for brassica field crops (turnips/swedes and Brussels sprouts) was estimated at £30.4M. The withdrawal of the fungicides tebuconazole (leading to a withdrawal of 5% of the Total Value of Output) and difenoconazole (5%) would reduce the Total Value of Output by £3.04M. The withdrawal of the insecticides thiacloprid (15%) and spinosad (16%) would significantly compromise aphid and cabbage root fly management respectively, leading to a reduction in Scottish Total Value of Output of 31% (£9.42M). This will exacerbate the difficulties in aphid management caused by the withdrawal of pymetrozine in 2020. Whilst there are short-term alternatives when it comes to herbicides, there are question marks over the continuing approval of pendimethalin and clomazone. Consequently, use of S-metolachlor may become more important in the future. However, S-metolachlor is at high risk of withdrawal, and its withdrawal could reduce the farm gate value of brassicas by 3% (£0.91M).

Carrots have a Scottish Total Value of Output of £42.2M. The withdrawal of the azole fungicides tebuconazole, difenoconazole and prothioconazole would reduce the Total Value of Output of carrots by 5% (£2.11M), 4% (£1.69M) and 6% (£2.53M) respectively. Withdrawal of the pyrethroid insecticides deltamethrin (6% - £2.53M) and lambda-cyhalothrin (7% - £2.95M) would have a marked effect on the ability to manage carrot fly, and with the confirmed withdrawal of thiacloprid (5% - £2.11M) leading to management of willow-carrot aphid reliant on just one or two active substances, increasing the pressure for insecticide resistance. The withdrawal of the herbicides linuron (which has already been withdrawn) and potentially metribuzin are estimated to reduce the Total Value of Output of Scottish carrots by 20% (£8.44M) due to a lack of options for post-emergence chemical control of broad leaved weeds.

3.1.9 Forestry

Within the forestry sector (nurseries and plantations), pest, weed and disease management are very reliant on Extension of Authorisation for Minor Use (EAMUs), with only a few on-label approved active substances (Table 5 – in Appendix). This reliance on EAMUs is unsustainable in the long-term, as the on-label approvals for the active substance may be withdrawn or the EAMU itself may be time-limited or withdrawn. In Table 5 only the key EAMUs for forestry plantations are listed, as the list of EAMUs for nurseries alone numbers one hundred and thirty six at the time of writing.

Whilst there are only five active substances at high risk of withdrawal in the forestry sector (Table 5), the withdrawal of glyphosate (and to a lesser extent, pendimethalin) would have a significant impact on the ability to achieve effective weed management. The withdrawal of the

emergency authorisation for asulam for use in hand-held sprayers would significantly affect bracken management.

The withdrawal of urea, used as a fungicide to prevent the spread of root rot from tree stumps, would have a significant impact, particularly as the one alternative - *Phlebiopsis gigantea* – is only approved for use on pine stumps, and the approval for this expires in January 2022.

Withdrawal of cypermethrin would affect pine weevil management, although it is slowly being phased out and replaced by alpha cypermethrin and acetamiprid. Several active substances are at medium risk of withdrawal and/or have short UK expiry dates.

The forestry area in the United Kingdom in 2018 is 3.17 million hectares (Forestry Commission, 2018). Scottish forestry accounts for 1.45M ha (45.7%) of the UK total (Forestry Statistics, 2018).

Gross value added (GVA) measures the contribution to the economy of each individual producer, industry or sector. It is the difference between the value of outputs and the value of intermediate consumption, so mainly comprises employment costs and profits. The GVA for the forestry sector in Scotland is £954M (Roots for Further Growth, 2018). The impact of the withdrawal of cypermethrin and alpha-cypermethrin for pine weevil management is estimated to be a 1% reduction in value (Wynn, 2014). In Scotland this equates to a withdrawal in GVA of £9.54M. Estimates of between £4M directly and £40M indirectly have been made at the UK level (Ian Willoughby, Forestry Commission, pers. comm). The use of alpha-cypermethrin or cypermethrin is, in many cases, the only economically, environmentally, socially and technically feasible way of preventing pine weevil damage. The only other alternatives are the neonicotinoid active substance acetamiprid and the use of entomopathogenic nematodes. If pine weevil is not managed effectively it would be difficult to establish the next crop of trees on many sites. The impact of the withdrawal of propyzamide is a 1% reduction in value (Wynn, 2014). This would be a withdrawal in GVA of £9.54M to Scottish forestry. The potential withdrawal of glyphosate would exacerbate this to a great extent.

The withdrawal of urea as a commodity substance for reducing the spread of root rot from tree stumps will increase tree losses after felling.

Within the forest nursery sector, it is difficult to put financial figures on the potential losses if particular active substances were to be withdrawn. The withdrawal of cypermethrin and alpha-cypermethrin would certainly impact on the survival of young trees in the nursery due to pine weevil damage, and the short term dependency on EAMUs for the vast majority of pest, weed and disease management in nurseries makes an assessment of impact difficult to ascertain. Pest weed and disease management in nurseries will almost certainly become more challenging and expensive.

3.1.10 Amenity

The amenity sector (vegetation and grass) has a limited choice of active substances, several of which are EAMUs (Table 6). In the amenity sector, risk of public exposure to pesticides is high, consequently organisations such as the Amenity Forum (the industry-led, voluntary initiative recognised by Government) have been advocating responsible use of chemical pesticides and only as part of an integrated programme of control. The integrated use of active substances in the amenity sector can provide significant benefits to society, such as management of conservation areas, invasive species and flood risks; maintain access to high quality sporting facilities, and allow access to safe public spaces by preventing weed growth on hard surfaces creating trip hazards. The Amenity Forum in particular has been active in promoting best

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practice guidelines for pest, weed and disease management in the amenity sector, encouraging mechanical and biological control options where applicable.

The active substances glyphosate, 2,4-D (both herbicides), mancozeb (fungicide) and metaldehyde (molluscicide) are all at high risk of withdrawal. Whilst there are alternatives to these, many are at medium risk of withdrawal and/or have short UK expiry dates.

Assessing the financial impact of active substance withdrawals in the amenity sector is difficult, as there is no specific financial value that can be easily attributed to this sector beyond aesthetic improvement, management of conservation areas, invasive species and flood risks; and allowing the public safe access and use of sporting facilities and public spaces. However, a study undertaken by Oxford Economics (2017) suggested that a ban on glyphosate for weed management in the amenity sector would add at least £228 million to the UK's council tax bill each year, and the additional requirements for funding the alternatives would require an increase in the average household council tax bill of £7.80.

3.1.11 Natural environment and ornamental horticulture

Pesticide use in the natural environment sector is already very restricted with invasive species management being one of the main uses. Management of bracken with an annual emergency authorisation for asulam, and management of Japanese knotweed with glyphosate are both under threat, with both active substances at high risk of potential withdrawal. It is also possible that fungicide use to manage disease in trees of significant cultural or heritage value might be affected, but we are not aware of any such examples. Leaf hopper management in the context of the bacterial pathogen *Xylella fastidiosa* could be affected but, as this is not an area of current usage, no value can currently be ascribed. The necessary tools in the form of effective but safe active substances will be required to manage the threat of invasive species establishing in Scotland, and the potential withdrawal of effective substances such as glyphosate, diquat and asulam are a cause for concern.

Within the ornamental horticultural sector there is a large reliance on extensions of authorisation for minor use, which if not maintained or renewed will have a significant impact on the management of diseases, pests and weeds. The relatively few active substances that currently have a full approval for use in this sector include some active substances that are under medium to high risk of withdrawal. These include mancozeb (for botrytis and downy mildew management), the confirmed loss of thiacloprid (aphids, beetles and whitefly), pymetrozine (aphids) and diquat (weeds). At risk of withdrawal are cypermethrin (aphids and other insect pests), glyphosate and propyzamide (weeds) and spinosad (thrips). The withdrawal of active substances coupled with a reduction in the current Extensions of Authorisations for Minor Use would have a significant impact on the ornamental horticulture industry in Scotland, as management of a range of pests, weeds and diseases would become challenging and more expensive. Reliance on a select few active substances would increase the risk of disease and pest resistance within this intensively managed sector. An increased uptake of the available biological pesticides is likely, but with increased costs to the grower and the consumer.

3.1.12 Amateur use

Pesticides with approval for amateur use (i.e. gardeners) are already restricted with few of the actives at risk of withdrawal likely to have significant impact on the health of garden plants. Herbicides, molluscicides and insecticides represent the main usage and there are only three fungicides approved for amateur use on edible plants and non-edible plants. Of those approved for edible crops these include triticonazole, tebuconazole and trifloxystrobin but

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only for use on protected squashes and cucumbers, so a very small element of amateur garden production. There are no fungicides approved for use on crops which overlap significantly with Scotland's main agricultural crops such as potatoes or soft fruit so there is no enhanced danger of transfer to the agriculture sector as a result of withdrawals of garden products.

Glyphosate would be the most significant loss to gardens, but amateur gardeners are more likely to be able to apply alternative methods of control such as hand weeding, not applicable to commercial settings, in the event of glyphosate being withdrawn. There is some limited use of dicamba in the amateur garden sector and this remains until at least 2023 and is not thought to be at risk of withdrawal.

For slug and snail control, ferric phosphate remains a solution when metaldehyde is withdrawn. Encouragingly, there has been an uptake of alternative solutions such as the use of fatty acids and acetamiprid for insect pest management in place of products already withdrawn and at risk of withdrawal, such as deltamethrin and cypermethrin. The risk of transfer of pests, weeds and diseases from garden or allotment settings to a commercial setting is unlikely to be significantly increased by active substance withdrawals, and the major focus should be on preventative campaigns such as the 'don't risk it' campaign to discourage bringing plant material home from foreign holidays to alleviate the risk of invasive species. Given safety concerns around the use of pesticides by amateur users and issues around storage and disposal, benefits to further restriction probably outweigh the negatives.

4 Conclusions

This report assesses the risks and impacts on plant health that the potential withdrawal of active substances used in Scotland for pest, weed and disease management would have on the agriculture, production horticulture, forestry, amenity sectors and on the natural environment/ornamental horticulture sectors. This report was prepared using detailed industry-generated evidence of upper-bound impacts on total value of output for Scottish crops. These are commonly mitigated by adaptations in practice which are explored in a linked report on economic impacts using case studies (PHC 2020_09). The conclusions below should therefore be used and interpreted in the context of the second report which identifies the mitigations taken up by growers.

For all sectors, the withdrawal of key substances without viable alternatives would have a significant impact on the ability to manage pests, weeds and diseases effectively and economically. The Total Value of Output for production and forestry sectors would be negatively affected, with the soft fruit, field vegetables and ornamental horticulture sectors in particular under threat. Alternatives for many of the active substances at risk of withdrawal are either limited, are short-term EAMUs, more expensive or require a further shift into the use of biological pesticides and non-chemical control. Further adoption of integrated approaches to pest management will be necessary to achieve effective pest, weed and disease management. However, with a reduced range of active substances available, the number of pest, weed and disease management options available may well be less than growers are used to, and this may have an impact on the quality and yield of specific crops. It remains to be seen whether the markets will adjust to take into account the increased costs associated with crop protection in particular sectors. The soft fruit sector, for example, will have access to a much more restricted range of chemical pesticides. Consequently, the cost of production is likely to increase as alternative approaches for managing crops such as use of pest and disease monitoring, forecasting pest and disease outbreaks, biopesticides, release of biological controls, non-chemical and more expensive chemical pesticides and so on are utilised.

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This shift to a more integrated approach to pest, weed and disease management (IPM) whilst welcomed, will not happen overnight, particularly in sectors where there may still be sufficient active substances available to reduce the pace of IPM adoption. Consequently, there is a role to play for Scottish Government, the MRP's and agronomy consultants to engage with stakeholders and encourage the adoption of IPM approaches across all sectors in preparation for the withdrawal of pesticides that growers have relied on over many years. Other uncertainties and pressures such as Brexit, the possibility of a new subsidy regime, the threat from invasive pest species, climate change, demands from processors, supermarkets, the public and politicians and increased interest in sustainability in key markets are all driving reduced reliance on pesticides and greater uptake of IPM. Successful implementation of IPM will require more accurate and detailed crop surveillance and consideration of factors such as weather and climate which drive risk. It will also require training and support on the use of alternative control measures, such as biologicals and greater appreciation and understanding of whole-systems based approaches to reduce pest risk. Enhanced host resistance will provide some mitigation but will require dialogue with breeders (and end-users). Consequently, knowledge exchange between stakeholders within the Scottish plant health sector is to be encouraged as a matter of priority to ensure that Scotland maintains and improves its plant health in the future.

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When using the Appendix tables overleaf the Estimated Total Value of Output Loss (£M) figures should be used and interpreted in the context that they are generated using industry-generated evidence on upper-bound impacts for Scottish crops. These will be mitigated by adaptations in practice which are explored in a linked report on economic impacts using case studies (PHC 2020/09).

6 Appendix I

Table 1. Arable 2018 Principal active substances (n=50) listed in descending order of area treated and coded by likelihood of withdrawal: High risk of withdrawal, Medium risk of withdrawal, No/low risk of withdrawal.

Active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide

Active substance	Type	UK expiry date	Comments	Estimated Total Value of Output Loss (£M)
Prothioconazole	F/S	31-Jan-24	Very widely used on Scottish cereal and oilseed crops on its own and in a range of formulations for a range of diseases. Also used as a seed treatment in cereals. Most effective azole fungicide against Septoria in wheat, although insensitivity is occurring in Scotland. This and other azole fungicides are at risk of withdrawal and would reduce the options available for Septoria management. A limited number of new fungicides are in the pipeline that will only partially mitigate. Impact of loss estimated as proportionally similar to the rest of UK	£8.3M
Chlorothalonil	F	20-May-20	The approval and use of chlorothalonil ended in May 2020. Very widely used in arable crops (cereals and legumes). Applied to >80% winter barley and >90% winter wheat in 2018 for control of a range of diseases. Due to its multi-site mode of action, it was effective at reducing risk of resistance in other actives. It was the most effective control measure to protect barley crops from Ramularia leaf spot in Scottish barley crops. Also used on combinable peas and beans for mildew and chocolate spot. There are multi-site alternatives for use in cereals and legumes, although these are less effective. Its withdrawal increases the risk of resistance development in existing and in-development fungicides. The impact to Scotland is significant but is proportionally similar to the rest of the UK	£7.01M
Tebuconazole	F/S	28-Feb-23	Depending on product, it has Feb 2022 UK expiry date as a single active and in some mixtures. EFSA state it has 2 PBT criteria (Persistent, Bioaccumulative, Toxic). Alternatives exist for the major	£1.05M

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Epoxiconazole	F	31-Oct-21	<p>crops, so it is unlikely to be re-registered. Impact of loss estimated as low in Scotland due to reduced risk of fusarium ear blights and reduced risk of brown rust.</p> <p>Available in some mixtures until 31 July 2022. Very effective against yellow rust on wheat but alternatives available. Reduced effectiveness against Septoria. It has 2 PBT criteria (toxic for reproduction and endocrine disrupting properties), so unlikely to be re-registered. New azoles such as mefentrifluconazole will partially mitigate – increased cost but also with increased efficacy. Impact estimated as lower than referenced sources as efficacy has declined against major pathogen targets.</p>	£0.41M
Chlormequat	G	31-May-24	<p>Plant growth regulator, some products approved until 2024, low risk of withdrawal.</p>	
Metsulfuron-methyl	H	30-Sept-25	<p>Herbicide used alone and in mixtures with other active substances. Authorisation for several products remains extant until a regulatory decision is taken under the ongoing application for renewal of the products. Impact in Scotland likely to be low unless several other actives at risk of withdrawal are also lost.</p>	<£0.1M
Fluxapyroxad	F	30-Jun-25	<p>Fungicide used alone and in mixture products with azoles in cereals. Also used in potatoes for rhizoctonia. Low risk of withdrawal.</p>	
Thifensulfuron-methyl	H	31-Dec-20	<p>Cereal herbicide used alone and in mixtures. Authorisation for several products remains extant until a regulatory decision is taken under the ongoing application for renewal of the products. Impact in Scotland likely to be low unless several other actives at risk of withdrawal are also lost.</p>	<£0.1M
Glyphosate	H	15-Dec-22	<p>Authorisations remain extant until a regulatory decision is taken under the ongoing applications for renewal of the products. Political and public pressure against glyphosate. Glyphosate has key roles for pre-sowing, stubble cleaning and stale seedbed, which is particularly important for problem and herbicide resistant annual grass weeds and is an essential component in reduced cultivation systems. Pre-harvest crop desiccation and weed control – the most effective control of</p>	£51.2M

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			couch grass. It is likely that couch grass will re-emerge as a problem weed if glyphosate is no longer available for its control. Stakeholders expressed an enhanced concern relative to referenced sources due to narrow harvest windows and wetter harvests in Scotland.	
Fluroxypyr	H	30-Jun-24	Herbicide approved for use in cereals, alone and in a mixture with other actives. Low risk of withdrawal.	
Diflufenican	H	30-Jun-23	Key herbicide in cereals. EFSA state it has 2 PBT criteria - medium risk of withdrawal. Impact is mitigated by availability of other actives.	<£0.1M
Trifloxystrobin	F	2033 (EU)	Cereal fungicide usually in a mixture with an azole. Approved at EU level until 2033. UK dossier under review. EFSA proposed no safe use. Other strobilurins and new generation fungicides will mitigate loss so the impact in Scotland is considered lower than national loss estimates – other more effective options are available	<£0.1M
Trinexapac-ethyl	G	31-Oct-23	Plant growth regulator due to be reviewed at same time as mepiquat chloride. If both are lost then could be limited options for growth regulators on cereals.	<£0.1M
Pendimethalin	H	2024 (EU)	Key herbicide that gives cost-effective control of a wide range of broad-leaved and grass weeds. Crucial in peas and beans and important in cereals. UK dossier under review. Has two PBT criteria so chances of renewal are low. Several products end of use in January 2021. Authorisation of some products remains extant until a regulatory decision is taken under the ongoing application for renewal of the products. Limited alternatives available in legumes. Impact expressed by stakeholders is that there would be lower uptake of legume crops in Scotland than desired due to weed management issues.	<£0.1M
Fenpropimorph	F	31-Oct-20	Fungicide used in cereals alone and in mixtures with azoles. Last use in October 2020. Renewal not applied for at EU level. Alternatives are available. Impact of loss estimated as lower than the rest of the UK.	<£0.1M
Mecoprop-P	H	31-Jul-23	Harmful to aquatic life so moderate risk of withdrawal. Widely used herbicide in cereals alone and in mixture products. Impact is mitigated to some extent by the availability of other herbicides.	<£0.1M

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Tribenuron-methyl	H	30-Apr-22	Herbicide used alone and in mixtures with other active substances. Authorisation for several products remains extant until a regulatory decision is taken under the ongoing application for renewal of the products. Impact in Scotland likely to be low unless several other actives at risk of withdrawal are also lost.	<£0.1M
Lambda-cyhalothrin	I	31-May-22	Widely used insecticide on a range of crops. Loss along with other pyrethroid insecticides would reduce options for the management of aphids on a range of crops and aphid-vectored viruses such as barley yellow dwarf virus and potato viruses. Also issues with resistance in pests such as peach-potato aphid, grain aphid and cabbage stem flea beetle. Authorisation for several products remains extant until a regulatory decision is taken under the ongoing application for renewal of the products.	£4.42M
Imazalil	S	30-Jun-24	Seed treatment used on cereals with ipconazole, and as a potato tuber treatment to prevent disease developing in store. Use on seed potatoes only - ware use revoked. Only alternative to thiabendazole in potatoes which was lost in 2019.	
Ipconazole	S	28-Jul-27	Seed treatment used alone and with imazalil on wheat and barley.	
Mancozeb	F	31-Jul-23	Vital in potatoes for protectant activity against blight and its role in reducing the risk of other active substances developing resistance. Recent use in wheat as a multisite alternative to chlorothalonil. Currently under review at EU level. Stakeholders estimate the impact of loss as higher in Scotland due to the value of the seed potato crop. Impacts on cereals were felt to be similar to referenced UK sources.	£0.66M
Cymoxanil	F	29-Feb-24	Important potato blight fungicide, valuable anti-resistance partner used in mixtures and alone. A mix with zoxamide authorisation remains extant until a regulatory decision is taken under the ongoing applications for renewal of the products. Impact estimated as higher than referenced sources due to value of the seed crop.	£0.38M
Picolinofen	H		Herbicide used alone and in mixtures with other active substances. Authorisation for several products remains extant until a regulatory	

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			decision is taken under the ongoing application for renewal of the products.	
Flufenacet	H	30-Apr-23	Herbicide used in cereals alone and in product mixtures. UK dossier under review for several products. EFSA state it has 2 PBT criteria, medium risk of withdrawal. Impact of loss is likely to be low as there are other alternative herbicides available for the Scottish cereals sector.	<£0.1M
Florasulam	H	30-Jul-33	Herbicide used in mixture with other active substances such as pinoxaden, diflufenican and others. Authorisation for several products remains extant until a regulatory decision is taken under the ongoing application for renewal of the products.	
Bixafen	F	31-Mar-26	Cereal fungicide used alone and in product mixtures with azoles and other active substances.	
Haulauxifen-methyl	H	5-Feb-2028	Herbicide used alone and in mixtures in cereals and oilseed rape.	
Fluoxastrobin	F	31-Jan-24	Cereal fungicide used alone and in product mixture with azoles. UK authorisations remain extant until a regulatory decision is taken under the ongoing applications for renewal of several products.	
Spiroxamine	F	31-Jan-24	Fungicide used in mixture products with azoles in cereals to manage primarily powdery mildew for which other actives are available. Impact of loss estimated as lower than referenced sources – there is barley mlo resistance in most spring barleys drilled in Scotland and is still effective.	<£0.1M
Prochloraz	F/S	30-Jun-26	Can be used in mixtures until end of February 2023. Main uses are in cereals for control of eyespot and in oilseed rape for Alternaria, but alternatives available. Impact low in Scotland and superseded by other actives	<£0.1M
Fludioxonil	F	30-Mar-23	Used as a seed treatment alone and with other active substances in cereals. Used in potatoes as a treatment against seed-borne diseases.	
Pyraclostrobin	F	31-Jul-22	Cereal fungicide used alone and in product mixture with azoles. Also some use in legumes.	
Prohexadione-calcium	G	30-Jun-24	Plant growth regulator used alone and in mixtures on cereals.	

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Boscalid	F	31-Jan-23	Fungicide used primarily on winter wheat, oilseed rape and legumes. Cereal approvals in mixture products up for renewal in October 2021. Impact low in Scotland and superseded by new actives.	<£0.1M
2-Chloroethylphosphonic acid	G	N/A	No longer available. Other alternative plant growth regulators available.	<£0.1M
Mepiquat chloride	G	31-Aug-23	Plant growth regulator used in cereals. Current approval ends in 2023. Alternatives are available. Impact in Scotland likely to be low, although concern expressed by stakeholders that other plant growth regulators are also at risk of loss.	<£0.1M
Cyazofamid	F	31-Jan-24	Fungicide used solely in potatoes. End of approval will restrict options for blight control and increase the risk of other actives developing resistance.	
Fluopyram	F/S	31-Jan-24	Used in mixtures as a seed treatment in cereals and as a foliar fungicide in cereals, oilseed rape and potatoes.	
Metaldehyde	M	31-Dec-21	Main molluscicide pellet used in Scotland, particularly in potato, oilseed and wheat crops. The withdrawal of the cereal seed treatment clothianidin only leaves ferric phosphate as an alternative option. There have been restrictions on metaldehyde use over the last few years and growers are now starting to increase use of ferric phosphate. Impact on total value estimates moderated downwards from referenced national estimates because of the availability of the alternative active ferric phosphate which has also come down in price over the last year. UK Government announced ban of all outdoor use of metaldehyde slug pellets by March 2022.	<£0.1M
Cyflufenamid	F	30-Sep-25	Mildewicide used in cereals.	
Pinoxaden	H	31-Dec-28	Cereal herbicide with some products approved until 2028. Good alternative to other herbicides.	
Proquinazid	F	31-Jan-25	Mildewicide used in cereals alone and in mixtures with other fungicides to broaden activity against other cereal diseases.	

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Dimethomorph	F	31-Jan-24	Fungicide used for potato blight management. Key to limit risk of resistance. Impact estimated as higher than referenced sources due to value of the Scottish seed crop compared to national ware crops.	<£0.1M
Diquat	H	04-Feb-20	Widely used herbicide in arable cropping. There is no alternative for control of emerged grass weeds in potatoes apart from glyphosate that is authorised for use in ware crops. Very important desiccant in potatoes. There are no like-for-like replacements for diquat and the alternatives are likely to be more expensive (1.5x to 2x the cost of diquat) and less effective. Impact in potatoes is mitigated to some extent by other desiccant products in potatoes, however, stakeholders are concerned at effectiveness of these alternatives as the 2020 season is the first season of use of these products.	<£0.1M
Dicamba	H	30-Jun-23	Herbicide used in mixtures on cereals.	
Cyprodinil	F	31-Oct-23	Some mixture product fungicide approvals end in October 2021. May not be renewed beyond 2023 due to having two PBT criteria. Value loss estimates are small as other more effective actives remain.	<£0.1M
Azoxystrobin	F	30-Jun-27	Fungicide used alone and in mixtures in cereals, oilseed rape and potatoes. Low risk of loss although some of its azole mixing partners may be at risk.	
Mandipropamid	F	31-Jan-26	Fungicide used in the management of potato blight, particularly tuber blight. Used in product mixtures and stand-alone. Key fungicide in managing blight resistance to other actives.	
Esfenvalerate	I			
Thiram	S	30-Jan-20	Now withdrawn – previously used as a seed treatment in oilseed rape and legumes.	

1 = no/low risk of withdrawal

2 = medium risk of withdrawal

3 = high risk of withdrawal

Type of active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide, BP-biopesticide

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Table 2. Soft Fruit 2018 Principal active substances (n=20) listed in descending order of area treated and coded by likelihood of withdrawal: High risk of withdrawal, Medium risk of withdrawal, No/low risk of withdrawal.

Active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide

Active substance	Type	UK expiry date	Comments	Estimated Value of Output Loss (£M)	Total
Fenhexamid	F	2030 (EU)	UK dossier currently under review. EU approval until 2030. Key product for management of Botrytis in soft fruit. There are alternatives available but many are Extensions of Authorisation for Minor Use (EAMU) and/or biopesticides, so future availability of these is uncertain.		
<i>Bacillus subtilis</i>	BP	31-Oct-23	Biofungicide primarily for botrytis control through EAMUs. One of the alternatives to fludioxonil, cyprodinil, fenhexamid, iprodione. Should this fail to be renewed there would be few options for botrytis management.		
Thiacloprid	I	03-Feb-21	Neonicotinoid insecticide for the management of insect pests on soft fruit. EU announced non-renewal in Oct 2019. Has full approvals and several EAMUs. Few alternative options available. Lambda-cyhalothrin at risk of withdrawal as is indoxacarb.	£16.8M	
Trifloxistrobin	F	2033 (EU)	Used in a product mix with fluopyram as a fungicide in protected strawberries. Approved at EU level until 2033. UK dossier under review. EFSA proposed no safe use. Product authorisations remain extant until a regulatory decision is taken on the renewal of the products.	<£0.1M	

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Fluopyram	F	31-Jan-24	Used in a product mix with trifloxistrobin as a fungicide in protected strawberries. Product authorisations remain extant until a regulatory decision is taken on the renewal of the products.	
Fludioxonil	F	30-Mar-23	Current approvals for use on soft fruit end in 2023. Key product for management of botrytis in soft fruit. There are alternatives available, but many are also under threat of withdrawal, Extensions of Authorisation for Minor Use (EAMU) and/or biopesticides, so future availability of these is uncertain.	<£0.1M
Cyprodinil	F	30-Apr-23	Current approvals for use in mixture products on soft fruit end in 2023. Key product for management of botrytis in soft fruit. There are alternatives available, but many are also under threat of withdrawal, Extensions of Authorisation for Minor Use (EAMU) and/or biopesticides, so future availability of these is uncertain.	<£0.1M
Bupirimate	F	30-Nov-26	Fungicide for powdery mildew control in soft fruit. There are alternatives available, but many are also under threat, are Extensions of Authorisation for Minor Use (EAMU) and/or biopesticides.	£11.9M
Lambda-cyhalothrin	I	31-May-22	EAMU for several pests on soft fruit, UK dossier currently under review. Key insecticide for managing pests on a wide range of soft fruit in Scotland. Few 'like for like' alternatives are available and future EAMU availability is uncertain, depending on ongoing review. One of the alternatives, indoxacarb, is itself under threat as EFSA highlight a high long-term risk to wild mammals, which is a critical area of concern, so indoxacarb is unlikely to be available after 2022.	£13.29M

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Pyraclostrobin	F	31-Jul-23	Fungicide used in a product mix with boscalid on blackcurrants and strawberries, with EAMUs for other soft fruit crops. Targets botrytis, mildew and other diseases. Withdrawal of other fungicides such as fludioxonil, cyprodonil, boscalid, myclobutanil and iprodione (the latter two having already been withdrawn) leaves the management of botrytis and powdery mildew with just a few alternatives.	<£0.1M
Boscalid	F	31-Jan-22	Fungicide used in a product mix with pyraclostrobin on blackcurrants and strawberries, with EAMUs for other soft fruit crops. Targets botrytis, mildew and other diseases. Withdrawal of other fungicides such as fludioxonil, cyprodonil, pyraclostrobin, myclobutanil and iprodione (the latter two having already gone) leaves the management of botrytis and powdery mildew with just a few alternatives.	<£0.1M
Sulphur	F	30-Jun-23	Broad spectrum fungicide, with particular use against powdery mildew in strawberries and blackcurrants. Low risk of withdrawal, although current UK expiry date of June 2023. With withdrawal of several other fungicides, management of powdery mildew will be difficult.	
Azoxystrobin	F	30-Jun-27	Fungicide used alone and in a product with difenoconazole (expiry in June 2023) against several diseases in soft fruit, as well as an EAMU for powdery mildew in raspberry and blackberry. Withdrawal of other fungicides such as fludioxonil, cyprodonil, boscalid, pyraclostrobin, myclobutanil and iprodione (the latter two having already been withdrawn) leaves the management of botrytis and powdery mildew with just a few alternatives.	

This report to be used and interpreted in conjunction with report PHC2020/09

Pyrimethanil	F	31-Oct-23	Fungicide with full approvals and EAMU's for use in a range of soft fruit crops both indoors and outdoors. Botrytis a key target for this fungicide. Withdrawal of other fungicides such as fludioxonil, cyprodonil, boscalid, pyraclostrobin, myclobutanil and iprodione (the latter two having already been withdrawn) leaves the management of botrytis with just a few alternatives including pyrimethanil.	
Diquat	H	04-Feb-20	Widely used herbicide in soft fruit. Its withdrawal in February 2020 has reduced the options available for effective weed management, particularly if glyphosate or napropamide are withdrawn.	£0.2M
Penconazole	F	30-Jun-24	Widely used fungicide for management of powdery mildew. There are alternatives available but many are other fungicides at risk of withdrawal, EAMUs and/or biopesticides.	
Cyflufenamid	F	30-Sep-25	Fungicide with EAMU for powdery mildew management in strawberries. There are alternatives available but many are other fungicides at risk of withdrawal, EAMUs and/or biopesticides.	
Quinoxyfen	F	27-Mar-20	Fungicide with EAMUs for powdery mildew control in strawberry, blackcurrant, redcurrant and blueberry crops. Withdrawn in 2020.	<£0.1M
<i>Ampelomyces quisqualis</i> strain AQ 10	BP	2033 (EU)	Biofungicide used for powdery mildew management with full approvals and EAMU's on a range of soft fruit crops. UK authorisations remain extant until a regulatory decision for renewal of the product. There are alternatives available but many are other fungicides at risk of withdrawal or EAMUs.	<£0.1M

This report to be used and interpreted in conjunction with report PHC2020/09

Abamectin

I

31-Oct-23

Mainly used in protected crops. EAMUs for mite and thrip control. Important as an alternative mode of action in resistance management (given the alternatives often neonicotinoids or pyrethroids). Particularly important as an EAMU as an acaricide, and an IPM compatible product with low side effects on beneficials. Alternatives are also under threat (e.g. clofentezine and spirodiclofen), tend to have restricted uses or tend to be EAMUs or biopesticides.

£12.3M

1 = no/low risk of withdrawal

2 = medium risk of withdrawal

3 = high risk of withdrawal

Type of active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide, BP-biopesticide

This report to be used and interpreted in conjunction with report PHC2020/09

Table 3. Grass and Fodder 2017 Principal active substances (n=30) listed in descending order of area treated and coded by likelihood of withdrawal: High risk of withdrawal, Medium risk of withdrawal, No/low risk of withdrawal.

Active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide

Active substance	Type	UK expiry date	Comments
Fluroxypyr	H	30-Jun-27	Widely used herbicide approved for use in grassland and some fodder crops alone and in a mixture with other actives. Also, several EAMUs. Low risk of withdrawal in the short term (at least until 2027). Will become even more important due to withdrawals of other herbicides.
MCPA	H	30-Apr-23	Grassland herbicide used alone and in product mixtures. An alternative to the at risk 2,4-D.
Triclopyr	H	31-Oct-23	Grassland herbicide used in mixture with other active substances. Some products have earlier expiry dates and other products have authorisations remaining extant until a regulatory decision is taken for renewal of the products. Withdrawal of this and other grassland herbicides would reduce options for weed management.
Clopyralid	H	31-Oct-23	Herbicide used in grassland and some fodder crops, including maize as a single product and in mixtures. Some product mixtures have already been lost in 2020.
Asulam	H	N/A	Has Emergency Authorisation currently approved annually for bracken control. No longer approved for use in grassland or fodder crops.
2,4-D	H	31-Oct-21	Important in grassland, and whilst there are some alternatives these are also under threat. Used alone and in product mixtures. The main use is in permanent pasture for ragwort control. UK dossier under review for single and mixture products.
Glyphosate	H	15-Dec-22	Renewed in 2017 for 5 years. Political and public pressure against glyphosate. Used on grass and fodder crops pre-sowing and to burn off grass prior to following crops.
2,4-DB	H	30-Oct-21	Used alone and in product mixtures in grassland. Several other herbicides are at risk of withdrawal, so alternative options will be limited if it is not renewed, but at low risk of withdrawal

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Prothioconazole	F/S	31-Jan-24	Used as a seed treatment with bixafen or tebuconazole in grassland seed crops (EAMU). No alternatives are available.
Thiram	S	30-Jan-20	Now withdrawn – previously used as a seed treatment in grass and fodder.
Aminopyralid	H	04-Jun-24	Used alone and in a product mixture in grassland. Current approval ends in June 2024. Withdrawal of this and other grassland herbicides will reduce options for weed management.
Tribenuron-methyl	H	30-Apr-22	One product has approval for use in grassland (also as an EAMU until April 2021). Withdrawal of this and other grassland herbicides will reduce options for weed management.
Thiamethoxam	S	N/A	Neonicotinoid insecticide no longer approved for use on outdoor crops (2018). Was used as a seed treatment in fodder brassicas. No other seed treatment option currently available.
Metazachlor	H	31-Jan-24	Herbicide with EAMU for use on some fodder brassicas. Its withdrawal would be particularly problematic due to withdrawals of other herbicides as few alternatives available.
Trifloxystrobin	F	2033 (EU)	EAMU approval in mixture with tebuconazole for fodder brassicas and alone on grassland (seed), rye and triticale. Approved at EU level until 2033. UK dossier under review. EFSA proposed no safe use.
Chlorothalonil	F	20-May-20	EU voted for non-renewal for the approval for chlorothalonil in March 2019, and last use in May 2020. Multi-site fungicide that had a role to play in resistance management. Few alternatives exist for disease management in grass seed crops and lupins.
Tebuconazole	F/S	28-Feb-23	Fungicide used on fodder brassicas and an EAMU for grassland seed crops. Alternatives available for use on fodder crops but grassland alternatives are limited, particularly with potential withdrawal of prothioconazole.
Dimethenamid-P	H	30-Apr-22	Used in a mixture with other herbicides on forage maize and fodder beet, with an EAMU for use on fodder brassicas. Has authorisations extant until a regulatory decision is taken for renewal of the products. Detected

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			in groundwater. Withdrawal of this and other herbicides will reduce options for weed management.
Dicamba	H	30-Jun-23	Herbicide used in mixtures. Dossier for forage maize approval currently under review.
Fluoxastrobin	F	31-Jan-24	Fungicide used in mixtures but no current approvals on fodder or grassland but approved on winter rye.
Amidosulfuron	H	30-Jun-23	Herbicide used on grassland. Withdrawal of this and other herbicides will reduce options for grassland weed management.
Metamitron	H	28-Feb-25	Herbicide used on fodder beet crops. Long approval available and will likely increase in use due to withdrawal of other herbicides.
Ethofumesate	H	30-Apr-34	Herbicide used on fodder beet and grassland seed crops. Used alone and in mixtures. One solo product has approval until 2034. Other solo products and mixture products have shorter UK expiry dates or dossiers are under review. Low risk of withdrawal and likely to become more important as other herbicides are lost.
Pendimethalin	H	2024 (EU)	Herbicide that gives cost-effective control of a wide range of broad-leaved and grass weeds in forage maize. EAMUs for use in grassland seed crops. UK dossier under review. Several products end of approval in January 2021. Withdrawal of this and other herbicides will reduce options for weed management.
Desmedipham	H	1-Jul-20	Fodder beet herbicide used in mixtures with other active substances withdrawn in 2020. At EU level no safe use identified. Withdrawal of this and other herbicides will reduce options for weed management.
Phenmedipham	H	31-Jan-23	Fodder beet herbicide used alone and in product mixtures. At EU level no safe use identified and non-renewal proposed. Withdrawal of this and other herbicides will reduce options for weed management. UK dossier currently under review.
Fenpropimorph	F	31-Oct-20	Fungicide used alone and in product mixtures as EAMUs in grassland seed crops and fodder beet. Last use Oct 2020. Withdrawal of EAMUs for this fungicide would limit fungicide options in these crops.

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Epoxiconazole	F	31-Oct-21	Fungicide used alone and in product mixtures in fodder beet and forage maize disease management. EAMUs available for use in grassland (seed crops). Withdrawal of this active along with other fungicides will limit disease management options.
Lenacil	H	30-Jun-23	Herbicide used alone and in product mixtures on fodder beet. Several EAMUs also available for use on fodder beet. Withdrawal of this and other herbicides will reduce options for weed management.
Methiocarb	S	N/A	Insecticide seed treatment used in forage maize seed crops. Only alternative is thiacloprid (neonicotinoid) seed treatment which has UK end date of Feb 2021. No other alternatives are currently available.

1 = no/low risk of withdrawal

2 = medium risk of withdrawal

3 = high risk of withdrawal

Type of active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide

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Table 4. Field vegetables 2017 Principal active substances (n=30) listed in descending order of area treated and coded by likelihood of withdrawal: High risk of withdrawal, Medium risk of withdrawal, No/low risk of withdrawal.

Active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide

Active substance	Type	UK expiry date	Comments	Estimated Total Value of Output Loss (£M)
Lambda-cyhalothrin	I	31-May-22	Insecticide widely used on field vegetables. Has full approvals and several EAMUs. UK dossier under review for several products. Withdrawal of this active would limit the options available for pest management of field vegetables, particularly indoxacarb, which itself is under threat as EFSA highlight a high long-term risk for wild mammals. Other alternatives include spinosad, which is also at risk of withdrawal. Could see greater uptake of biopesticides such as <i>Bacillus thuringiensis</i> . There are also some resistance issues with this active (and other pyrethroid insecticides) with diamondback moth and peach-potato aphid in particular exhibiting resistance.	£2.95M
Metalaxyl-M	F/S	31-Dec-22	Widely used fungicide as a seed treatment (with other fungicides) and as a foliar treatment and has several EAMUs. A key fungicide used in carrots, parsnips and vegetable brassicas. It has a UK expiry date of Dec 2022. Alternatives are limited, e.g. for cavity spot in carrots the only current alternative is the biopesticide <i>Bacillus subtilis</i> as an EAMU which ends in October 2023.	<£0.1M
Fludioxonil	F/S	30-Apr-23	Fungicide seed treatment used alone or in product mix as an EAMU on carrots for the control of a range of seed borne diseases. Alternatives are at risk of withdrawal.	<£0.1M
Pendimethalin	H	2024 (EU)	Herbicide that gives cost-effective control of a wide range of broad-leaved and grass weeds in field vegetables. Full	<£0.1M

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			approvals and EAMUs in a range of field vegetable crops. UK dossier under review. Several products end of use in January 2021. Withdrawal of this herbicide will, along with other herbicides at risk of withdrawal, reduce options for weed management as there will be few alternatives.	
			Fungicide used in product mixture with boscalid in a range of crops. Also has several EAMUs with boscalid. Withdrawal of pyraclostrobin as well as boscalid would reduce the alternatives available for disease management of field vegetable crops.	<£0.1M
Pyraclostrobin	F	31-Jul-23		
			Boscalid used a product mix with pyraclostrobin. With both boscalid and pyraclostrobin having UK expiry dates of July 2023, their withdrawal would have a significant impact on disease management in Scottish vegetable crops. The few alternatives are also under threat (e.g. metalaxyl-M) or are EAMUs.	<£0.1M
Boscalid	F	31-Jul-23		
			Fungicide used alone and in product mixes in a range of field vegetable crops. There are also several EAMUs. Whilst there are alternatives available many of these are at risk of withdrawal. Azoxystrobin does have a reasonably distant UK expiry date of June 2027.	
Azoxystrobin	F	30-Jun-27		
			Primarily a potato fungicide, there is an EAMU as a product mix with two other fungicides for use as a seed treatment on carrots and parsnips. The only other option for pythium management in carrots is the biopesticide <i>Bacillus subtilis</i> , which is also an EAMU and ends in October 2023.	<£0.1M
Cymoxanil	S	31-Dec-22		
			Herbicide in a product mix with other actives. Currently no approvals or EAMUs for use in field vegetable crops.	<£0.1M
Imazamox	H	31-Oct-26		
			Fungicide widely used in Scottish vegetable production, notably on carrots, turnips/swedes, Brussels sprouts and leeks for management of alternaria and a range of other	£2.53M
Prothioconazole	F	31-Jan-24		

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			diseases. Withdrawal of this, along with other fungicides, would leave few alternatives available for disease management.	
Linuron	H	N/A	Herbicide no longer available (withdrawn in 2017).	£8.44M
Pirimicarb	I	31-Oct-23	Insecticide specifically targeting aphids. However, no longer has approvals or EAMUs for use on field vegetables.	<£0.1M
Clomazone	H	30-Apr-23	Herbicide used in carrots and EAMUs for use in several brassica vegetable crops. Several alternatives to clomazone are also at risk of withdrawal, e.g. pendimethalin, which would leave few alternatives available.	<£0.1M
Metaldehyde	M	31-Dec-21	Main molluscicide pellet used in Scotland. The loss of metaldehyde only leaves ferric phosphate as an option. There have been restrictions on metaldehyde use over the last few years and growers are now starting to increase use of ferric phosphate.	<£0.1M
Metazachlor	H	31-Jan-24	Residual herbicide used in vegetable brassicas. Applied to the vast majority of calabrese, cabbages, swedes, turnips and other brassicas in Scotland. Has a reasonable UK expiry date of January 2024 although, if lost, it will be particularly problematic as few alternatives are available.	
Ferric phosphate	M	30-Jun-33	Will be the only alternative to metaldehyde slug pellets. Has a long approval date (2033) but reliance on one active for slug management is a cause for concern.	
Deltamethrin	I	30-Apr-23	Insecticide widely used on field vegetables. Has full approvals and several EAMUs. Withdrawal of this active would limit the options available for pest management of field vegetables, particularly as other actives such as indoxacarb and spinosad are at risk of withdrawal. There are also some resistance issues with this active (and other pyrethroid insecticides) with diamondback moth and peach-potato aphid in particular exhibiting resistance.	£2.53M

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Tebuconazole	F	28-Feb-23	Fungicide widely used on field vegetables as a single product and a mixture product with trifloxystrobin. Applied to carrots and Brussels sprouts. Has several EAMUs as well. Withdrawal of tebuconazole would reduce the alternatives for disease management of field vegetable crops, many of which are also under threat of withdrawal. Renewed in 2017 for 5 years. Political and public pressure against glyphosate. Used on field vegetable crops, primarily pre-sowing stubble cleaning and stale seedbed weed management. Withdrawal of glyphosate along with other herbicides at risk of withdrawal would leave few alternatives available. Political and public pressure against glyphosate.	£3.63M
Glyphosate	H	15-Dec-22		
Isopyrazam	F	30-Sep-25	Fungicide with several EAMUs for disease management in field vegetables. This fungicide is one of the main alternatives to the azoles and other fungicides at risk. Has a relatively long approval until 2025 so would expect an increase in its use.	
Indoxacarb	I	30-Apr-23	A key insecticide with approvals on a range of field vegetables including several EAMUs. Important for targeting pests resistant to pyrethroid insecticides such as diamondback moth. EFSA highlight high long-term risk for wild mammals, which is a critical area of concern, so unlikely to be available after 2023. Alternatives include spinosad, which is also at risk of withdrawal. Could see greater uptake of biopesticides such as <i>Bacillus thuringiensis</i> .	<£0.1M
Cyprodinil	F	31-Apr-23	Fungicide in product mix on carrots and EAMU in a product mix in vegetable brassicas. Withdrawal of this along with other fungicides would leave few alternatives available for disease management.	<£0.1M

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Thiram	S	30-Jan-20	Fungicide seed treatment, important for the establishment of leafy vegetable crops. Withdrawn in January 2020. Withdrawal coupled with potential withdrawal of other seed treatments such as metalaxyl-M and fludioxonil puts establishment of crops at risk.	<£0.1M
Metribuzin	H	31-Jan-24	Herbicide with EAMUs for use in carrots and parsnips. Several alternatives to metribuzin are also at risk of withdrawal such as pendimethalin, which would leave few alternatives available.	£8.44M
Copper oxychloride	F	27-Mar-20	No longer has any approvals (including EAMUs) for use in field vegetables.	<£0.1M
Thiacloprid	I	03-Feb-21	Neonicotinoid insecticide for the management of insect pests on a range of field vegetable crops. Full approvals and several EAMUs. EU announced non-renewal in Oct 2019, date for final use Feb 2021. Few alternative options available.	£6.67M
Trifloxystrobin	F	31-Jan-21	Fungicide used on field vegetables as a mixture product with tebuconazole. Has several EAMUs as well. UK dossier under review for a tebuconazole + trifloxystrobin product. Withdrawal of trifloxystrobin (with tebuconazole) would reduce the alternatives for disease management of field vegetable crops, many of which are also under threat of withdrawal.	<£0.1M
Fenpropimorph	F	31-Dec-21	Fungicide with EAMUs for use in carrots and parsnips. Withdrawal of this along with other fungicides would leave few alternatives available for disease management.	<£0.1M
Difenoconazole	F	30-Jun-23	Fungicide used alone or in a product mix in a range of vegetable crops, notably carrots. Also, EAMUs available. More widely used in England and would expect increased use in Scotland as other fungicides are lost.	£3.21M
Sulphur	SU	30-Jun-23	Broad spectrum inorganic fungicide with approval and EAMUs. Low risk of withdrawal, although current UK	

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expiry date of June 2023. With withdrawal of several other fungicides disease management will be difficult.

1 = no/low risk of withdrawal

2 = medium risk of withdrawal

3 = high risk of withdrawal

Type of active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide

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Table 5. On-label active substances used in Forestry Nurseries (FN) and Forestry Plantations (FP) and key EAMUs for plantations

Active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide

Active substance	Type	FN/FP	UK expiry date	Comments
Urea	F	FP	31-Aug-20	A commodity substance (fertilizer) used as a fungicide to treat stumps to prevent the spread of root rot. If lost, there is no alternative for use on species other than pine.
Glyphosate	H	FN/FP	31-Dec-22	Widely used for weed management in nurseries and forestry. Political and public pressure against glyphosate.
Asulam	H	FP	N/A	Has Emergency Authorisation approved annually for bracken control. Its future use via hand-held sprayers, which is the primary method of selective bracken control on small scale forestry sites with rough terrain, is in significant doubt. There are no selective alternatives currently approved.
Alpha-cypermethrin	I	FP	31-Jan-23	Key insecticide along with cypermethrin and EAMU for acetamiprid for pine weevil management. Can only be used to treat trees off-site in nurseries before planting in forest.
Cyprodinil	F	FN	31-Mar-23	On-label and EAMU approvals for management of botrytis. Several alternatives as EAMUs.
Fludioxonil	F	FN	31-Apr-23	Product partner with cyprodinil for botrytis management. Several alternatives as EAMUs.
<i>Phlebiopsis gigantea</i>	BP	FN/FP	31-Jan-22	Biopesticide applied to tree stumps (pine only) to reduce the risk of root rot spreading to adjacent trees. UK expiry date of January 2022 so unless approval is renewed there will be no options for root rot management.
Propyzamide	H	FN/FP	31-Jul-21	Key herbicide in the management of weeds. UK expiry date of July 2021. Alternatives are cycloxdim and glyphosate with on-label

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Cyloxidim	H	FN	31-Nov-25	approvals. Several alternative active substances with EAMUs, especially for use in nurseries. Used in plantations as an alternative herbicide to propyzamide in some circumstances. Several alternative active substances with EAMUs
Diflubenzuron	I	FP	31-Dec-21	Insecticide specifically for the management of oak processionary moth but will have an impact on other caterpillar pests. Low risk of withdrawal although it has a UK expiry date of December 2021. Only alternative is the use of the biopesticide <i>Bacillus thuringiensis</i> (EAMU).
Cypermethrin	I	FP	30-Mar-23	Along with alpha-cypermethrin and the EAMU for acetamiprid, cypermethrin has been the preferred option for post-planting top up sprays to protect young trees from pine weevil. High risk of withdrawal and restrictions in its use have led to a phasing in of acetamiprid as a replacement.
<i>Bacillus thuringiensis</i> (EAMU)	BP	FN/FP	31-Oct-22	Biopesticide specifically targeting caterpillars. EAMUs for use in nurseries and plantations. Has UK expiry date of October 2022. Only alternative are EAMUs for chlorantraniliprole and indoxacarb in nurseries, and diflubenzuron in plantations. Future of forestry approvals for BT products is unclear. Without it, a key weapon in the fight against oak processionary moth is lost. In reality, BT is the only insecticide likely to be permitted for use as an aerial application against oak processionary moth.
Acetamiprid (EAMU)	I	FN/FP	(2033) EU	Key insecticide for use as EAMUs in nurseries and plantations. Targets a range of pests in nurseries such as pine weevil, aphids, beetles and gall wasps. An increasingly important alternative to cypermethrin and alpha-cypermethrin for pine weevil management in forestry. Potentially at risk due to being a neonicotinoid.

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1-naphthylacetic acid (EAMU)	G	FP	30-Jun-26	A plant growth regulator used on Christmas trees.
Clopyralid (EAMU)	H	FN/FP	31-Oct-23	Herbicide with an EAMU as a stand-alone product and as a product mix with picloram. Several alternative active substances with EAMUs, especially for use in nurseries. In plantations used alone for selective compositae weed management for which there is no substitute.
Pendimethalin (EAMU)	H	FN/FP	2024 (EU)	Herbicide with an EAMU as a stand-alone product and as a product mix with picolinafen. Several alternative active substances with EAMUs, especially for use in nurseries.

1 = no/low risk of withdrawal
2 = medium risk of withdrawal
3 = high risk of withdrawal

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Table 6. On-label active substances used in Amenity vegetation and grass with selected EAMUs
Active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide

Active substance	Type	UK expiry date	Comments
<i>Bacillus thuringiensis</i>	BP	31-Oct-23	Biopesticide with on-label and EAMUs for caterpillar management on a range of amenity vegetation. Low risk of withdrawal although UK expiry date of October 2023.
Alpha-cypermethrin	I	31-Jan-23	Insecticide for pine weevil management in coniferous transplants. Can only be used to treat trees off-site in nurseries before planting.
Glyphosate	H	31-Dec-22	Widely used for weed management in amenity areas. Political and public pressure against glyphosate.
Deltamethrin	I	30-Apr-23	Main broad-spectrum insecticide used for control of pests on amenity vegetation such as aphids, capsids, caterpillars, mealybugs, scale insects, thrips and whitefly. Withdrawal of this active would limit the options available for pest management significantly.
Propyzamide	H	31-Jul-21	Herbicide used for annual and perennial weeds in amenity vegetation. Widely used with alternatives such as glyphosate, 2,4-D and flazasulfuron at risk or with short UK expiry dates. Some product approvals remain extant until a decision is taken under the ongoing application for renewal of the product.
Ferric Phosphate	M	30-Jun-33	Will be the only alternative to metaldehyde slug pellets from December 2021. Has a long approval date (2033), but reliance on one active for slug management is a cause for concern. Amenity vegetation may be an area where use of the biopesticide <i>Phasmarhabditis hermaphrodita</i> (Nemaslug) may increase significantly.
Flazasulfuron	H	2032 (EU)	Herbicide for management of annual and perennial weeds in amenity vegetation. It is low risk and authorisations remain extant until a regulatory decision is taken for renewal of the products, but EU approval until 2032. Alternative options such as propyzamide, glyphosate and 2,4-D all under threat.

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2,4-D	H	31-Dec-21	Herbicide used alone and in product mixtures in amenity vegetation and amenity grassland. UK dossier under review for some single and mixture products. Varying end use dates for some products. Alternatives such as propyzamide and glyphosate are at risk.
Diflubenzuron	I	31-Dec-21	Insecticide specifically for the management of caterpillar pests including oak processionary moth in amenity vegetation. Low risk of withdrawal although it has a UK expiry date of December 2021. Only alternative is the use of the biopesticide <i>Bacillus thuringiensis</i> and deltamethrin.
<i>Verticillium albo-atrum</i>	BP	9-Sept-99	Biopesticide used for the prevention of Dutch Elm Disease. Authorisation remains extant until a regulatory decision is taken for renewal of the product.
Isoxaben	H	30-Nov-26	Herbicide for broad-leaf weed management in amenity vegetation.
Mancozeb	F	31-Jul-23	Fungicide for the management of scabs, downy mildew and other diseases in amenity vegetation. One of the few broad-spectrum fungicides approved for use in the sector. Currently under review at EU level.
Ethofumesate	H	30-Jan-20	Herbicide used in amenity grassland. Its approval on amenity grassland ended in January 2020. Alternatives include clopyralid + triclopyr and florasulam + fluroxypyr mixture products, although these are also at risk of withdrawal. There are several EAMUs for other active substances, so alternatives exist in the short term.
Propiconazole	F	19-Mar-20	Fungicide for disease patches on amenity grass due to fusarium and anthracnose. Last use date of March 2020. There are alternatives available but some of these have been withdrawn such as chlorothalonil or are at risk active substances such as tebuconazole and azoxystrobin. Would be few alternatives if these active substances are all lost.
Citronella oil	BP	28-Feb-25	Biopesticide for the spot treatment of ragwort in amenity grassland. Low risk of withdrawal.

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Clopyralid	H	31-Oct-23	Herbicide in product mix with triclopyr for control of brambles, broom, thistles, docks and other weeds in amenity grassland. Is rated as low risk but has UK expiry date of October 2023.
Florasulam	H	2030 (EU)	Herbicide used in mixture with other active substances such as clopyralid, fluroxypyr and 2,4-D in amenity grassland for management of annual and perennial weeds. Has EU approval until 2030 but UK approval currently under review.
Maleic hydrazide (EAMU)	G	31-Oct-20	Plant growth regulator used in amenity grassland and vegetation. EAMU ends in 2020 and dossier in UK currently under review.
Metaldehyde	M	31-Dec-21	Molluscicide for use in amenity grassland. With metaldehyde unlikely to be renewed at the end of 2021 this only leaves ferric phosphate as an option.
<i>Metarhizium anisopliae</i> (EAMU)	BP	30-Oct-23	Biopesticide with an EAMU against a range of soil dwelling insect pests in ornamental production. With a UK use up date of October 2023, renewal of this active substance is essential if pest management is to be maintained if chemical insecticides are lost.
<i>Bacillus subtilis</i> (EAMU)	BP	31-Oct-23	Biofungicide primarily for Phytophthora control in amenity vegetation. EAMU ends in 2023. Renewal dossier currently with EU. One of the alternatives to the likes of mancozeb and boscalid.
Boscalid (EAMU)	F	31-Jul-23	Fungicide used in a product mix with pyraclostrobin on amenity vegetation. Targets Botrytis, mildew and other diseases. Withdrawal of other fungicides leaves the management of botrytis and powdery mildew with just a few alternatives.
Mecoprop-P	H	31-Jul-23	Herbicide for use in amenity grassland. Harmful to aquatic life so moderate risk of withdrawal.
1 = no/low risk of withdrawal	Type of active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-		
2 = medium risk of withdrawal	molluscicide, BP-biopesticide		
3 = high risk of withdrawal			

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Table 7. On-label active substances used in Natural Environment and Ornamental Horticulture with selected EAMUs
Active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide

Active substance	Type	UK expiry date	Comments
<i>Bacillus thuringiensis</i>	BP	31-Oct-23	Biopesticide with on-label and EAMUs for caterpillar management in ornamental production. Low risk of withdrawal although UK expiry date of October 2023.
Glyphosate	H	31-Dec-22	Widely used for weed management in ornamental production and for management of invasive weeds such as Japanese knotweed and giant hogweed. Political and public pressure against glyphosate.
Deltamethrin	I	30-Apr-23	Broad-spectrum insecticide used for control of a wide range of pests in protected and outdoor ornamentals, and nursery stock. Withdrawal of this active would limit the options available for pest management significantly.
Propyzamide	H	31-Jul-21	Herbicide used for annual and perennial weeds in ornamental production. Widely used with alternatives such as glyphosate and 2,4-D at risk or with short UK expiry dates.
Ferric Phosphate	M	30-Jun-33	Currently the only alternative to metaldehyde slug pellets. Has a long approval date (2033) but reliance on one active for slug management is a cause for concern. Ornamental horticulture may be an area where use of the biopesticide <i>Phasmarhabditis hermaphrodita</i> (Nemaslug) may increase significantly.
2,4-D	H	31-Oct-21	Herbicide used alone and in product mixtures for weed management in trees and shrubs. UK dossier under review for single and mixture products. Alternatives such as propyzamide and glyphosate are also at risk.
Isoxaben	H	30-Nov-26	Herbicide for broad-leaf weed management in ornamental production.
Mancozeb	F	31-Jul-23	Fungicide for the management of downy mildew and other diseases in ornamental production alone and in product mixtures with metalaxyl-M,

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Diquat	H	04-Feb-20	which is also at high risk of withdrawal. One of the few broad-spectrum fungicides approved for use in the sector. Due to go in 2023. Widely used herbicide in ornamental flower production. Its withdrawal in February 2020 has reduced the options available for effective weed management, particularly if glyphosate is withdrawn.
Metalaxyl-M	F/S	31-Dec-22	Widely used fungicide seed treatment and foliar treatment alone and in product mixtures (such as with mancozeb) and has several EAMUs as well as on-label approvals. Alternatives are limited, particularly for management of phytophthora, pythium and downy mildew.
Chlorothalonil	F	20-May-20	EU voted for non-renewal for the approval for chlorothalonil in March 2019, with a UK use up date of May 2020. Multisite fungicide that had a role to play in resistance management. Few alternatives exist for management of diseases such as basal and neck rot in narcissi, and general disease control in ornamental production.
Clopyralid	H	31-Oct-23	Herbicide in product mix and used alone for managing weeds in ornamental horticulture. Is rated as low risk but has UK expiry date of October 2023.
Thiacloprid	I	3-Feb-21	Neonicotinoid insecticide for the management of insect pests in ornamentals and nursery stock. Full approvals and several EAMUs. Few alternative options available when it goes in February 2021.
Metaldehyde	M	31-Dec-21	Molluscicide for use in amenity grassland. With metaldehyde probably going in 2021 this only leaves ferric phosphate as an option.
<i>Metarhizium anisopliae</i> (EAMU)	BP	30-Oct-23	Biopesticide with an EAMU against a range of soil dwelling insect pests in ornamental production. With a UK use up date of October 2023, renewal of this active substance is essential if pest management of pests such as vine weevil, sciarid fly and thrips is to be maintained if chemical insecticides are lost.
<i>Bacillus subtilis</i> (EAMU)	BP	31-Oct-23	Biofungicide primarily for botrytis control in ornamental production. EAMU ends in 2023. One of the alternatives to the likes of mancozeb and boscalid.

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Boscalid (EAMU)	F	31-Jul-23	Fungicide used in a product mix with pyraclostrobin on amenity vegetation. Targets Botrytis, mildew and other diseases. Withdrawal of other fungicides leaves the management of botrytis and powdery mildew with just a few alternatives.
Mecoprop-P	H	31-Jul-23	Herbicide for use in amenity grassland. Harmful to aquatic life so moderate risk of withdrawal.

1 = no/low risk of withdrawal
2 = medium risk of withdrawal
3 = high risk of withdrawal

Type of active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide, BP-biopesticide

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7 Appendix II

7.1 Arable sector

Out of the 50 most applied active substances in Scotland to crops in the Arable sector (based on the last Scottish Pesticide Usage Survey in 2018), there are 12 active substances rated as high risk of potential withdrawal, 16 active substances rated medium risk of potential withdrawal, and 22 active substances rated No/low risk of potential withdrawal. Fig. 1 summarises the number of active substances at risk and the potential reduction in the upper-bound Total Value of Scottish Output (£M) if the High and Medium risk active substances are lost. The summary below should be used and interpreted in the context of report PHC 20_09 which identifies the adaptations taken up by Scottish growers which partially mitigate the upper-bound estimates below.

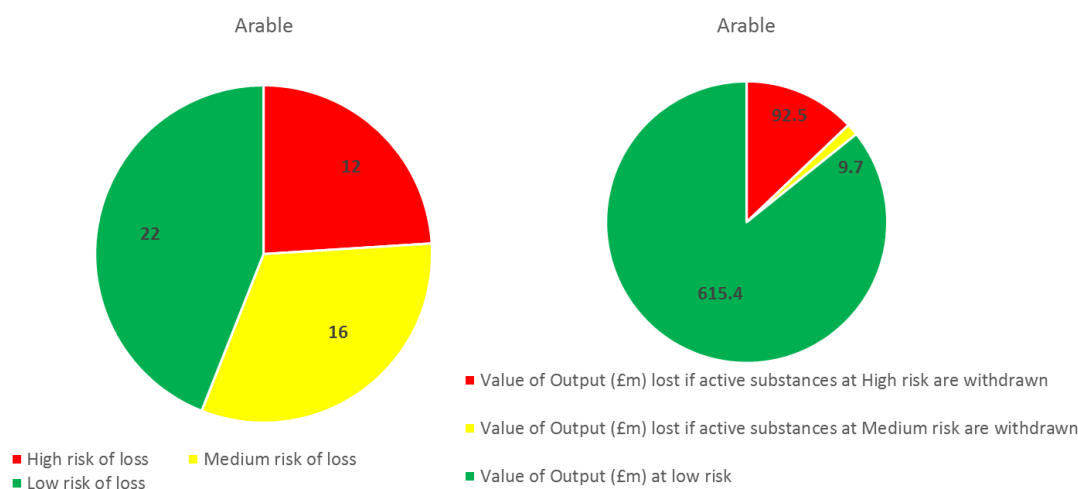


Fig. 1. Number of the most widely used (n=50) active substances at High, Medium or low risk of potential in the Scottish Arable sector (left), and (right) the potential reduction in the upper-bound Total Value of Scottish Output (£717.6M) if high and medium risk active substances are lost

Table 8 overleaf summarises the estimated reduction in the upper-bound value of Scottish Output for the sub-sectors Cereals, Oilseed rape, Legumes and Potatoes should the active substances at High and Medium risk of potential withdrawal occur.

Fig. 2 summarises the potential reduction in the upper-bound Total Value of Scottish Output (£M) for sub-sectors of the Scottish Arable sector if the High and Medium risk active substances are lost.

Alternatives for many of the active substances at risk of loss are either non-existent, are limited, more expensive, or require a greater shift into the use of biological pesticides and increased adoption of integrated approaches to achieve effective pest, weed and disease management. Targeted pesticide use within an integrated pest management (IPM) system is recommended to maintain effective management and conserve the remaining pesticides though reducing risk of resistance and insensitivity.

Table 8. The upper-bound Total Value of Scottish Output (£M) for the Arable sector and its sub-sectors and the potential reduction in Value (£M and %) if active substances at High and Medium risk are lost.

<i>Arable Sector</i>	<i>Total Value of Scottish Output (£M)</i>	<i>Potential reduction in Value of Scottish Output due to loss of active substances at risk (£M)</i>	<i>% reduction in Value of Scottish Output</i>
Whole sector	717.6	102.2	14.2
Cereals	441.5	59.2	13.4
Oilseed rape	44.8	9.4	21.0
Legumes	16.7	7.5	44.9
Potatoes	214.7	33.3	15.5

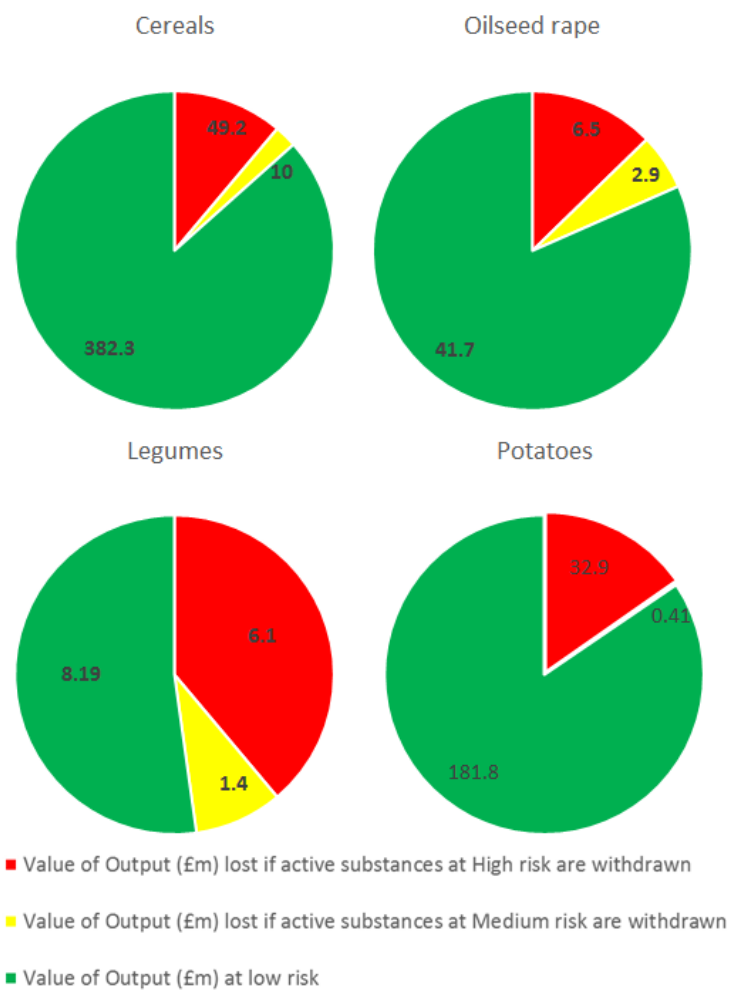


Fig. 2. The potential reduction in the upper-bound Total Value of Scottish Outputs of Cereals, Oilseed rape, Legumes and Potatoes (£M) if high and medium risk active substances are lost.

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7.2 Soft Fruit sector

Out of the 20 most applied active substances in Scotland to crops in the Soft fruit sector (based on the last Scottish Pesticide Usage Survey), 3 active substances are rated as high risk of withdrawal through being withdrawn already (e.g. diquat, quinoxifen), or scheduled for withdrawal (e.g. thiacloprid). There are 9 active substances rated medium risk of withdrawal, so their future availability is in doubt.

Only 8 active substances are rated No/low risk of potential withdrawal. For some active substances, dossiers for renewal of approvals are currently under review, and rated as No/low risk of potential withdrawal.

Fig. 3 summarises the number of active substances at risk and the potential reduction in the Total Value of Scottish Output (£M) of Strawberries and Raspberries if the High and Medium risk active substances are lost.



Fig. 3. Number of the most widely used active substances (n=20) at High, Medium or low risk of loss in the Scottish Soft Fruit sector (top), and (below) the potential reduction in the upper-bound Total Value of Scottish Output in Strawberries (£88.6M) and Raspberries (£20.2M) if high and medium risk active substances are lost.

Table 9. The upper-bound Total Value of Scottish Output (£M) for the Soft Fruit sector (Strawberries and Raspberries) and the potential reduction in Value (£M and %) if active substances at High and Medium risk are lost.

Soft Fruit Sector	Total Value of Scottish Output (£M)	Potential reduction in Value of Scottish Output due to loss of active substances at risk (£M)	% reduction in Value of Scottish Output
Strawberries	88.6	61.1	69.0
Raspberries	20.2	16.1	79.7

The Scottish soft fruit sector is particularly at risk of active substance withdrawals over the next few years, with many of them having Extensions of Authorisation for Minor Use (EAMUs) rather than on-label approvals for use on soft fruit crops. Of concern is that the current alternatives to the at-risk active substances are themselves at-risk or are EAMUs rather than full on-label approvals.

For soft fruit production, losses may be sufficiently severe as to make production uneconomic if no adaptations are made.

Alternatives for many of the active substances at risk of loss are either non-existent, are limited, more expensive, or require a greater shift into the use of biological pesticides and increased adoption of integrated approaches to achieve effective pest, weed and disease management. Targeted pesticide use within an integrated pest management (IPM) system is recommended to maintain effective management and conserve the remaining pesticides though reducing risk of resistance and insensitivity.

7.3 Grass and Fodder sector

Out of the 30 most applied active substances in Scotland to crops in the Grass and Fodder sector (based on the last Scottish Pesticide Usage Survey) 14 are at high risk of potential withdrawal, with a further 7 active substances at medium risk of potential withdrawal. Herbicides in particular are at risk of potential withdrawal. Of the remaining herbicides at low risk of withdrawal several have relatively short UK renewal dates or have Extension of Authorisation for Minor Use (EAMUs).

The withdrawal of the insecticide chlorpyrifos in 2016 has meant that pests such as leatherjackets and fruit fly in grass now have no chemical control options. On fodder brassicas, the withdrawal of pymetrozine and thiacloprid, coupled with risks to indoxacarb, spinosad and deltamethrin will reduce the options available for pest management on crops, leaving expensive active substances such as spirotetramat and *Bacillus thuringiensis* to replace them.

Fig. 4 summarises the number of active substances at risk.

Grass & Fodder

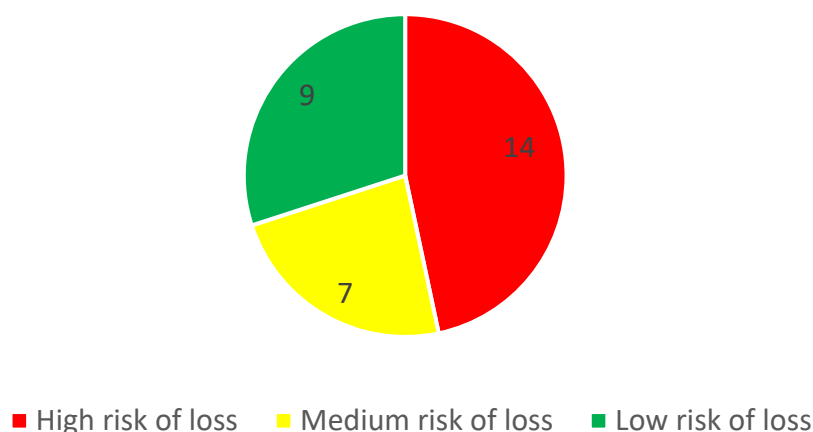


Fig. 4. Number of the most widely used active substances (n=30) at High, Medium or low risk of loss in the Scottish Grass and Fodder sector

Alternatives for many of the active substances at risk of loss are either non-existent, are limited, more expensive, or require a greater shift into the use of biological pesticides and increased adoption of integrated approaches to achieve effective pest, weed and disease management. Targeted pesticide use within an integrated pest management (IPM) system is recommended to maintain effective management and conserve the remaining pesticides though reducing risk of resistance and insensitivity.

7.4 *Field Vegetable sector*

There are a significant proportion of active substances applied to Scottish field vegetable crops (based on the last Scottish Pesticide Usage Survey) at high risk of potential withdrawal, have been lost already or are in short renewal dates. These include the fungicides, herbicides, insecticides and the molluscicide metaldehyde. Additionally, there are several active substances applied that are at medium risk of withdrawal which would exacerbate the impact on pest, weed and disease management.

Four fungicide seed treatment active substances are at high or medium risk of withdrawal, potentially leaving brassicas and carrots with few or no options against establishment diseases. The withdrawal of several foliar applied fungicides would severely hamper the management of diseases. The number of herbicides at high or medium risk of withdrawal is a particular cause for concern. Fig. 5 summarises the number of active substances at risk and the potential reduction in the Total Value of Scottish Output (£M) in Brassica field crops and Carrots if the High and Medium risk active substances are lost.

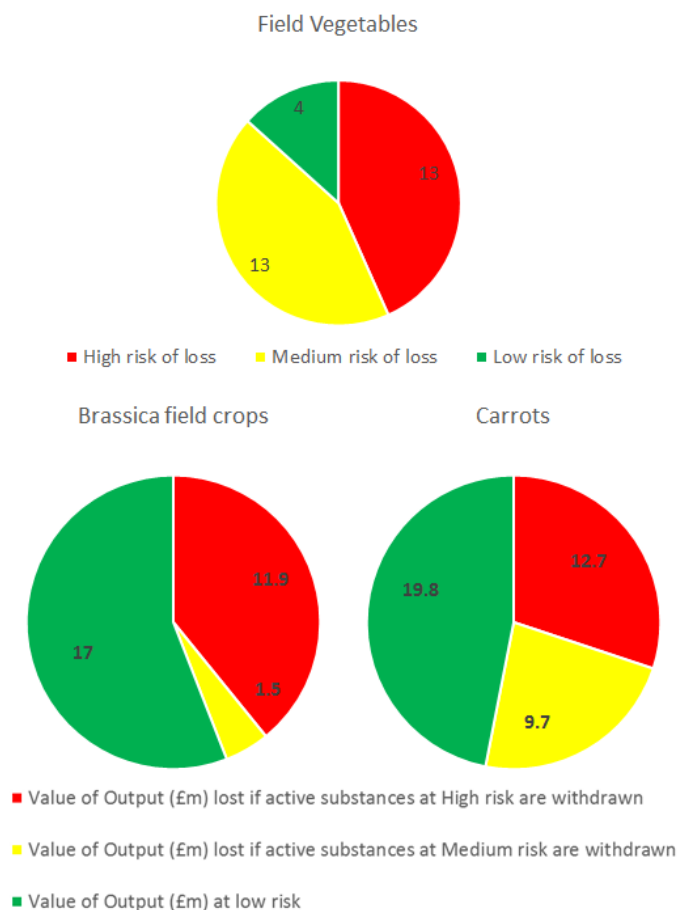


Fig. 5. Number of the most widely used active substances (n=30) at High, Medium or low risk of loss in the Scottish Field Vegetable sector (top), and (below) the potential reduction in the upper-bound Total Value of Scottish Output (£M) in Brassica field crops (turnips/swedes and Brussels sprouts) and Carrots if high and medium risk active substances are lost.

Table 10 summarises the estimated reduction in the value of Scottish Output for Brassica field crops and Carrots should the active substances at High and Medium risk of withdrawal occur.

Table 10. The upper-bound Total Value of Scottish Output (£M) for the Field Vegetable sector (Brassica field crops and Carrots) and the potential reduction in Value (£M and %) if active substances at High and Medium risk are lost.

Field Vegetable Sector	Total Value of Scottish Output (£M)	Potential reduction in Value of Scottish Output due to loss of active substances at risk (£M)	% reduction in Value of Scottish Output
Turnips/swedes and Brussels sprouts	30.4	13.4	44.1
Carrots	42.2	22.4	53.1

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Alternatives for many of the active substances at risk of loss are either non-existent, are limited, are Extensions of Authorisation for Minor Use (EAMUs) more expensive, or require a greater shift into the use of biological pesticides and increased adoption of integrated approaches to achieve effective pest, weed and disease management. Targeted pesticide use within an integrated pest management (IPM) system is recommended to maintain effective management and conserve the remaining pesticides though reducing risk of resistance and insensitivity.

7.5 Forestry sector

Within the Forestry sector (nurseries and plantations), pest, weed and disease management are very reliant on Extension of Authorisation for Minor Use (EAMUs), with only a few on-label approved active substances. This reliance on EAMUs is unsustainable in the long-term, as the on-label approvals for the active substance may be withdrawn or the EAMU itself may be time-limited or withdrawn. The list of EAMUs for nurseries alone numbers one hundred and thirty six at the time of writing.

Whilst there are only five active substances at high risk of potential withdrawal in the forestry sector, the potential withdrawal of glyphosate (and to a lesser extent, pendimethalin) would have a significant impact on the ability to achieve effective weed management. The withdrawal of the emergency authorisation for asulam for use in hand-held sprayers would significantly affect bracken management. Fig. 6 summarises the proportion of active substances at risk.

The withdrawal of urea, used as a fungicide to prevent the spread of root rot from tree stumps, would have a significant impact, particularly as the one alternative - *Phlebiopsis gigantea* – is only approved for use on pine stumps, and the approval for this expires in January 2022.

Withdrawal of cypermethrin would affect pine weevil management, although it is slowly being phased out and replaced by alpha cypermethrin and acetamiprid. Several active substances are at medium risk of withdrawal and/or have short UK renewal dates.

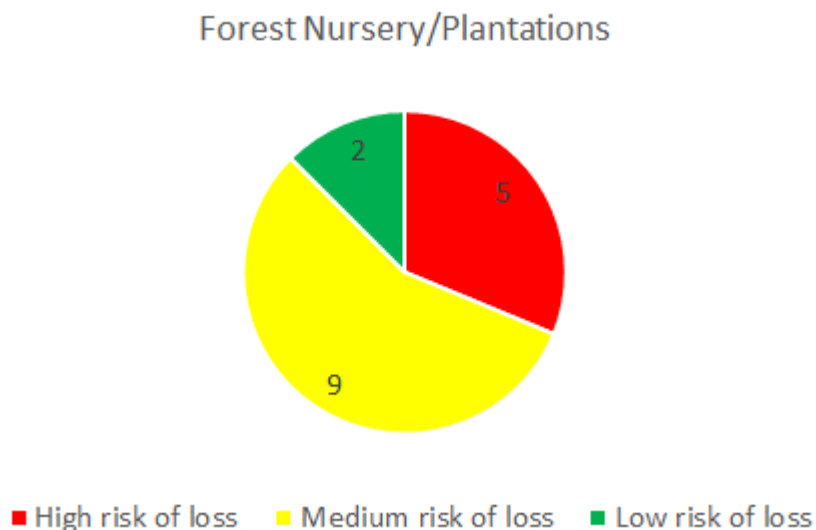


Fig. 6. Number of widely used active substances (n=16) at High, Medium or low risk of loss in the Forestry sector

Gross value added (GVA) measures the contribution to the economy of each individual producer, industry or sector. It is the difference between the value of outputs and the value of

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intermediate consumption, so mainly comprises employment costs and profits. The GVA for the forestry sector in Scotland is £954M (Forestry Statistics, 2018). The impact of the withdrawal of cypermethrin and alpha-cypermethrin for pine weevil management is estimated to be a 1% reduction in value. In Scotland this equates to a withdrawal in GVA of £9.54M. Estimates of between £4M directly and £40M indirectly have been made at the UK level. The use of alpha-cypermethrin or cypermethrin is, in many cases, the only economically, environmentally, socially and technically feasible way of preventing pine weevil damage. The only other alternatives are the neonicotinoid active substance acetamiprid and the use of entomopathogenic nematodes. If pine weevil is not managed effectively it would be difficult to establish the next crop of trees on many sites. The impact of the withdrawal of propyzamide is a 1% reduction in value. This would be a withdrawal in GVA of £9.54M to Scottish forestry. The potential withdrawal of glyphosate would exacerbate this to a great extent.

The withdrawal of urea as a commodity substance for reducing the spread of root rot from tree stumps will increase tree losses after felling.

Within the forest nursery sector, it is difficult to put financial figures on the potential losses if particular active substances were to be withdrawn. The withdrawal of cypermethrin and alpha-cypermethrin would certainly impact on the survival of young trees in the nursery due to pine weevil damage, and the short term dependency on EAMUs for the vast majority of pest, weed and disease management in nurseries makes an assessment of impact difficult to ascertain. Pest weed and disease management in nurseries will almost certainly become more challenging and expensive.

Alternatives for many of the active substances at risk of loss are either non-existent, are limited, are Extensions of Authorisation for Minor Use (EAMUs) more expensive, or require a greater shift into the use of biological pesticides and increased adoption of integrated approaches to achieve effective pest, weed and disease management. Targeted pesticide use within an integrated pest management (IPM) system is recommended to maintain effective management and conserve the remaining pesticides though reducing risk of resistance and insensitivity.

7.6 *Amenity sector*

The Amenity sector (vegetation and grass) has a limited choice of active substances, several of which are Extensions of Authorisation for Minor Use (EAMUs). In the Amenity sector, risk of public exposure to pesticides is high, consequently organisations such as the Amenity Forum have been advocating responsible use of chemical pesticides and only as part of an integrated programme of control. The integrated use of active substances in the amenity sector can provide significant benefits to society such as management of conservation areas, invasive species and flood risks; maintain access to high quality sporting facilities, and allow access to safe public spaces by preventing weed growth on hard surfaces creating trip hazards. The Amenity Forum in particular has been active in promoting best practice guidelines for pest, weed and disease management in the amenity sector, encouraging mechanical and biological control options where applicable. Fig. 7 summarises the number of active substances at risk.

The active substances glyphosate, 2,4-D (both herbicides) and mancozeb (fungicide) and at high risk of potential withdrawal, with metaldehyde (molluscicide) being lost in March 2022. Whilst there are alternatives to these, many of these are at medium risk of withdrawal and/or have short UK renewal dates.

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Amenity vegetation & grass

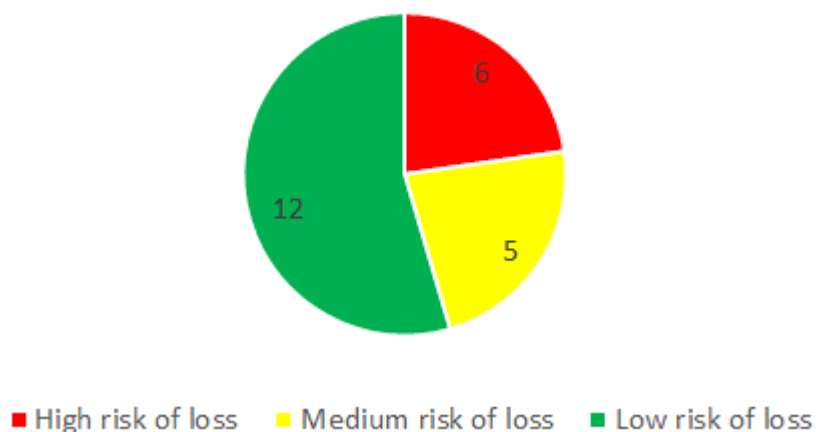


Fig. 7. Number of widely used active substances (n=23) at High, Medium or low risk of loss in the Amenity sector

Assessing the financial impact of active substance withdrawals in the amenity sector is difficult, as there is no specific financial value that can be easily attributed to this sector beyond aesthetic improvement, management of conservation areas, invasive species and flood risks; and allowing the public safe access and use of sporting facilities and public spaces. However, a study undertaken by Oxford Economics in 2017 suggested that a ban on glyphosate for weed management in the amenity sector would add at least £228 million to the UK's council tax bill each year, and the additional requirements for funding the alternatives would require an increase in the average household council tax bill of £7.80.

7.7 *Natural environment and ornamental horticulture, and amateur sectors*

Pesticide use in the Natural environment sector is already very restricted with invasive species management being one of the main uses. Management of bracken with an annual emergency authorisation for asulam, and management of Japanese knotweed with glyphosate are both under threat, with both active substances at high risk of withdrawal. It is also possible that fungicide use to manage disease in trees of significant cultural or heritage value might be affected, but we are not aware of any such examples. Leaf hopper management in the context of the bacterial pathogen *Xylella fastidiosa* could be affected, but as this is not an area of current usage no value can currently be ascribed. The necessary tools in the form of effective but safe active substances will be required to manage the threat of invasive species establishing in Scotland, and the potential withdrawal of effective substances such as glyphosate and asulam are a cause for concern (Fig. 8).

Natural Environment & Ornamental Horticulture

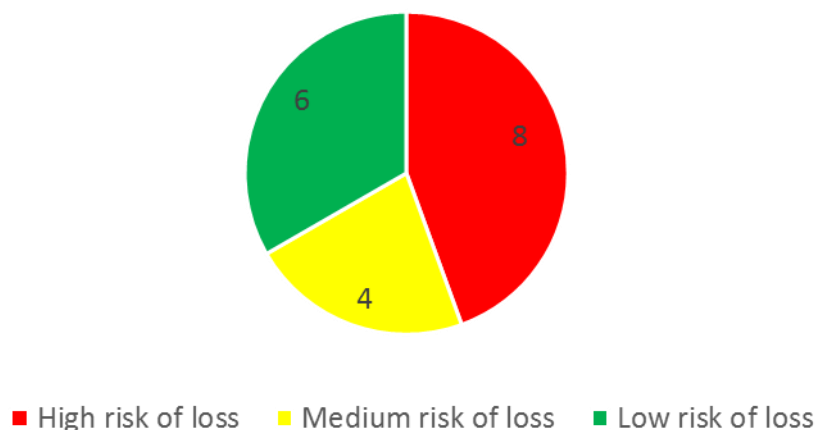


Fig. 8. Number of widely used active substances (n=18) at High, Medium or low risk of loss in the Natural environment and ornamental horticulture sector

Within the Ornamental horticultural sector there is a large reliance on extensions of authorisation for minor use, which if not maintained or renewed will have a significant impact on the management of diseases, pests and weeds. The relatively few active substances that currently have a full approval for use in this sector include some active substances that are under medium to high risk of withdrawal. These include mancozeb (for botrytis and downy mildew management), the confirmed loss of thiacloprid (aphids, beetles and whitefly), pymetrozine (aphids) and diquat (weeds). At risk of withdrawal are cypermethrin (aphids and other insect pests), glyphosate and propryzamide (weeds) and spinosad (thrips). The potential withdrawal of active substances coupled with a reduction in the current Extensions of Authorisations for Minor Use would have a significant impact on the ornamental horticulture industry in Scotland, as management of a range of pests, weeds and diseases would become challenging and more expensive. Reliance on a select few active substances would increase the risk of disease and pest resistance within this intensively managed sector. An increased uptake of the available biological pesticides is likely, but with increased costs to the grower and the consumer.

Pesticides with approval for amateur use (i.e. gardeners) are already restricted with few of the actives at risk of withdrawal (Fig. 9) likely to have significant impact on the health of garden plants. Herbicides, molluscicides and insecticides represent the main usage and there are no fungicides approved for amateur use on edible or non-edible plants. Amateur gardeners are more likely to be able to apply alternative methods of control such as hand weeding, not applicable to commercial settings, in the event of glyphosate being withdrawn. For slug and snail control ferric phosphate remains a solution when metaldehyde is probably withdrawn. Encouragingly, there has been an uptake of alternative solutions such as the use of fatty acids in place of products already withdrawn. The risk of transfer of pests weeds and diseases from garden or allotment settings to a commercial setting is unlikely to be significantly increased by pesticide withdrawals, and the major focus should be on preventive campaigns such as the 'don't risk it' campaign to discourage bringing plant parts home from foreign holidays to alleviate the risk of invasive species. Given safety concerns around the use of pesticides by amateur users and issues around storage and disposal, benefits to further restriction probably outweigh the negatives.

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Amateur Gardens

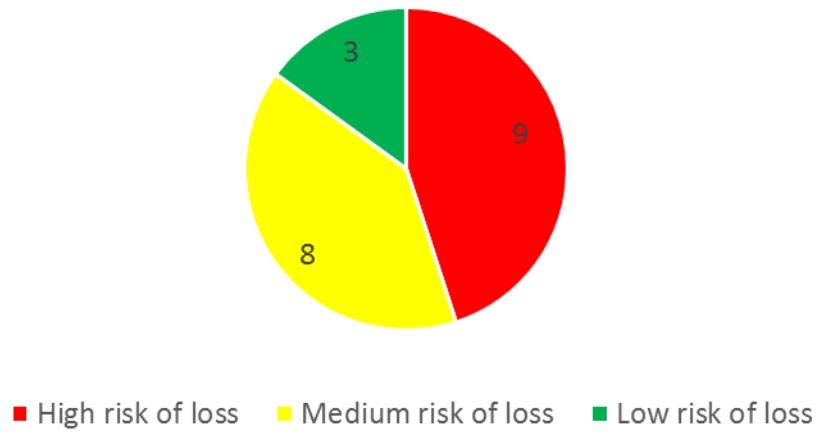


Fig. 9. Number of widely used active substances (n=20) at High, Medium or low risk of loss in the Amateur garden sector

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