# Economic Impact of Pesticide Withdrawals to Scotland, with Case Studies

PHC2020/09 - Project Summary Report

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# Content

# 1 Executive Summary

- From 1st January 2021, the UK is no longer participating in the EU's pesticide regulatory system and has introduced an independent regulatory regime. The Health and Safety Executive (HSE) will remain the national regulator for the whole of the UK, on behalf of each of the four country administrations. The UK administrations are already reviewing the National Action Plan on the Sustainable Use of Pesticides, which includes pesticide risk reduction targets and support for the adoption of non-chemical controls. Human health and environmental concerns mean that many 'active substances' are at risk of regulatory withdrawal.
- Although efforts are being made to develop alternative control measures, including new chemical products, biopesticides, physical treatments and adoption of enhanced risk-reduction measures such as crop rotations, the absence of current like-for-like alternative measures may result in lower yields, poorer quality and higher costs in many cases.
- For example, recent experience of pesticide withdrawals across Europe shows farm-level reductions in enterprise profitability, but also wider-scale effects on processors' viability, import volumes from countries with laxer production standards and (through changes in land use and other input usage) higher greenhouse gas emissions and a reduction in the availability of different break crops for inclusion in rotational sequences.
- Pesticides are widely used in Scotland for agricultural, horticultural and forestry production plus amenity and environmental management purposes. Although, due to differences in climate, latitude and enterprise mix, Scotland may be less impacted than England and other European countries, withdrawal of approved pesticides from usage would impact commodity output, with implications for rural land use and food production.
- The faster the pace of withdrawals and the more complete their coverage, the greater the potential impact. Yet the severity of likely impact varies, reflecting sectoral differences in current reliance on key active substances. Strawberries, raspberries, legumes, brassicas and carrots may be particularly vulnerable.
- Impacts can be mitigated through phased timing of withdrawals, to allow for the development and deployment of substitute products and practices. This suggests that a combined approach of seeking to prolong the availability of key active substances via strategic stewardship whilst accelerating R&D efforts and supporting adaptive management at the farm-level would be helpful.
- In particular, explicit support, including advice, training and funding, for Integrated Pest Management across all sectors (particularly those most exposed to withdrawals) has a role to play in demonstrating commitment to deploying alternative control measures to reduce pesticide usage and balance different policy objectives.
- Commitment to alternative measures and to stewardship of key substances as part of a mix of controls rather than the dominant default management response may help to delay complete withdrawals.

# 2 Introduction

1. Chemical forms of plant protection are widely used in Scottish agricultural, horticultural and forestry production plus for amenity and natural environment management purposes. Product types used include herbicides, fungicides and insecticides, but are all commonly referred to as pesticides and all contain at least one 'active substance'.

2. The availability and use of active substances are closely regulated, and increasing concern over human health and environmental impacts has led to a greater likelihood that some existing approvals will be withdrawn and/or that approvals for new products will not be granted.

3. From 1st January 2021, the UK is no longer participating in the EU's pesticide regulatory system and has introduced an independent regulatory regime. The Health and Safety Executive (HSE) will remain the national regulator for the whole of the UK, on behalf of each of the four country administrations. The UK administrations are already reviewing the National Action Plan on the Sustainable Use of Pesticides, which includes pesticide risk reduction targets and support for the adoption of non-chemical controls.

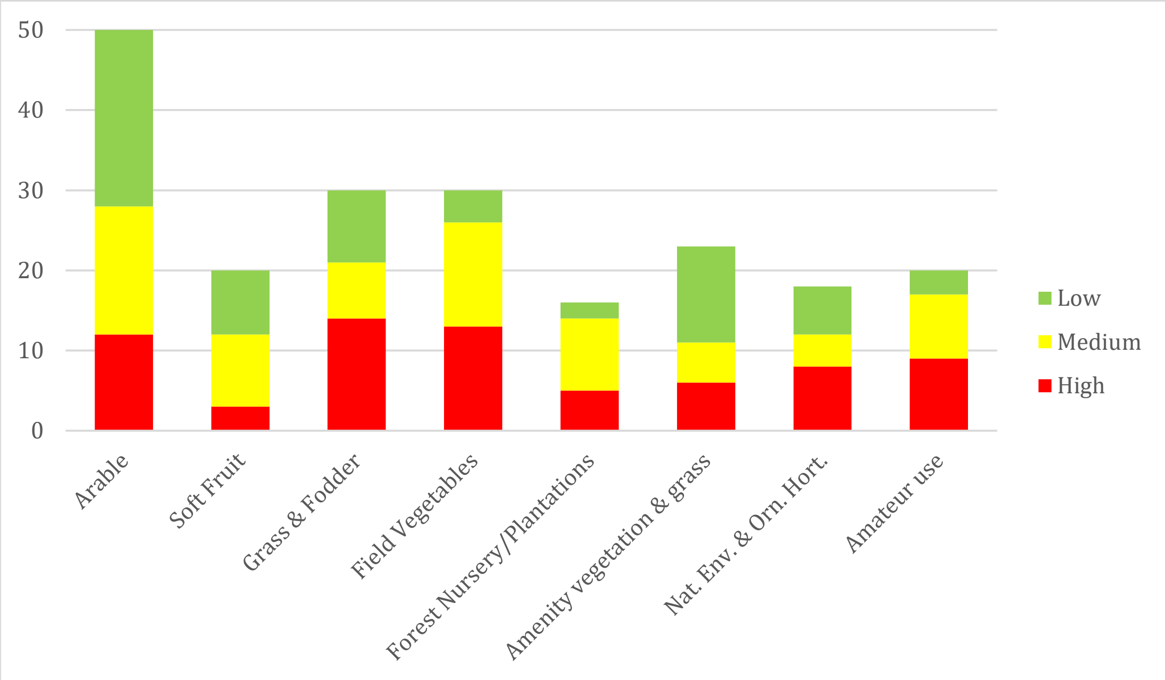
4. Outcomes of this process are of interest to users currently reliant upon access to a mix of products to combat a range of pests, weeds and diseases. For example, constrained abilities to protect commodity production from damage may lead to reduced output value because of lower yields and/or quality, whilst costs may also increase to further reduce profit margins or the affordability of amenity maintenance. Similarly, constrained abilities to combat invasive species may reduce the effectiveness and affordability of environmental management.

5. Such potential impacts are of policy interest given government objectives relating to, for example, vibrant rural economies, increased afforestation, and growth of the food and drink sector, but which also need to be balanced against policy interests to protect human and environmental health. Consequently, there is a need to understand the likely magnitude and distribution of potential impacts, but also how they may be mitigated.

# 3 Withdrawal risks

6. Pesticide usage survey reports have been used to identify the current deployment of active substances across different sectors in Scotland. This information has then been combined with a 'traffic light' classification of the estimated risk of withdrawal, derived from AHDB and SASA data (see Evans, 2020). The combined results of this analysis are summarised in Figure 1 below.

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




*Note: all values in Figures 1, 2 and 3 derived from Evans (2021)*

7. Figure 1 shows that of the number of commonly used active substances in each sector a significant proportion are judged to be at high or medium risk of withdrawal. Nonetheless, a number of substances are also considered to be at low risk of withdrawal in all cases.

8. Given the breadth of specific plant species within a sector (for example, arable includes wheat, barley, oats, oilseed rape, potatoes etc.) and variation in specific weed, pest and disease problems and hence intensity of use of particular active substances, assessment of actual exposure to withdrawal risks requires a more detailed breakdown of usage.

# 4 Estimated upper-bound commodity impacts

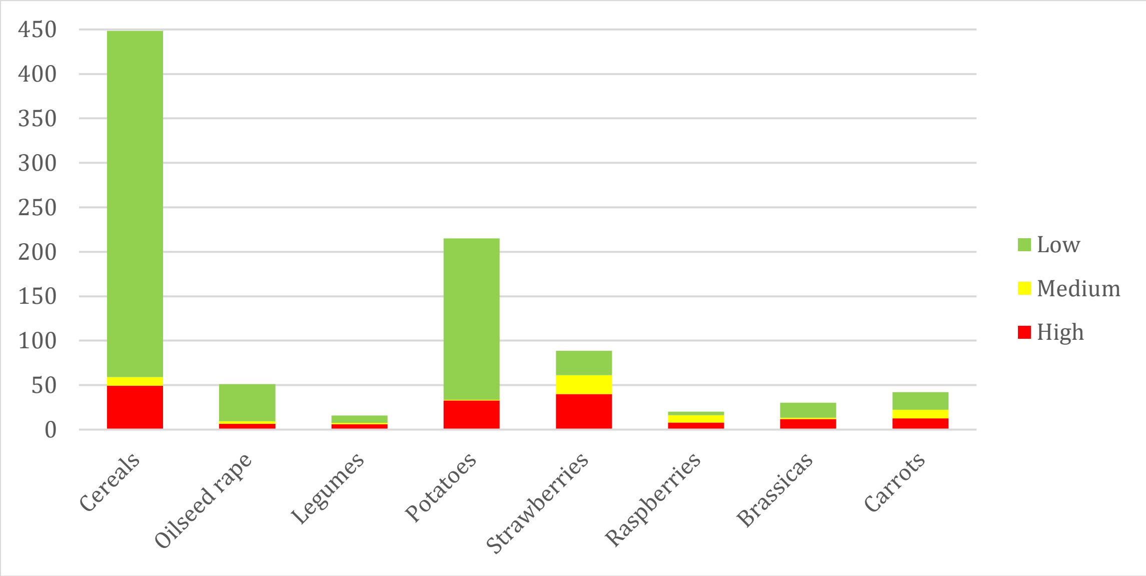
9. From figure 1 above, estimation of the contribution of pesticides to overall productivity and output is difficult. For example, damage abatement can be achieved in different ways, is conditional upon the actual incidence of weeds, pests and diseases, and is affected by intensity of use.

10. Nonetheless, estimates of the potential impact on the output value of selected commodity sectors [1] have been calculated and are summarised in Figure 2. Calculations were made for particular plant species within each sector, taking account

[1] The use of pesticides for amenity maintenance (including amateur gardening) and environmental management does not generate a marketed output, and hence it not included here. However, withdrawal impacts would be felt in other ways, such as reduced enjoyment from a higher prevalence of weeds and/or greater recourse to manual weeding. Similarly, no estimate has been generated for grass and fodder due to its value being dependent on subsequent use for livestock production, nor for forestry due to a lack of comparable data.

of previous UK-level studies but also using insights from experts and stakeholders to identify any Scottish-specific circumstances likely to increase or reduce impacts. For example, a higher or lower prevalence of a particular pest, weed or disease (see Evans, 2020; Wynn, 2014).

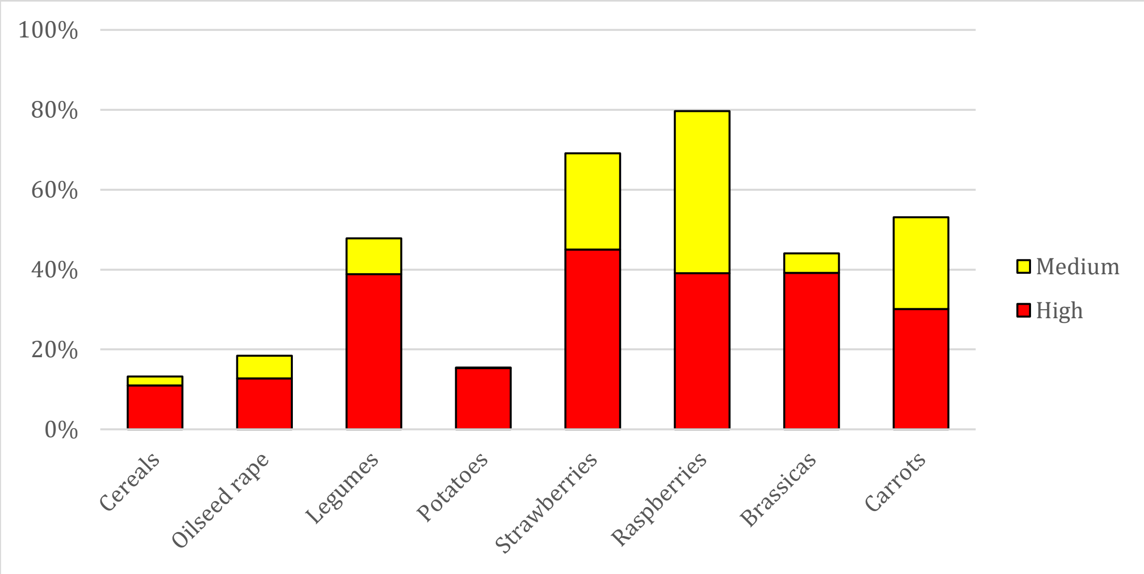
*Figure 2: Estimated impact on output value (£m reduction) of withdrawal of all currently used active substances, by risk category, by Scottish commodity sector*




11. Figure 2 shows the estimated impact in £m terms, highlighting the relative size of different sectors within Scotland but also variation in the degree of reliance upon active substances in different withdrawal risk categories. For example, cereals account for the largest total output value, but most of this would be unaffected by the withdrawal of high and medium risk substances. By contrast, strawberries account for a much smaller output value but a higher proportion of it would be affected by the withdrawal of high and medium risk substances.

12. Figure 3 shows this more clearly by presenting the same results but in percentage terms and only for high and medium withdrawal risk categories. This highlights that strawberries, raspberries, legumes, brassicas and carrots would be most affected in relative terms. Such cases reflect a high degree of reliance upon intensive use of a few key active substances to combat particular pests and diseases.

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




13. However, although illustrating why withdrawal risks needs to be understood and managed, the values presented in Figures 2 and 3 are estimated upper-bound impacts for static scenarios in which all commonly used active substances in a given withdrawal risk category are withdrawn immediately and simultaneously. In reality, actual impacts may be mitigated by a number of dynamic factors.

## 5 Impact Mitigation

14. As shown in Figure 1, the risk of withdrawal varies across different active substances. In addition, the timing of possible withdrawals also varies somewhat. Consequently, even if all substances were ultimately to be withdrawn, estimated upper-bound impacts would not be felt immediately. Equally, the likely staggered phasing of the timing of individual withdrawals offers the opportunity for adaptative management to adopt alternative protection strategies. Nevertheless, recent experiences outwith Scotland illustrate limits to mitigation effectiveness (see Annex 1).

15. For example, withdrawal of neonicotinoids has significantly reduced overall production of oilseed rape across Europe. This has implications for the viability of processors and has led to surges in imports, primarily from production expanding in countries where neonicotinoids are still permitted - which implies global neonicotinoid usage may not be declining, and highlights complexities associated with standards and international trade.

16. Whilst Scottish oilseed rape producers are currently less exposed to Cabbage Stem Flea Beetle risks than English counterparts, the potential for future impacts is apparent given that climate change is likely to affect the future incidence of pests and disease threats in Scotland.

17. Similarly, loss of neonicotinoids has exposed sugar beet producers to higher risks of output losses from virus yellows. British Sugar is seeking to maintain its domestic production base through explicit financial risk-sharing with growers. Again, this is relevant to future developments in Scotland given current aspirations to reintroduce sugar beet as the basis for bioethanol production.

18. Separately, adoption of alternative control measures requiring additional field operations incurs additional fossil fuel usage, thereby increasing greenhouse gas emissions. For example, withdrawal of Diquat has forced potato growers to either resort to more frequent applications of other chemicals and/or flailing for foliage desiccation. Moreover, the reduced viability of enterprises such as oilseed rape, sugar beet, potatoes and legumes is limiting the availability of break crops for inclusion in rotational control measures.

19. To some extent, due to its climate, latitude and mix of farm enterprises, Scottish agriculture has escaped some of the impacts felt in England and other parts of Europe following recent bans on widely used chemicals and the same might apply to additional future withdrawals. However, the above examples confirm the difficulties encountered by sectors reliant on key active substances if like-for-like alternative control measures are not readily available.

20. This suggests that a combined approach of seeking to prolong the availability of key active substances, where environmental and health impacts allow, whilst accelerating R&D efforts and supporting adaptive management at the farm-level to discover and implement alternative control measures would be helpful. In particular, explicit support, including advice, training and funding, for resistant plant varieties, biological controls, habitat manipulation and enhanced planning and monitoring (collectively referred to as Integrated Pest Management, IPM) has a role to play in demonstrating commitment to deploying alternative control measures to reduce pesticide usage and balance different policy objectives.

21. Demonstrating such commitment by policy support and industry uptake and presenting the seeking of prolonged availability of key substances as active stewardship of substances within a mix of control measures, rather than simply the default management option, may help to delay withdrawals. That is, subject to evidence on environmental and health risks, regulatory imperatives to withdraw immediately and completely might be relaxed in favour of strategic stewardship of active substances as part of a broader approach to controlling plant damage.[2] This broader approach might help to balance policy interests to protect human and environmental health whilst maintaining commodity production and employment in rural sectors.

22. Current policy encouragement for IPM is comparatively light-touch but could be expanded to include all sectors and strengthened to include the provision of advice and training, grant-aid for relevant capital investment and research and development, and conditionality obligations to deploy elements of IPM (alongside other possible future

[2] Although the scope for influencing regulatory controls is perhaps limited by Scotland being but one part of the UK, and the UK still possibly being subject to EU regulatory requirements.

compliance requirements such as carbon, nutrient and biodiversity planning). Specific attention to sectors more exposed to withdrawal risks would be prudent.

# 6 Other considerations

23. Beyond the scope for adaptive management to mitigate potential impacts, it is also important to consider external factors. In particular, the tightening of regulatory controls on pesticides is not restricted to the UK but is occurring elsewhere too, notably across the EU. This means that UK and Scottish users will not necessarily be placed at a competitive disadvantage by withdrawals since producers and supply-chains elsewhere will also have to cope with lower yields and higher production costs.

24. This extends to quality too since if all sources of a given commodity will be subject to, for example, aesthetic blemishes or a degree of contamination, domestic demand and price levels will be impacted less than if only Scottish (or UK) producers were affected. Hence the estimated impacts on output value shown in Figures 2 and 3 may be offset to some extent by market-level dynamics. However, much may depend upon implementation of the Trade and Cooperation Agreement with the EU and other post-Brexit trade arrangements between the UK and other countries in terms of production standards and tariff protections (UK imports of oilseed rape from countries such as Australia and Ukraine where neonicotinoids are still permitted illustrates this point starkly).

25. Separately, even if estimated upper-bound impacts were realised, this overstates the overall economic loss since at least some of the land, labour and capital displaced from current production would, over time, be reallocated to other uses. This transition would be locally disruptive and might hamper achievement of some specific stated policy objectives but would not necessarily result in lower overall economic activity at the national level.

# 7 Conclusions

26. Pesticides are widely used in Scotland, and their withdrawal would disrupt current production activities. Estimates of the impacts on output for selected sectors reveal variability in exposure to withdrawal risks and illustrate the potential magnitude of negative effects. These have implications for policy interest in patterns of economic activity, employment and land use. For example, with respect to ambitions to increase afforestation rates, grow the food and drink sector and maintain vibrant rural economies.

27. However, calculated impact estimates represent upper-bounds under specific scenarios and actual impacts could be mitigated by staggered withdrawals over time, market-level adjustments, and the adoption of alternative management practices. The latter includes wider uptake of IPM to reduce reliance upon pesticides but also to, potentially, prolong regulatory approval of at least some active substances. Such an approach might help to balance policy interests to protect human and environmental health whilst maintaining commodity production and employment in rural sectors.

28. Demonstrating commitment to reducing reliance on pesticides, by policy support and industry uptake, and presenting the seeking of prolonged availability of key substances as active stewardship of substances within a mix of control measures, rather than simply the default management option, may help to delay withdrawals. That is, subject to evidence on environmental and health risks, regulatory imperatives to withdraw might be delayed and/or reduced in favour of strategic stewardship of active substances as part of a broader approach to controlling plant damage.

# 8 References


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 (PHC).

Wynn, S. (2014) Endocrine disruptors – collation impacts across all sectors to give clear messages on impacts of changing availability on farmers and production. Agriculture and Horticulture Development Board.


# 9 Annex 1 - Case studies: Impact and Actions arising from Pesticide Withdrawals in Scotland with relevance to clothianidin, thiamethoxam, diquat, linuron and chlorpyrifos

## 9.1 *Key Points from case studies*

- By virtue of climate and cropping density, the economic viability of the Scottish crop sector has not yet suffered from pesticide withdrawals to the extent evidenced in England and mainland Europe. However, the Scottish case studies in this report have demonstrated increased costs to the grower where adaptation has been necessary.
- In individual cases the UK has been forced to transition from a net exporter to a net importer of crops to supply home demand and sustain existing processing capacity.
- The UK currently permits the import of certain food grown abroad that is treated with pesticides already withdrawn from use in this country.
- As food output declines as a result of pesticide withdrawal, the UK becomes less resilient to production shocks and price volatility in global markets.
- The severity of impact of pesticide withdrawal, exhibits differentiation at EU level, UK level and at a Scottish level but by varying degrees has resulted in accelerated resistance developing to remaining actives, increased GHG emissions arising from adopted processes, biodiversity loss arising from land-use substitution and higher demands on water resources.
- Some alternative cultural crop husbandry practices introduced to substitute a pesticide withdrawal have resulted in negative impacts on the carbon net-zero agenda.
- Growers are now being financially incentivised by some food processors to continue to grow those crops most at risk of failure as a result of pesticide withdrawals.
- Innovation in integrated pest management techniques has mainly been re-active to pesticide loss. Biological and other non-chemical control applications currently demonstrate difficulty in scaling up to commercial requirements.

## *9.2 Introduction to case studies*

Against a backdrop of pressures to withdraw pesticides and concerns about the negative impacts on domestic production, the UK administrations are reviewing the National Action Plan on the Sustainable Use of Pesticides, which will review risk and dependency and increase financial and other support measures to British farmers to adopt non-chemical alternatives. Support to take up alternatives to pesticides is an acknowledgement of the fact that the pace at which pests, weeds and diseases have evolved resistance, and the rates at which pesticides have been restricted by legislation, have been much faster than the pace at which alternatives have been developed or made available.

As of 1st January 2021, GB will introduce a new independent pesticides regulatory regime with the current legislative framework being retained in National Law. The UK will have no formal role in EU decision making processes. The UK will no longer participate in the EU's Registration, Evaluation, Authorisation & Testing and Restriction of Chemicals (REACH) system and has instead established UK REACH under the Health and Safety Executive (HSE). New decisions by EU REACH will not apply in Great Britain. Pesticides seeking new authorisations, amendments or renewals may now need to apply under both the GB and EU pesticides regimes.

The Health and Safety Executive (HSE) will remain the national regulator for the UK administrations. A GB programme for the review of the safety of active substances will be developed and all existing active substance approvals, PPP authorisations and Maximum Residue Levels (MRLs) will continue to be valid in Great Britain.

In addition, from 1 January 2021, existing EU PPP authorisations will remain valid until the expiry date valid on 31 December 2020, even if the EU subsequently alters those dates. UK authorisations may be reviewed, however, if requirements are no longer satisfied. Active substance approvals expiring within 3 years of the end of the transition period (31 December 2020), will each be extended for 3 years to allow time for the necessary GB evaluation work. HSE will however retain the power to review active substance approvals at any time, should new evidence identify concerns to human health or the environment. New decisions taken under the EU regime will not apply in GB. This includes active substance and MRL decisions and any new EU PPP legislation. New applications for active substance approvals, PPP authorisations and MRLs will need to be submitted under both the GB and EU regimes to gain access to both markets.

Pesticide regulation is complicated and contentious, and any changes, even the simplest, take time. Consequently, given concerns about environmental and human health impacts, there is the possibility that some active substances will be withdrawn in the near future and hence it is useful to review experiences with past withdrawals to gain some insights into potential future impacts.

Impacts arising from pesticide losses may be different in Scotland, reflecting different pest, weed and disease pressures and cropping practices. The remainder of this report summarises information gleaned from industry sources, including stakeholder interviews and reports, in relation to withdrawals in recent years of some specific active substances. This was done to gain insight on preferred and achievable adaptations in Scotland so that UK estimates of economic losses arising from pesticide could be informed by a Scottish context.

## 9.3 Actives used for case studies

This section presents an overview of previous experiences of pesticide withdrawals for selected examples. Information was drawn from interviews with agronomists and growers for the following sectors. Informal interviews, conducted by telephone, collated current industry thinking on where the impacts have been most acute.

The aim was to elicit information on impacts arising from the withdrawals and identify those mitigation measures that have already been taken which could inform likely future mitigation actions that Scottish growers would use (e.g. flea beetle in brassica species)

### 9.3.1 Clothianidin & Thiamethoxam

In 2013 the European Union changed the approval conditions for three neonicotinoid active substances - clothianidin, imidacloprid, and thiamethoxam such that they were prohibited from use on several crops attractive to bees, including oilseed rape. Since 1st December 2013 therefore farmers have been unable to buy or sow seeds that are treated with these active ingredients and on 27th April 2018 the EU agreed to a ban on all outdoor use.

When implementing the restrictions, the European Commission also confirmed that within two years it would initiate a review of impacts. A study to identify the major economic and non-pollinator-related environmental consequences was conducted by research consultancy HFFA Research GmbH[1]. It was concluded and presented in early 2017 and provides an important post-ban analysis conducted several years after the event. As an EU member at the time many of the outcomes bear relevance to the current UK oilseed sector.

It is important to bear in mind that prior to the ban farmers have relied on neonicotinoids as an effective seed treatment option for the protection of oilseed rape from cabbage stem flea beetle (CSFB) damage. The study identified three base impacts of the ban on oilseed rape farming within European boundaries.

- a negative yield impact of 4% resulting in 912,000 tons of missing harvest
- an average of 6.3% of harvest quality losses
- an average of 0.73 additional foliar applications per hectare of cultivated oilseed rape

These impacts translate into almost €350 million for European market revenue losses, more than €50 million revenue losses due to lower quality, close to €120 million additional production costs, and well above €360 million in upstream and downstream industries. In total the study estimates that the neonicotinoid ban has cost the European oilseed rape farming industry almost €900 million a year.

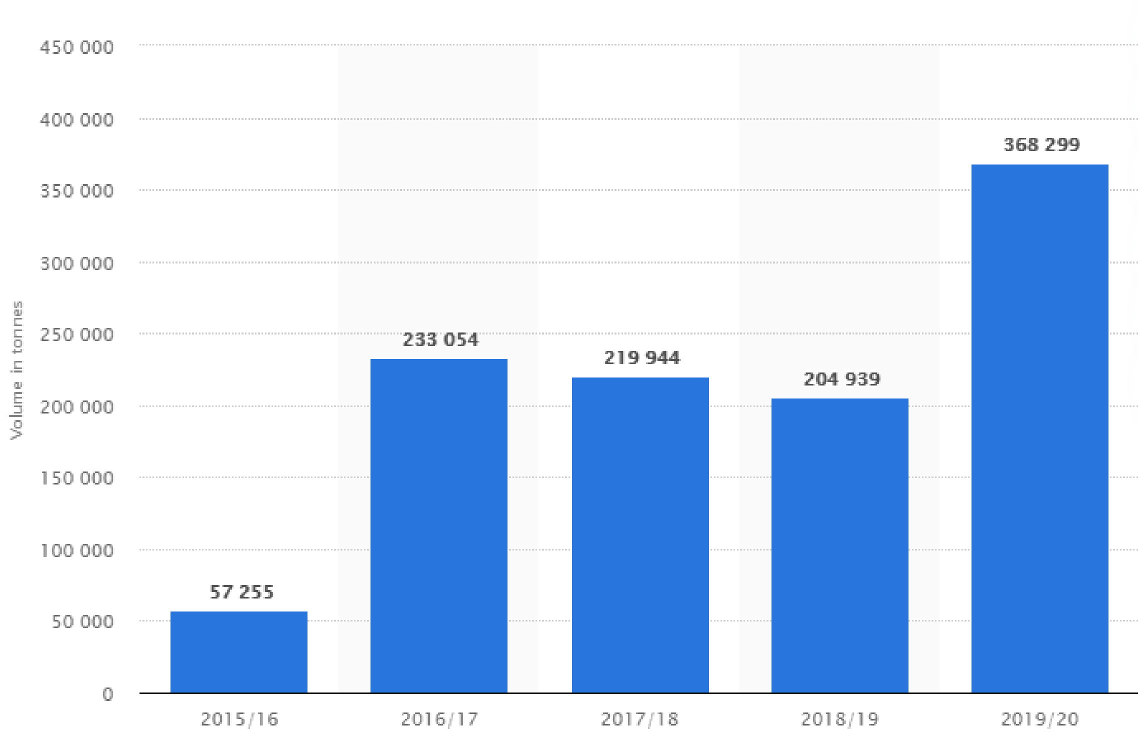
The study also found that impacts spread beyond European country borders. For example, with global demand holding constant, the missing harvest in the EU is produced elsewhere. Since global land productivity will not rise as a direct consequence of the ban, such a production increase requires additional land resources. Shifting oilseed rape production outside the EU is estimated to require an additional 533,000 hectares of land outside Europe, cause 80.2 million tons of $CO^2$ emissions (equivalent to greenhouse gas emissions of Austria for one year), 1.3 billion m3 of additional water consumption and lead to biodiversity losses related to the conversion of grassland and natural habitats rich in species into arable land. This production has been taken up in other parts of the world such as the Americas, Ukraine and Australia where noenicitinoids, banned in the UK and EU, remain widely used.

Data reported by Scottish Government in the two years after the ban[16] evidences the lower levels of pest damage in Scotland, relative to English crops. For Scottish growers, the interviewees described being forced to switch to other, management solutions to address pest pressure. A common approach has been to spray pyrethroids, commonly as tank mixes whilst applying autumn herbicides or fungicides. In the European context, a switch to pyrethroid sprays has caused direct effects at farm level; the additional foliar insecticide applications resulted in additional Greenhouse Gas emissions of an estimated equivalent of 0.03 million tonnes of $CO^2$, 1.4 million $m^3$ of additional water use annually and an increase in production costs of approximately €120 million. The results of that study suggest that the impacts of the European Commission's decision to restrict the application of three neonicotinoids in the EU go beyond economic costs but also have considerable impacts on the environment that will need to be weighed against the previous negative impacts of neonicotinoids. For Scotland, the switch to foliar sprays will not have had the same impact of greenhouse gas emissions as pyrethroids are applied in tank mix with other field-passes but the negative impact of pyrethroids sprays on beneficials is a shared concern.

In the UK specifically, production of oilseed rape has now dropped to its lowest level in 15 years and consequently the UK's position as a net exporter has been reversed. Imports of oilseed rape have risen from 57,255 tonnes in 2015/16 to 368,299 tonnes in 2019/20. (Figure 4).

From a production level at its peak in 2011 of 2.80 M tonnes there has been a decline in production (continuous since 2017), such that 2020's crop recorded only 1.071 M tonnes; a fall of 68% over the last 9 years. In the last three years alone, the area sown to the crop has declined by 27%, from 583,000 ha to 388,000 ha. In 2019 the estimated cost of CSFB to UK growers was £79M.

*Figure 4. UK rapeseed imports 2015-2020 (tonnes)*



Currently UK lost production has been substituted with imports from countries like Ukraine, where continued neonicotinoid use also allows a huge competitive advantage. The area of oilseed rape in Ukraine is increasing, and more than 90% of its oilseed rape exports are to countries where neonicotinoids are now banned.

It is not just the reduction in UK oilseed rape production that is of concern but also our domestic oilseed processing capacity. In 2019, UK crushers looked to fill the 2M tonne capacity and were forced to import, with many of these imports having been treated with neonicotinoids. The scenario will repeat for the 2020 crop. While this is obviously a necessity to keep the supply chain running, it is not sustainable and the threat of losing the crushing industry from UK shores is of greater risk. Increased handling costs and small ports restrict the success of reliance on imported produce and these pressures are therefore likely to force processors to crush elsewhere. Although the risk of importing pests and diseases on rape seed for crushing is relatively low, for any future examples where there is a switch to greater reliance on crop imports then any associated plant health risks should be assessed.

So acute is the shortfall in oilseed rape production that DEFRA is being lobbied by the NFU to support a Government-funded scheme which would see farmers reimbursed for up to 80% of the costs associated with trying to grow oilseed rape if their crop fails. Industry believes the oilseed rape area needs to stabilise at around half a million ha to prevent the risks of processing plants closing and jobs being lost.

As English rotations move to linseed and beans as alternatives to oilseed rape, Scottish growers are seeing the benefit of this, with good prices and manageable levels of pest damage for oilseed rape crops grown north of the Border. As yet, the Scottish oilseed sector has not been impacted by the withdrawal of neonicotinoids; the cooler climate and current relative scarcity of the crop being the two major reasons cabbage stem flea beetle populations have not impacted economically. The EU/UK scenario, however, provides an important illustration of the consequences of the neonicotinoid ban in conjunction with climate change and an increased crop uptake. In summary, Scottish growers have not needed to adapt yet because of lower pressure but the point here is to learn from the English experience. A move to alternative crops may also necessitate learning from the English experience.

With CSFB starting to impact upon vegetables and brassicas, the AHDB are currently funding three research projects focusing on the pest. The first is a three-year project which aims to develop an IPM strategy for CSFB in oilseed rape[2]. Researchers have conducted a meta-analysis based on 14 years' worth of trial data to uncover some of the risk factors surrounding CSFB damage[3]. Alongside this, the team at RSK ADAS Ltd. have done trials looking at the impacts of variety and seed rate and have been exploring alternative methods of control, including winter defoliation of crops to reduce larval numbers and trap cropping of adults using volunteer oilseed rape. Further work is being done by PhD researchers at John Innes Centre and Harper Adams University[4]. The first of these projects is looking to uncover a genetic basis for CSFB resistance in oilseed rape, and the second is seeking novel methods of control using biopesticides. Further projects to develop formulations of a fungal biopesticide have also recently been launched building on earlier work by Crop Health and Protection and CABI[5]. It is hoped that through this work, the control of CSFB will become more manageable, leading to reductions in populations. The research will also uncover more information about flea beetle biology and ecology, which could have wider implications for the management of brassica flea beetle species.

Such has been the risk to the sugar beet crop, emergency authorisations have been granted by UK Government Ministers for the use of 'Poncho Beta' and 'Cruiser SB' as seed treatments on sugar beet to provide protection against the virus yellows complex transmitted by the virus vector, peach-potato aphid (*Myzus persicae*). 'Cruiser SB' contains thiamethoxam and 'Poncho Beta' a pyrethroid/neonicotinoid combination (beta-cyfluthrin/clothianidin).

Regulations (EU) Nos. 2018/784 and 2018/785 prohibited the application of clothianidin and thiamethoxam to seeds from 19 September 2018 and sowing treated seed from 19 December 2018 for all remaining crop groups, including sugar beet. The 2019 harvested crop was the first therefore to be drilled with untreated seed.

Tasked with the review, the UK Expert Committee on Pesticides (ECP) noted requests for emergency authorisations are assessed against a number of criteria, including: whether use is limited and controlled; the case for need; and understanding of the risks associated with the proposed use.

ECP noted (Advice to Ministers, August 2018) that:

- It is not currently possible to limit treatment on a risk basis to a proportion of the crop when treating *Myzus persicae*. The decision on whether to treat seeds would depend on whether a virus risk prediction model exceeded a defined threshold. The model, however, is claimed to be robust only to regional level (though work is underway to improve its granularity). Fields with treated seed tend to be located relatively close to the four sugar beet processing plants. The treatment of seeds would take place in late February 2019 - this is later than usual – when results of a national aphid monitoring survey become available and can be combined with the modelling work. HSE would review the monitoring data. *(8th January 2021: government approves emergency authorisation of Cruiser SB based on threshold monitoring results and with strict caveats on subsequent flowering crops*)
- All UK sugar beet is grown under commercial contracting arrangements. This provides an effective mechanism for controlling the distribution and use of the treated seed and, for example, any restrictions on the planting of following crops.

The case for need was based on:

1. There being no alternative authorised insecticides (foliar pyrethroids are largely ineffective due to widespread resistance of *Myzus persicae*).
2. A current lack of cultural and physical controls providing effective control of *Myzus persicae* (although industry has invested significantly to address this, including a £1.1m plant breeding project).
3. The proven effectiveness of these seed treatments in preventing yield losses ranging from 0-17%, with an average loss of 7.9% (this estimated by Government to be worth approximately £18m).

There were several unacceptable environmental risks associated with the use of these products and they would be concentrated in areas planted to sugar beet, namely:

1. The persistence and mobility of clothianidin and thiamethoxam in soils could result in residues with the potential to cause unacceptable effects to bees in following crops and flowering plants in field margins. ECP noted that no evidence was presented as to whether the applicant's proposed 16-month restriction on planting a flowering crop following the drilling of the treated seed would mitigate potential impacts.
2. Birds and mammals eating seedlings from treated seed and birds consuming pelleted seed. The Committee recognised that these risks had been determined on a conservative basis but that no higher tier data were available to refine the assessment.

3. In some soil types the highest concentrations of thiamethoxam and clothianidin in surface waters were assessed as adversely impacting populations of aquatic insects.

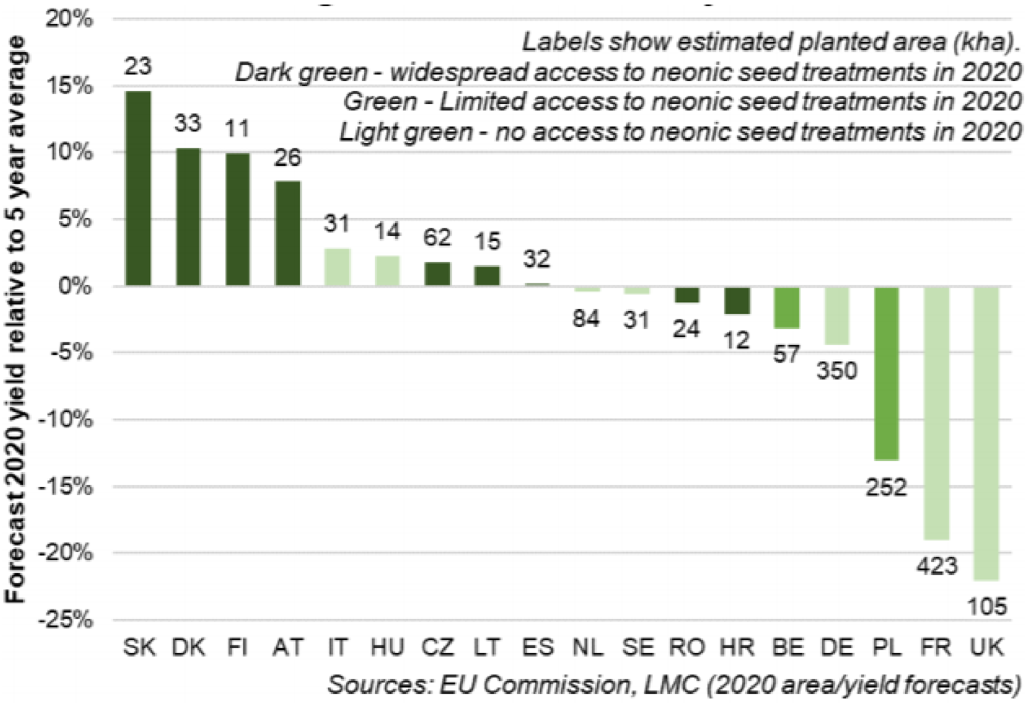
Sugar beet is an emerging alterative crop for Scotland and so impacts from elsewhere in the UK and in Europe could become more relevant to Scottish growers. Although the Committee recognised the importance of these seed treatments to sugar beet cultivation, the ECP advised that on the basis of the scientific evidence presented, particularly in relation to the potential degree of environmental risk, the case had not yet been made to grant an emergency authorisation for this use.

Consequentially the 2020 crop of sugar beet was the 2nd to be drilled without protection from virus yellows. In August 2020 year and ahead the 2021 sugar beet harvest, British Sugar has predicted a 15% drop in sugar beet yields nationally in view of the unquantifiable risk of yield loss from virus yellows. Notable that this forecast was made against a backdrop of yield improvements of 25% over the last ten years, aided by new seed varieties and the development work of the British Beet Research Organisation.

Considering the potential financial risk virus yellows could pose to growers, British Sugar and the National Farmers' Union's sugar board have negotiated new contracts from 2021, including a £12m virus yellows crop assurance fund and an innovative futures-linked contract pilot scheme[6]. The assurance fund will compensate growers for a proportion of yield losses from virus yellows disease, which has become an increasing concern since the ban on neonicotinoid seed treatments, previously used to protect the crop from virus-carrying aphids. Grower's losses will be compensated if they deliver less than 90% of their contracted tonnage, provided they meet certain conditions. British Sugar says it will pay 45% of the value of the shortfall, with the compensation payment capped at a 35% yield loss.

The scale of damage to beet crops from Virus Yellows is becoming clear. This is particularly evident in some of those countries with more maritime climates and milder winters but has also been impacted by aphid migration patterns. While poor weather conditions throughout spring and summer as well as assorted other issues, such as the fungus Cercospora, will no doubt also have played a part in this year's yields, there is a clear correlation with those countries that faced limited or no access to neonicotinoid seed treatments in 2020 also suffering the largest yield losses relative to average (Figure 5)[7].

*Figure 5. Forecast 2020 Sugar Beet Yields*




The relevance of current issues with neonicotinoids and the control of virus yellows, become very much greater when viewed in the context of national future ambitions. This may be illustrated in this case study on thoughts to develop the Scottish bioeconomy:

Diversity of cropping in rotations is integral to IPM and in addition local production of sugar beet for energy could aid renewable energy targets and reduce the use of fossil fuels. Details of a Rural Innovation Support Service (RISS) project, and commentary from partners is shown in Appendix 1. Couple this with the ambitions to develop Scottish enterprise, as in the example given, and an aligned, well informed policy on pesticide re-approvals and withdrawals gains greater merit and traction.

### *9.3.2 Diquat*

Diquat is a non-selective herbicide for use as a desiccant in barley, green beans, lentils, lucerne, peas, red clover, soya beans, wheat and white clover, haulm destruction in potatoes, and aquatic weed control.

Since the 1960's, diquat has played an important role in the rapid desiccation of potato haulm, to enable cost-effective harvesting of disease-free and damage-free tubers. In October 2018, following successive 'no opinion' votes by Standing Committees and an Appeal Committee on the re-approval of diquat, the Commission was handed power to adopt its proposed non-renewal. This it did, and in consequence diquat could no longer be used after 4 February 2020. In the UK, the Chemicals Regulation Division of the Health and Safety Executive gave a date for diquat products to be withdrawn from the market by 31 July 2019, with a use-up period for growers up to 4 February 2020. The 2019 growing crop would, therefore, provide the final opportunity to trial alternative desiccation options on farm before the 2020 season whereupon diquat could no longer be applied to crops.

The withdrawal of diquat and the absence of like-for-like herbicide replacements available on the market poses a real challenge to growers because of its use as a desiccant as well as an herbicide. Potato haulm destruction, which is usually carried out by chemical desiccation, plays a crucial pre-harvest role as it stops the tubers bulking and allows their skins to set. It also reduces the risk of bacteria, fungus and viruses getting into the crop.

AHDB-funded research, led by Dr Mark Stalham, Head of NIAB CUF, used the 2019 growing season at sites in Lincolnshire, Suffolk and Dundee to trial alternative defoliation techniques[9].

The two active ingredients currently approved for desiccation in the absence of diquat are both protoporphyrinogen oxidase inhibitors (PPOs); Gozai (pyraflufen-ethyl) and Spotlight Plus (carfentrazone-ethyl) which have previously had a role primarily as stem desiccants.

Their performance was evaluated in different sequences alongside the unapproved alternatives, Finalsan (pelargonic acid) and Saltex (brine product) and compared with diquat and undefoliated control treatments. Diquat performed as expected and was the most effective chemical in removing leaves. Saltex was as effective as diquat under hotter, brighter conditions and there was rapid leaf wilting in most experiments. Spotlight and Gozai were both similar in terms of leaf kill, but in general these PPP products (applied individually or in combination) were 2-4 days slower in killing leaves than diquat.

The practical recommendations from the trials cited decision making processes centred on temperature when applying PPOs, soil moisture at the time of desiccation, variety choice and nitrogen management as being critical elements.

As Scottish growers contemplate their options, many have moved to a flail and spray system (flail distributors report shortages in supply, December 2020) because neither PPOs is as effective as diquat at removing the foliage[9]. Mechanical flailing using tractor-mounted flails was included in the research to investigate performance and a hand-simulated haulm puller was applied to the seed experiments to mimic commercial practice.

Re-growth and compaction from additional wheeling's were highlighted as two of the problems often associated with flail operations and there was significant soil compaction in the wheeled furrows and edges of ridges following flailing, particularly on the silty clay loam soils. Not being able to travel on wet soils at the optimum time for the crop and spray efficacy will be an issue for Scottish growers. The level of compaction observed would increase the risk of bruising at harvest owing to clods and green tuber numbers. Another problem of flailing is the potential spread of the blackleg pathogen *Pectobacterium*, both within and between fields, and its subsequent contamination of potato tubers (with important consequences for seed production).

Using the Gozai and Spotlight sequence works out at 151% higher cost than using diquat alone. If growers are moving to a flail and spray system from a diquat-alone system, then for a two or three-section flail and Spotlight, growers will see a 205% or 211% increase in their costs respectively. If the grower already uses a flail to top the haulm and continues to use in combination with a PPO inhibitor, then the cost increase is less significant – the region of 13 – 15% (Table 1).

Ultimately the regime growers will use will depend on their circumstances and the market for the crop. Diquat gave more reliable desiccation than Spotlight/Gozai combinations and, because of the risk associated with relying totally on PPO inhibitors, many growers will use flail followed by spray, even when the soil is wet.

*Table 1 Cost comparison of potato haulm destruction techniques 2019 (per M. Stalham, May 2020[9])*

| **Cost (£/ha)** | **Diquat only** | **2 section flail and diquat** | **3 section flail and diquat** | **2 section flail and Spotlight** | **3 section flail and Spotlight** | **Gozai and spotlight** |
|---|---|---|---|---|---|---|
| **Chemicals** | 28 | 18 | 18 | 38 | 38 | 100 |
| **Application** | 30 | 15 | 15 | 15 | 15 | 45 |
| **Flailing** | | 124 | 127 | 124 | 127 | |
| **Total** | 58 | 156 | 160 | 177 | 180 | 145 |
| Cost difference to diquat only | | | | **119** | **122** | **87** |
| Cost difference to 2 or 3 flail plus diquat | | | | 21 | 20 | -11 |

Data collated and presented by Scottish National Statistics for the 2018 cropping year illustrated that diquat was applied to 74% of the 12,091ha grown for seed, and 85% of the 15,268ha grown for ware[10].

Of the 27,400ha grown in total therefore, in the region of 21,900ha received diquat as a pre-emergence herbicide and/or haulm desiccant. Based on the AHDB cost analysis, the sector usage of diquat and its application totalled £1.2 Million in 2018 and in the absence on diquat, the increases in costs are significant; adopting the flailing of haulm in association with permitted desiccants would increase the annual spend in Scotland to £3.9 Million. In the absence of flailing, the use of permitted desiccant chemistry alone, would increase spend to £3.2 Million.

Further negative impacts as a result of flailing would increase the likelihood of greater soil compaction, increase GHG emissions (resulting from increased machinery use) and invoke a gross margin 'foregone' on uncropped headland areas, potentially accounting for 12% of field area. By self-calculation, this last point alone has a potential to lose the Scottish industry £6.5M in gross margin value.

The Scottish pea vining sector, conversely, has greater concerns over the future potential loss of seed treatments (e.g. Wakil XL used to manage seed-borne disease) than it does over the loss of diquat. In the event of a missed harvest opportunity and due to the relatively low growing costs, growers favour incorporation of a poor-quality crop rather than desiccating in order to facilitate alternative crop uses.

In addition, the absence of diquat as an aid to crop management will make growers concerned in the future about growing break crops of linseed or combinable peas, for example. Alternatives such as glyphosate or carfentrazone-ethyl may be slower acting or less consistent but will mitigate the loss to some degree. The use of glyphosate amongst interviewees was very much aligned with ease of combining and preserving germination quality on seed crops. Loss of crop diversity in the rotation is counterproductive to an industry encouraged to align itself with cultural controls and integrated pest management techniques.

### 9.3.3 Chlorpyrifos

The Chemicals Regulation Directorate revoked the authorisations in the UK for all commercial products containing chlorpyrifos-ethyl, such as Dursban WG and Equity, effective from 1st April 2016. The EU adopted the measures in January 2020, after the European Food Safety Authority continued to express concerns about possible genotoxic and neurological effects particularly in children. Widely used chlorpyrifos insecticides like Dursban WG and Equity have been used for decades to control a wide range of pests in arable crops, vegetables, soft fruit and grassland. The products help control pests such as aphids, caterpillars, wheat bulb fly, frit-fly and leatherjackets.

In the case study interviews, pyrethroids remain the principal form of insect control employed in terms of area treated. However, this was the only chemical group to see a decrease in use from 2017, as recorded in the 2019 Scottish Pesticide Use on Vegetable Crops Survey. In these vegetable crops the use of insecticides with other modes of action (spinosad, pymetrozine, indoxacarb, spirotetramat and flonicamid) all increased. This is likely to be related to the pyrethroid resistance status of several target species. One noted increase is in the active substance spinosad, which is one of the few options remaining for the treatment of cabbage root fly after the application of chlorpyriphos was restricted to use in propagation areas[11].

Following behind these is a new insecticide product –– coded BAS480 BCI –– for the reduction in wireworm damage in potatoes, with approval anticipated towards the end of 2022[12]. It is a biological active containing *Beauveria bassiana* formulated with an attractant bait in a granular form and will be applied at a rate of 10kg/ha, *Beauveria bassiana* is an entomopathogenic fungus which can infect a number of arthropod pest species. Coniodospores of the fungus attach to the insect's cuticle and then germinate producing penetrating hyphae, which enter and proliferate inside the insect's body. The fungus then feeds on its host which will become progressively more dehydrated and/or depleted of nutrients, leading to its demise. In trials the damage from wireworm has been reduced by around 50% and the coded product has been performing with efficacy close to that seen with the previously available wireworm treatment, ethoprophos (Mocap). Biological actives are complicated to make and distribute so higher cost can be anticipated.

Losses arising from the withdrawal of chlorpyrifos in spring barley were estimated at 0.5% of Scottish GVA by Evans, A. (2020) Potential impacts arising from pesticide withdrawals to Scotland's plant health (Report PHC2018_15) giving an upper bound value of £1.37M. Actual losses are likely to be substantially lower as damage to spring barley crops from leatherjacket grazing can be partially alleviated by avoiding fields just out of grass, by surveying field populations and selecting lower risk situations, and by rolling crops although this latter option can lead to soil capping and emergence problems.

Gains from new non-chemical options like those above could be negated by anticipated increased pest pressures arising from climate change, with thrips becoming a bigger issue on onion crops for example. As conventional crop protection products are lost and new approvals become more difficult, it is often minor horticultural crops which are hardest hit. Onions for example are impacted by the withdrawal of linuron, as noted in the section below. In the amenity grass sector, nematodes have been used to manage chafer grubs and leatherjackets. Each of the two nematode species used, *Heterorhabditis bacteriophora* for chafer grubs and *Steinernema feltiae* for leatherjackets, can be applied at the same time and do not disrupt each other. Both species are native to Britain, have been used effectively for many years, don't require any specific Personal Protective Equipment, are persistent in the soil for long-term control and are safe for users and the environment.

The nematodes are natural predators of the two grub species. When purchased, they are produced to be at an infective juvenile stage, maintained in this state by refrigeration. Once applied, they warm up and move through the soil solution, their objective being to locate and enter a suitable host, either through the skin or orifices. They then release a symbiotic bacterium which kills the host, usually within 24-48 hours. As noted for other non-chemical options, this is a more costly option and less reliable than chlorpyrifphos which is tolerated in the amenity sector.

### *9.3.4 Linuron*

The decision not to renew approvals for linuron meant disposal, storage and use of stocks had to be complete by June 2018.

The agronomic challenges facing carrot and onion growers have not changed, against a backdrop of product revocations and regulatory hurdles, the loss of linuron had a big impact on these crops, leaving some key challenges with nettle, mayweed and volunteer potato control. Linuron had been a key component of herbicide programs along with pendimethalin, prosulfocarb, metobromuron and metribuzin. It formed the basis of commercial programs and was used in a tank mix both pre- and post-emergence, to complement the weed control spectrums of the other actives. The case study interviews show that, with linuron withdrawn this leaves growers with only pendimethalin and clomazone for pre-emergence weed control; in fact, pendimethalin was the most used active substance by weight in 2019 in the Scottish Pesticide Use Survey on Vegetable Crops, with total weight applied increasing 16 per cent since 2017. In addition, the changes to the approval for prosulfocarb have also made weed control more difficult with the useful later post-emergence applications no longer being permitted.

In the UK, Bayer has increased the crop protection options available for carrots and onions with products including the herbicide aclonifen. There are three EAMUs covering aclonifen use in carrots, parsnips, root parsley, garlic, onion, shallot, caraway, dill and parsley which permit one pre-emergence treatment at a maximum individual dose of 1.75 L/ha.

They were sought by the AHDB EAMU programme following good results in SCEPTREplus trials. So far, the AHDB-funded SCEPTREplus project, which aims to identify sustainable plant protection products for use in horticultural crops, has evaluated 200 conventional products, as well as 40 biopesticides, botanicals, biologicals or basic substances. A number of products identified are however on the margins of crop safety, and further work is required to understand and guide growers on how they can be used effectively to avoid commercially unacceptable levels of crop damage[13].

The SCEPTREplus programme continues to deliver new EAMUs to help plug gaps in our crop protection armoury. It aims to deliver applied research on high priority disease, pest and weed problems in fresh produce and ornamental crops in order to support approval of products and devise and develop IPM programmes.

Linuron had been a mainstay of potato production for the past 25 years, with 62% of ware crops receiving treatment according to the Pesticide Usage Survey 2016 and 48% in 2014. With the loss of linuron (and diquat), together with likely restrictions on dose rate for a number of other actives, Scottish stakeholders interviewed identified that weed control in potatoes has also changed and will continue to change dramatically. In the future, it will be more complicated with more complex tank mixes and will force growers towards greater use of residual herbicides at the early post-planting stage. The loss of diquat means earlier herbicide application with spraying advocated at seven to ten days after planting, once ridges are settled. Contact sprays, such as Gozai (pyraflufen-ethyl) or Shark (carfentrazone-ethyl), are limited to no more than 10% emerged; any later and the growth will be seriously checked. This is a complete change in strategy because diquat could be applied much later, at up to 40% crop emergence. Residual herbicides still remain the best means of post-planting weed control and the most cost-effective are metribuzin, aclonifen and prosulfocarb. Aclonifen is not a replacement for the higher rates of linuron but, of the recent introductions, it has the best spectrum of control and is more cost effective. Aclonifen is a new herbicide from Bayer which is a residual with a different mode of action. As the weed emerges through the soil surface it picks up the active substance on its hypocotyl (in broadleaf weeds) or coleoptile (in grasses). Aclonifen's best attribute is that take-up by the weed is less constrained by soil moisture than with other residuals. It is also probably the best product for control of black bindweed, although post-emergence treatments will still be required in several situations.

A new herbicide product (coded BAS656) contains dimethenamid-P and is also very close to emerging from the pipeline, with its arrival anticipated in 2021[14].

## *9.4 Conclusions from case studies*

The case studies show that, following the loss in chemicals, alternative chemical options were the main adaptation made, where these were available (Table 2). These mitigated upper bound total loss estimates, although they commonly carried additional costs compared to the withdrawn options. Upper and lower estimates of total loss estimates from a withdrawal varied widely by active, and in some cases such as diquat they were very significant. Issues with lower efficacy with the alternative chemistry used and with pesticide resistance were commonly cited in interviews. Moreover, the case studies illustrate the possible future threats for certain Scottish agricultural sectors in light of the outcomes already experienced elsewhere.

*Table 2. Main adaptations made or anticipated by Scottish growers and agronomists.*

| Active ingredient | Main adaptation and comment |
|---|---|
| Clothianidin & Thiamethoxam | Pyrethroid sprays, to which widespread resistance. Multi-sector disruption (oilseed rape, sugar beet) evidenced south of the border, requiring support interventions in a de-stabilised market, more susceptible to global price volatility impacts. Calls for adaptation of current legislation to help mitigate disruption. Pressures currently low in Scotland but expected to increase. |
| Clorpyrifos | Pyrethroid sprays but with increasing uptake of other chemical control options, largely due to issues with pyrethroid resistance. Non-chemical options more suited to amenity sector and controlled environment crops than field scale agriculture because of cost and scalability. Levy payers funding targeted to IPM alternatives although development timescales required are leaving industry devoid of short-term solutions |
| Diquat | Flailing widely adopted as an alternative option in potatoes resulting in significant extra cost, increased operational emissions, a higher percentage of in-field area uncropped, possible spread of bacterial diseases and increased damage to soils and tubers. Pre-emergence herbicide alternatives invoke significant higher input cost and reduced application flexibility. Absence of a rapid contact desiccant may disincentivise growers of seed crops, pulses, and legumes as rotational options to the detriment of integrated farm management principles, although this has not yet translated into reduced planting areas which should be monitored going forward. |

| | |
|---|---|
| Linuron | Alternative chemical options, with lower efficacy than linuron and carrying a greater risk of crop damage with narrower application opportunities. An example of where a rapid withdrawal exposes industry to loss ahead of new product evolution. |

The advantage to be gained in observing issues experienced elsewhere is particularly the case regarding neonicotinoids. The failure to control cabbage stem flea beetle in oilseed rape in England, for example, has challenged its financial viability as a break crop at a time when diversity in rotations is being promoted by government. Such has been the yield loss that the UK, once a net exporter is now a net importer, and has a crush capacity that is no longer fulfilled from domestic supply. Subsequently, the country has become less resilient to price volatility.

Understanding trade-offs and unintended consequences of a change in agricultural practice will be crucial in safeguarding the Scottish and UK food systems from production shocks as global connectivity in food trade increases.

On a European scale the loss of neonicotinoids has proved to be the precursor not only to revenue losses and additional production costs, but also to habitat loss (as a result of land use substitution), increased GHG emissions, upstream and downstream industry losses and additional resource (water) consumption. Adapted practices are possible, however, and on a European scale a review in 2019 concluded that the most common alternative to neonicotinoids (89% of cases) was the use of another chemical insecticide (mostly pyrethroids)[15]. This was very similar to the feedback from those interviewed for this report, where pyrethroids were the primary alternative used. However, the European study also identifies that in 78% of cases, at least one non-chemical alternative method could replace neonicotinoids (e.g. microorganisms, semiochemicals or surface coatings). Nonchemical options (for the neonicotinoids and the other case study examples) mitigate some predicted yield losses but are less predictable in their actions and are a more costly alternative and, as evident from interviews, they are not yet available at the scale needed.

The sugar beet industry, hit by virus yellows in the two years post ban, has seen yields decline against a backdrop of prior, year on year improvements over the last decade, aided by new seed varieties and the development work of the British Beet Research Organisation. In both the above cases, such has been the magnitude of change, evidence is now emerging that representational organisations are starting to put financial mechanisms in place to underwrite potential losses as a direct result of the consequences of pesticide withdrawals and are seeking government assistance.

In a similar vein, future investments, for example in the development of Scotland's bioeconomy, must have available consultation opportunities not only with the ongoing pesticide review agenda, but also with legislative guidance such as the Water Framework Directive and the Environment Strategy for Scotland.

The loss of diquat and linuron have a relevance to Scotland in view of the importance of the potato crop. The widespread adoption of haulm flailing as an alternative route to desiccation in response to the ban, has undermined policy ambitions toward carbon neutrality, reductions in GHG emissions, soil structure improvements and efficient land use. Assisted permitted chemical alternatives have reduced efficacy compared to diquat and linuron and presented a greater risk of crop damage and invoked a greater cost to the grower.

There is ample evidence of grower levy funds being channelled into developing Integrated Pest Management (IPM) techniques albeit on timescales that have proved reactive rather than proactive. There are still issues around the complexity of IPM and the scalability of biological interventions that are currently used in controlled environments to their usage in fields and in large scale agricultural practice.

The impacts arising from pesticide withdrawals in the UK also have a global context. Corteva's insecticide chlorpyrifos has been banned in several U.S. states, Europe and four other countries, but production and use continue in, for example, Russia and China. Whilst in the UK its loss has been mitigated to a degree by alternative insecticide use, cultural and biological controls, residues of chlorpyrifos continue to be detected on foods imported into the country. This highlights the importance of future policy in protecting the UK standards of production from cheaper imported goods.

# 10 Appendices

## *10.1 Sugar beet as an emerging alternative Scottish crop – comment from partners in a RISS Scottish Sugar Beets project*

Almost 50 years on from the closure of the Scottish Sugar Beet factory in Cupar, a Rural Innovation Support Service (Scottish Government funded) project with a group of local growers aims to investigate the feasibility of re-establishing the crop in eastern Scotland. However, this time around, the aim is for the crop to contribute to climate change mitigation by producing bioethanol as a fuel additive as well as new plant-based biotech products, rather than sugar for human consumption.

Last summer a report by the National Non-Food Crops Centre[8] identified that a refinery would need up to 20,000ha of sugar beet from arable land of class 3.1 or better within a 30-60-mile radius of the refinery plants location and the RISS projects aims to help local growers meet the technical challenges associated with meeting that demand.

Prof. Derek Stewart, agri-food business sector lead at The James Hutton Institute, said it was an "exciting opportunity" for the Scottish Bioeconomy. "Scottish farming is progressive, and the resurrection of sugar beet production could both diversify farm incomes whilst helping to deliver to the Scottish Climate Change targets. Iain Riddell from SAC Consulting, who facilitated the group, said "The feasibility of re-establishing the growing and processing of the crop in Scotland has brought together stakeholders with the will, the knowledge and the capability to make that vision reality. A resurrected crop and a new refinery could offer a huge opportunity for agriculture to contribute to $CO^2$ reduction and in the creation of new plant-derived products but farmers will also have to factor in the feasibility, risk and reward of growing a crop that is new to most of them. We have experience of producing the closely related energy beet crops for AD and the growing of fodder beet for livestock, and it should be possible to grow sugar beet, but comprehensive trials will be required to assess yield, sugar content and hardiness of modern varieties in Scottish conditions. We'd see the opportunity best suited to the better arable land in Angus, Fife and Perth and Kinross, potentially extending into the Lothians and Aberdeenshire, all depending on the refinery's location."

Project collaborators included Scottish Enterprise, The James Hutton Institute, SAOS and IBioIC (the Industrial Biotechnology Innovation Centre), and farmers will have a chance to join in shortly through the Rural Innovation Support Service (RISS) project

Ian Archer, technical director at Industrial Biotechnology Innovation Centre, said: "Biotechnology is the technology that underpins the bio-economy enabling the creation of new products and new processes to replace those we currently make from fossil-based resources. We currently import all the bioethanol blended into forecourt petrol from England and France.

Initially, Scottish sugar beet can be used as a raw material to provide a secure source of Scottish bioethanol from a local supply chain. In time, the supply chain around the production of industrial-grade sugar syrup from sugar beet will draw high-value manufacturing companies and entrepreneurs to Scotland to set up new facilities that use biotechnology to produce materials, medicines and other everyday products from this sustainable natural resource. Successfully reinstating a local source of sugar beet will enable the biotechnology sector to flourish in Scotland and with it, contribute to a just transition to a low carbon economy."

Details of the project are available on the RISS website:-

https://www.innovativefarmers.org/welcometoriss/current-riss-groups/

As with other sections of this report, while the impact of neonicotinoids on sugar beet has, at present, lower impact for Scottish growers, it is reasonable to assume these impacts will increase as the crop acreage in Scotland increases and also as pest pressures increase with a warming climate. This could limit future profitability of the sugar beet crop in Scotland and in addition limit the impact it could have in IPM programmes by broadening Scottish rotational choices.

## *10.2 Abbreviations used*

| | |
|---|---|
| AHDB | Agricultural & Horticultural Development Board |
| CSFB | Cabbage Stem Flea Beetle |
| DEFRA | Department Environment Food & Rural Affairs |
| EAMU | Extension of Authorisation for Minor Use |
| ECP | The UK Expert Committee on Pesticides |
| EU | European Union |
| GB | Great Britain |
| GHG | Greenhouse Gas |
| HSE | Health & Safety Executive |
| | |
| IPM | Integrated Pest Management |
| NFU | National Farmers Union |
| PPP | Plant protection products |
| PPO | Protoporphyrinogen oxidase inhibitors |
| REACH | Registration, Evaluation, Authorisation & Testing and Restriction of Chemicals |
| RISS | Rural Innovation & Support Service |
| SAOS | Scottish Agricultural Organisation Society |
| UK | United Kingdom |

## *10.3 Financial assumptions*

Costing assumptions (Per Mark Tofcliff, AHDB https://ahdb.org.uk/news/the-cost-of-desiccation-without-diquat)

| **Active ingredient / example product** | **Price** | **Additional notes** |
|---|---|---|
| Diquat | £7/litre | |
| Pyraflufen-ethyl (Gozai) | £36/litre | 0.8 litres per ha application rate |
| Carfentrazone-ethyl (Spotlight Plus | £38/litre | 1 litre per ha application rate |
| MSO wetting agent | £3/litre | |
| Spraying cost | £15/litre | Labour, fuel. Water. Repairs & depreciation |
| Flail – 2 section | £35,000 | 2 ha/hour work rate |
| Flail – 3 section | | 1.5 ha/hour work rate |
| Tractor driver – cost to employer | £11.50 /hour | |
| Diesel | £0.62/litre | 8 litre per hour fuel consumption |

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