Potential impacts arising from pesticide withdrawals to Scotland's agriculture sector

This document is a collection of excerpts from the final reports of:

1. A. Evans (2020). Potential Impacts Arising from Pesticide Withdrawals to Scotland's Plant Health: Project Final Report. PHC2018/15. Scotland's Centre of Expertise for Plant Health
2. F. Burnett, M. Bowsher-Gibbs and D. Dunbar (2021). Economic Impact of Pesticide Withdrawals to Scotland, with Case Studies: Project Summary Report. PHC2020/09. Scotland's Centre of Expertise for Plant Health

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Summary

Out of the 50 most applied active substances in Scotland to crops in the Agriculture/Production Horticulture sector (based on the last Scottish Pesticide Usage Survey), there are 12 active substances rated as at high risk of withdrawal, 19 active substances rated medium risk of withdrawal, and 19 active substances rated No/low risk of withdrawal. 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.

Potato

The nematicides oxamyl and ethoprophos used for management of Potato Cyst Nematode (PCN) and Free-Living Nematodes (FLN) are currently both on yearly renewals in the UK, with the former at a high risk of loss and the latter a medium risk of loss. The introduction of a new nematicide active substance in 2018 – fluopyram – has provided an alternative option for PCN although the control of FLN has not been proven in the Scottish situation and is not on the product label.

The potential loss of mancozeb will put pressure on other active substances and with it the risk of fungicide resistance in potato blight. The cost of production will increase through the use of more expensive products to maintain yields, estimated to have an impact of £0.66M on the Total Value of Output of Scottish potato crops. The additional issue of fluazinam resistance in blight has been estimated to lead to an extra £2.1M in UK costs through the use of more expensive active substances (£0.41M for Scottish potato crops).

The loss of diquat in Feb 2020 to 'burn off' and desiccate potatoes could have a significant impact especially in the Scottish seed crop and particularly with softer skinned European varieties that are being grown in greater quantities in Scotland. Alternatives such as flailing and other desiccants are only around 60% as effective as diquat in burning down crops. 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.

Virus management in Scottish seed potatoes is reliant on non-pyrethroid active substances due to the main virus vector (peach-potato aphid) being resistant to pyrethroid insecticides. After 2022 there will potentially be just three active substances effective against this aphid. This will restrict the number of aphicide applications to a maximum of 8 in total. 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 loss of key herbicides in potatoes such as linuron (already withdrawn) and potential loss of metribuzin (15% of the Scottish Total Value of Output of £214.7M - £32.21M) in Jan 2022 would have left a significant 'hole' in weed management in Scottish potatoes, especially with other herbicides also at risk or being withdrawn such as glyphosate and pendimethalin. However, in March 2019 a new active substance, aclonifen, was granted approval for use on potatoes, and will help to 'plug the gap' when metribuzin and other herbicides are unavailable.

Cereals

The loss of chlorothalonil in 2020 coupled with the potential loss of at-risk azole fungicides would make the management of diseases such as Septoria leaf blotch on Scottish winter wheat crops very difficult and Ramularia on barley crops impossible. It has been estimated that the loss of prothioconazole would reduce the annual Scottish Total Value of Output of winter wheat (£120.01M) by 2% - £2.40M. The additional loss of chlorothalonil (2% reduction) and epoxiconazole (0.4% reduction) would together reduce the Scottish Total Value of Output of Scottish wheat by £2.88M. 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 loss of prothioconazole (both 1% of Total Value of Output), resulting in £0.46M and £2.75M losses respectively.

The loss of the insecticide chlorpyrifos in 2016 has raised the risk of leatherjacket damage in spring barley, potentially taking 0.5% (£1.37M) off the Scottish Total Value of Output (£2.74M). There are currently no pesticide options available to manage this pest, growers having to rely on techniques such as rolling the crop. Due to the revocation of the neonicotionoid cereal seed treatments at the end of 2018, there will be an increase in the use of pyrethroid insecticides to manage aphids and Barley Yellow Dwarf Virus (BYDV). The potential loss of lambda-cyhalothrin (medium risk of loss) 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% (Total Value of Output of £0.47M for winter barley, £1.2M for winter wheat and £2.75M for spring barley), particularly in light of grain aphid resistance to pyrethroids..

The loss of metaldehyde in 2020 is mitigated by the availability of ferric phosphate as a straight (if not more expensive) alternative.

Whilst some herbicides used in cereals are at high or medium risk of loss, there are several alternatives available and economic impact on cereals is likely to be minimal.

Oilseed rape

The loss of the seed treatment thiram in January 2020 will leave oilseed rape at risk of diseases at crop emergence such as damping off however,new fungicide seed treatment options are in the pipeline. In winter oilseed rape (Scottish Total Value of Output of £44.75M), the potential loss of 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.

There is widespread pyrethroid insecticide 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. There are no other approved alternatives to the pyrethroids to manage this pest. Peach-potato aphid is also resistant to the pyrethroid insecticides. After October 2022 only flonicamid may be available for managing peach-potato aphid/turnip yellows virus on oilseed rape. In the spring pollen beetles are demonstrating resistance to the pyrethroid insecticides. With thiacloprid potentially going in October 2022 and pymetrozine in January 2020, acetamiprid and indoxacarb (medium and high risk of loss respectively) will be the only alternatives to pyrethroids for the control of pollen beetle.

As with cereals, growers have an alternative molluscicide available to metaldehyde (going in March 2022) in the form of ferric phosphate.

Whilst some herbicides used in oilseed rape are at high or medium risk of loss such as glyphosate, clomazone and propyzamide, there are several alternatives available and economic impact is likely to be minimal.

Legumes

Scottish legume crops have lost the fungicide iprodione in 2018 and thiram will be unavailable after 2020. Alternative fungicide seed treatments in particular are limited, with a biopesticide (*Gliocladium catenulatum*) the only alternative. There are several fungicides at medium or high risk of loss which are key foliar applied active substances in the management of diseases such as botrytis, sclerotinia, damping off, chocolate spot and downy mildew. The scheduled loss of chlorothalonil alone has been estimated to 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 loss of the herbicide active substance linuron in 2018 is estimated to reduce farmgate value of combining peas and beans by 4% (equivalent to £0.67M of Scottish Total Value of Output). Alternatives such as glyphosate, pendimethalin and clomazone are all at high risk of

loss. There will be a need for growers to look at EAMUs rather than on-label approvals for weed management in the short term.

Conclusions

This report summarises the risk of withdrawal and the impact that the loss of active substances used in Scotland for pest, weed and disease management would have on the agriculture sector. The loss of key substances will have a significant impact on the ability to manage pests, weeds and diseases effectively and economically. The Total Value of Output for agriculture will be negatively affected, with field vegetables in particular under threat. Alternatives for many of the active substances at risk of loss are either limited, more expensive or require a further shift into the use of biological pesticides. Further adoption of integrated approaches to pest management is 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 will 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. 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, more expensive chemical pesticides and so on are utilised.

This shift to a more integrated approach to pest, weed and disease management (IPM) whilst welcomed, will not happen overnight, particularly for crops 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 encourage the adoption of IPM approaches in preparation for the loss of pesticides that growers have relied on over many years. Other pressures such as Brexit, a new subsidy regime perhaps, the threat from invasive pest species, climate change, demands from processors, supermarkets, the public and politicians are all driving growers towards IPM to a greater or lesser extent. 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.

Summary statistics

Figure 1: Number of commonly used active substances estimated to be at low, medium and high risk of withdrawal, by Scottish sector

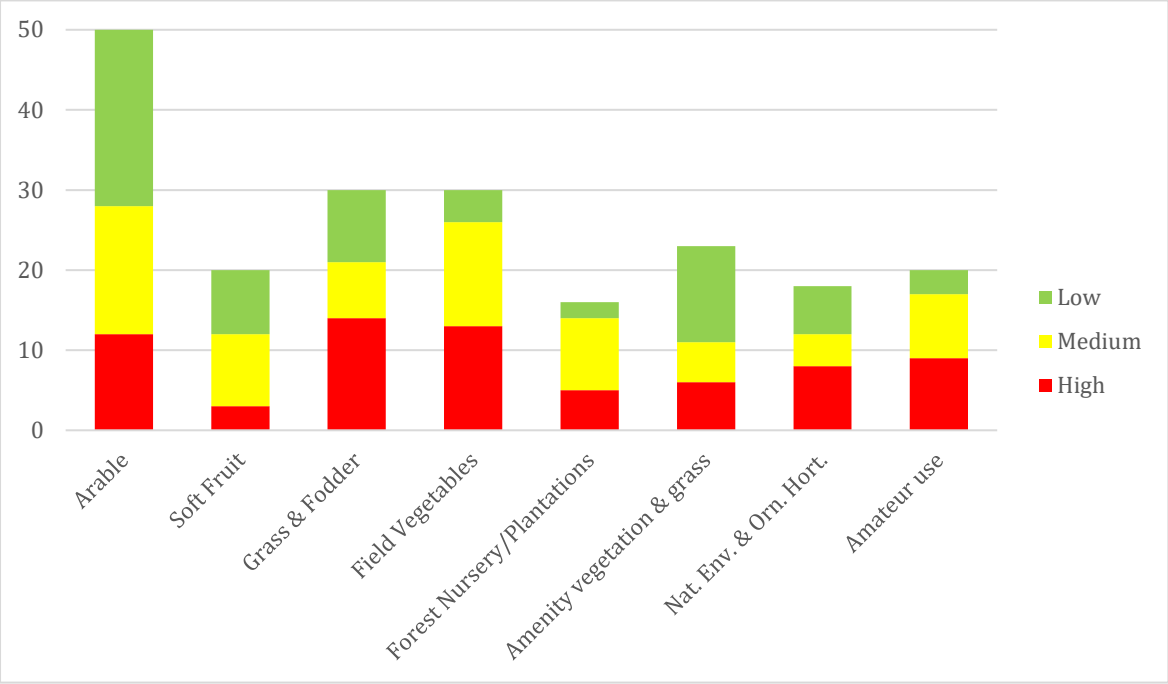

Figure 2: Estimated impact on output value (£m reduction) of withdrawal of all currently used active substances, by risk category, by Scottish commodity sector

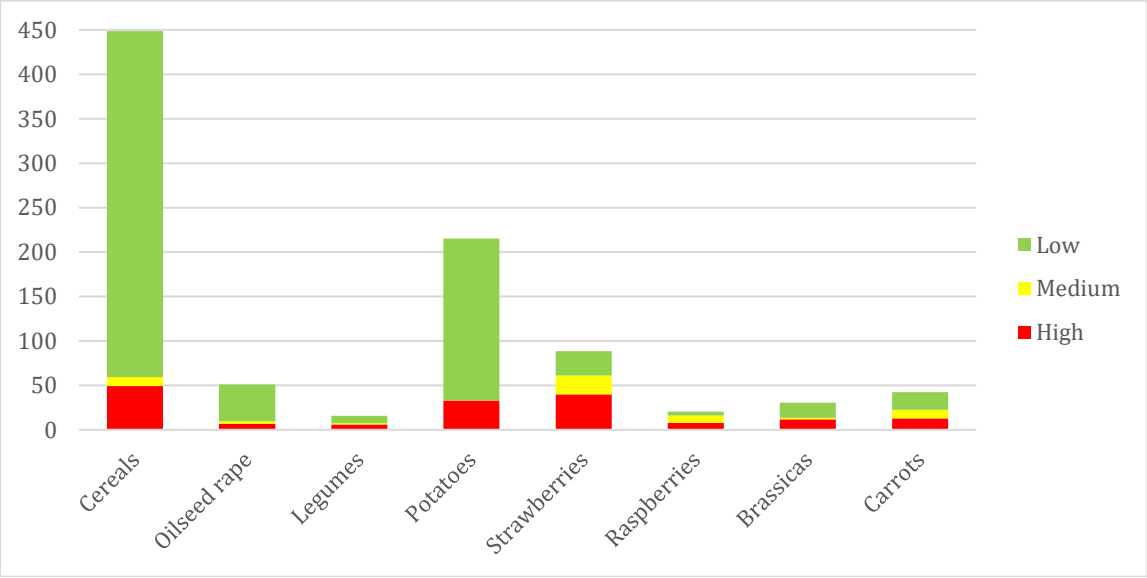

Figure 3: Estimated impact on output value (% reduction) of withdrawal of currently used active substances at high or medium risk, by Scottish commodity sector

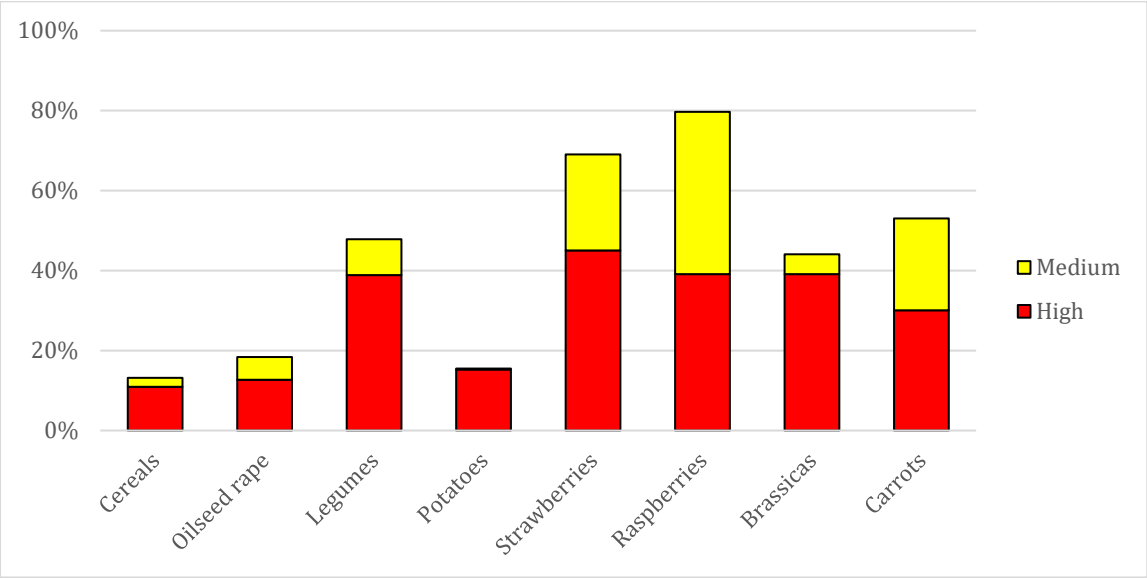

Table 1 Arable 2016 Principal active substances (n=50) listed by area treated

Active substance	Type	UK renewal date	Comments
Prothioconazole	F/S	31-Jan-22	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. New fungicides are in the pipeline.
Chlorothalonil	F	May-20	EU voted for non-renewal for the approval for chlorothalonil in March 2019, with UK use up date of May 2020. Very widely used in arable crops (cereals and legumes). Applied to >70% winter barley and >80% winter wheat for control of a range of diseases. Due to its multisite mode of action, effective at reducing risk of resistance in other actives. This is the only current 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. Is the most commonly used pesticide in Scottish arable agriculture by weight. There are multisite alternatives for use in cereals and legumes, however these are less effective. Several mixture products of chlorothalonil and another fungicide will also be unavailable from May 2020.
Tebuconazole	F/S	28-Feb-22	Depending on product, has Feb 2022 UK renewal date as a single active and in some mixtures. Availability in a mixture with fluoxastrobin for use on oilseed rape until March 2023. EFSA state it has 2 PBT criteria (Persistent, Bioaccumulative, Toxic). Alternatives exist for the major crops, so is unlikely to be re-registered.
Prochloraz	F/S	28-Feb-22	Uses in mixtures by end of February 2022. Use as individual active ended January 2019. Main uses are in cereals for control of eyespot and in oilseed rape for Alternaria, alternatives are available.
Epoxiconazole	F	31-Oct-21	Available in some mixtures until 31 July 2022. Very effective against yellow rust on wheat, but alternatives available. Reduced effectiveness against Septoria. Two PBT criteria toxic for reproduction and endocrine disrupting properties so unlikely to be re-registered.
Chlormequat	G	31-May-24	Plant growth regulator, some products approved until 2024, low risk of loss.
Glyphosate	H	15-Dec-22	Renewed in 2017 for 5 years, likely to have its authorisation expiry date extended to December 2025 in UK. 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 couch grass. It is likely that couch grass will re-emerge as a problem weed if glyphosate is no longer available for its control.
Mecoprop-P	H	31-Jul-22	Harmful to aquatic life so moderate risk of loss. Widely used herbicide in cereals alone and in mixture products.

Metsulfuron-methyl	H	30-Sep-25	Widely used on herbicide on cereals. EFSA state it has 2 PBT criteria (Persistent, Bioaccumulative, Toxic) so medium (possibly high) risk of loss.
Spiroxamine	F	31-Jan-22	Fungicide used in mixture products with azoles in cereals.
Trinexapac-ethyl	G	31-Oct-21	Plant growth regulator, alternative products are available.
Diflufenican	H	30-Jun-22	Key herbicide in cereals. EFSA state it has 2 PBT criteria - medium risk of loss.
Thifensulfuron-methyl	H	19-Oct-21	Herbicide approved for use in cereals, usually in a mixture with other actives. Latest use-up date of 19th October 2021. There are alternatives available.
Triticonazole	S	N/A	No longer available. Primarily used as a seed treatment applied as a co-formulated mixture. Limited alternatives available
Fluroxypyr	H	30-Jun-24	Herbicide approved for use in cereals, alone and in a mixture with other actives. Low risk of loss.
Fluxapyroxad	F	30-Jun-25	Fungicide used alone and in mixture products with azoles in cereals. Also used in potatoes for rhizoctonia. Low risk of loss.
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.
Cymoxanil	F	29-Feb-24	Important potato blight fungicide, valuable anti-resistance partner. Applied to 95% of ware and 87% seed potatoes in Scotland in 2016.
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. Limited alternatives available in legumes.
Tribenuron-Methyl	H	30-Apr-22	Cereal herbicide used alone and in mixture products. UK dossier under review for some of the mixture products.
Fluopyram	F/S	31-Jan-22	Fungicide used in cereals and oilseed rape. Several mixture products have dossier under review. New nematicide product in potatoes approved in 2018 until 2026
Lambda-cyhalothrin	I	31-May-22	Pyrethroid nsecticide widely used on cereals and oilseed rape and potatoes. UK dossier under review for several products. Key insecticide for aphid and virus management in cereals and potatoes, but resistance issues (peach-potato aphid, grain aphid, pollen beetles, cabbage stem flea beetle, pea and bean weevil). EFSA state it has two PBT criteria so chances of renewal are slim. Few non-pyrethroid alternatives currently available.
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.
Fluoxastrobin	F	31-Jan-22	Cereal fungicide used alone and in product mixture with azoles. UK dossier under review for several products.
Bixafen	F	31-Mar-26	Cereal fungicide, used alone and in product mixtures with azoles.
Flufenacet	H	30-Apr-22	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 loss.
Mancozeb	F	31-Jul-22	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. One product mix has dossier currently under UK review.
Pyraclostrobin	F	31-Jul-22	Cereal fungicide used alone and in product mixture with azoles. Also some use in legumes.
Picolinafen	H	31-Dec-19	Cereal herbicide used alone and in mixture products. UK dossier under review for some of the mixture products. Has approval in EU until 2031. Related active alinofen has just received approval in UK (March 2019) for use on potatoes.
Proquinazid	F	31-Jan-23	Cereal herbicide used alone and in mixture products. Limited importance in cereals.
2-Chloroethylphosphonic acid	G	N/A	No longer available. Other alternative plant growth regulators available.
Florasulam	H	30-Jun-33	Cereal herbicide used alone and in mixtures with other products. Low risk of loss and has approvals for some products until 2033.
Dicamba	H	30-Jun-22	Cereal herbicide used in mixtures. Dossier for grain maize approval currently under review but cereals approvals to be re-registered in 2022.
Cyazofamid	F	31-Jan-22	Fungicide used solely in potatoes. End of current approval in January 2022, which will restrict options for blight control, and increase the risk of other actives developing resistance.
Boscalid	F	31-Jan-22	Fungicide used primarily on winter wheat, oilseed rape and legumes. Cereal approval up for renewal in October 2021.
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, applied to 92% and 93% of seed and ware potato crops in 2016 respectively. There are no like-for-like replacements for diquat and the alternatives are likely to be more expensive.
Metaldehyde	M	31-Mar-22	Main molluscicide pellet used in Scotland, particularly in potato, oilseed and wheat crops. The loss of the cereal seed treatment clothianidin, will lead to an increase in the use of slug pellets, and with metaldehyde going in 2022 this 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.
Folpet	F	30-Jan-22	Fungicide used in cereals in product mixtures with epoxiconazole and alone. Has multisite activity and would be used more when chlorothalonil is lost in 2020. Loss of both folpet and chlorothalonil would create issues in cereals in terms of resistance to other actives.
Picoxystrobin	F	N/A	No longer available (withdrawn in 2018).
Mepiquat chloride	G	31-Aug-21	Plant growth regulator used in cereals. Current approval ends in 2021. Alternatives available at least until 2024.
Fluazinam	F	31-Aug-22	Key potato blight fungicide, applied to 91% of ware potatoes and 76% of seed potatoes in 2016. Issues with blight resistance to fluazinam, so use likely to decline as alternatives are adopted.
Cyprodinil	F	31-Oct-21	Cereal fungicide approval ends in October 2021. May not be renewed due to having two PBT criteria.
Pinoxaden	H	31-Dec-28	Cereal herbicide with some products approved until 2028. Good alternative to other herbicides.

Prohexadione-calcium	G	30-Jun-24	Plant growth regulator used in cereals. Alternative to other actives such as mepiquat chloride and chlormequat.
Isopyrazam	F	30-Sep-25	Fungicide used in mixtures and alone in cereals and oilseed rape. EFSA state it has 2 PBT criteria so medium risk of loss. There are alternatives available.
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.
Penthiopyrad	F	21-Oct-26	Cereal fungicide used in a tank-mix with other multisite fungicides such as chlorothalonil and in product mixtures. Low risk of loss.
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 whose UK renewal date is Dec 2019.
Metconazole	F/G	31-Oct-22	Fungicide used in cereals, oilseed rape and legumes. Combined use as a plant growth regulator in oilseed rape but generally alternatives are available.
Fludioxonil	S	30-Apr-22	Fungicide seed treatment used alone or in product mix on cereals grown for seed) and alone on potatoes for the control of a range of seed borne diseases.

1 = no/low risk of loss 2 = medium risk of loss 3 = high risk of loss	Type of active substance: F-fungicide, H-herbicide, I-insecticide, G-growth regulator, S-seed treatment, M-molluscicide

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