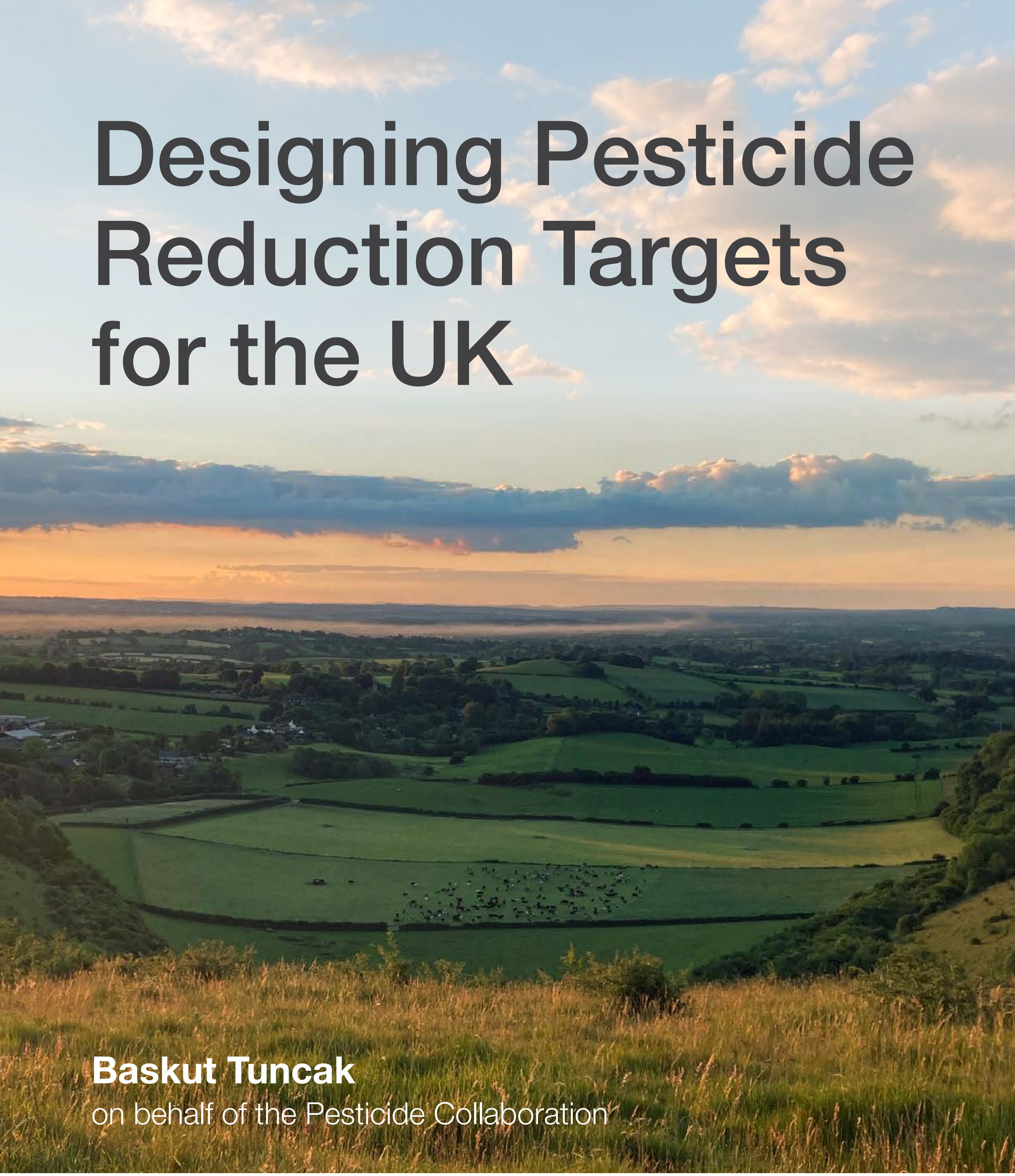

Designing Pesticide Reduction Targets for the UK

Baskut Tuncak
on behalf of the Pesticide Collaboration

THE PESTICIDE COLLABORATION

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ACRONYMS

BCF	Bioconcentration Factors
BTSF	Better Training for Safer Foods
ECP	Expert Committee on Pesticides
EDC	Endocrine Disrupting Chemicals
ELMS	Environmental Land Management Schemes
EPA	Environmental Protection Agency (US)
ETR	Exposure Toxicity Ratios
EYP	Environmental Yardstick for Pesticides
FAO	Food and Agriculture Organization
GHS	Globally Harmonised System
HHP	Highly Hazardous Pesticides
HRI	Harmonised Risk Indicators
HSE	Health and Safety Executive
IARC	International Agency for Research on Cancer
IPM	Integrated Pest Management
NAP	National Action Plan [for the Sustainable Use of Pesticides]
ODS	Ozone Depleting Substances
OECD	Organisation for Economic Co-operation and Development
OEP	Office for Environmental Protection
PAN	Pesticide Action Network
PEC	Predicted Environmental Concentrations
PIC	Prior Informed Consent
PL	Pesticide Load
PLI	Pesticide Load Indicator
POP	Persistent Organic Pollutants
PPP	Plant Protection Product
PRI	Pesticide Risk Indicator
PRTR	Pollutant Release and Transfer Registers
PUR	Pesticide Use Reduction
PURP	Pesticide Use Reduction Plan
PUSSTATS	Pesticide Use Survey Statistics
SUD	Sustainable Use Directive
TFI	Treatment Frequency Index
TRI	Toxics Release Inventory
TUR	Toxics Use Reduction
TURA	Toxics Use Reduction Act
TURP	Toxics Use Reduction Planner
WHO	World Health Organisation

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EXECUTIVE SUMMARY

By The Pesticide Collaboration

Background

Pesticides are used in large quantities across the UK, and for a variety of purposes. By far the most widespread of these is in agriculture, with 40 million hectares treated in 2020 and an average of 13.5 different active substances applied to arable crops. An intensification of agriculture post World War II focused on increasing yield at all costs and this has, over time, created a farming system locked in to high levels of pesticide use.

There is widespread agreement in scientific literature that pesticides are a major contributing factor to wildlife declines on and around farmland, as well as insect declines around the world. There is also an increasing amount of compelling evidence that pesticides are having negative, long-term impacts on human health, helping to drive rises in chronic diseases such as cancers and neurological illnesses including Parkinson's.

Pesticides are designed to kill unwanted organisms, but they are rarely specific to their target species and many pesticides persist for a long time, for example in soil and water. Although individual active substances are tested before they are approved, there are several fundamental gaps in this process that mean that real-world impacts are not captured in their entirety. The approvals process also does not take account of the so-called 'cocktail effect' – in other words the impact on humans, wildlife and the landscape more broadly of being exposed to multiple different chemicals over an extended period of time.

The drive for a reduction in harms from pesticide use

The UK Government committed to "reducing the environmental impact of pesticides" in its 25-year Environment Plan published in 2018.

In 2019, the UK Government consulted on a draft updated National Action Plan for the Sustainable Use of Pesticides (NAP) where its stated aim was to "minimise the risks and impacts of pesticides to human health and the environment, while ensuring pests and pesticide resistance are managed effectively." The draft also committed to "establish[ing] a set of clear targets to support the reduction of risk associated with pesticide use by the end of 2022". However, at the time of publishing this report in December 2022, not only are targets seemingly nowhere near being set, the final version of the NAP itself has still not been published.

Under the Environment Act 2021, the Government has also agreed to a legally binding target for species abundance for 2030, aiming to halt the decline of nature. Although the detail of the interim targets that will support this apex target is still to be published, the evidence pack to support its development acknowledges that "a reduction in the use of pesticides [and critical loads of atmospheric nitrogen] is deemed critically important".

More and more farmers are choosing to move away from high levels of pesticide use, and are finding more nature-friendly ways to manage pests and diseases on their farm. These farmers are, more often than not, finding that their profits are improved by these approaches, due to the reduced costs of inputs combined with improvements in soil health and increases in beneficial biodiversity on their farms[1].

The benefits of Pesticide Reduction Targets

Setting a suite of measurable reduction targets to minimise the harm caused by pesticides brings a wide range of benefits.

It sends a clear message from Government that reversing nature's decline and protecting human health are priorities. The Government has already implied numerous times, including through the examples given above, that it believes reducing the impact of pesticides is important. However, without reduction targets there is no over-arching framework to either drive or measure progress towards this ambition.

Setting a clear direction of travel is important to drive innovation, focus attention on safer and more sustainable alternatives, and to provide reassurance to farmers and other pesticide users that they will receive support to enable them to contribute towards meeting reduction targets.

Setting measurable targets makes it easier to quantify how pesticide reduction can contribute towards other legally binding targets, such as the species abundance target and net zero.

Across Europe many countries have attempted to set pesticide reduction targets, with varying outcomes and degrees of success. We have the opportunity to benefit from their experience and set realistic and ambitious targets designed for the UK context.

Of course, targets and indicators alone are unlikely to be sufficient to reach their objectives. Supporting systems must be established, including research and development, as well as systems for the deployment and adoption of safer alternatives. Farmers and other users will require financial, technical, political and consumer support to ensure that more sustainable solutions are adopted.

Pesticide Reduction Targets in the UK

This report details the experiences of other countries that have set pesticide reduction targets and sets out the Pesticide Collaboration's recommendations for the kind of targets the UK should adopt.

The report highlights the inadequacies of existing pesticide usage data as a major barrier to both setting and measuring progress towards UK pesticide reduction targets. Current pesticide usage survey data, published on the PUSSTATS website, has a time lag, fails to adequately cover some of the key types of pesticide use (e.g. amenity and amateur use), doesn't provide information in sufficient geographical detail, relies on self-reporting, only identifies individual active substances and classes of pesticide, and does not provide information on product usage. Ideally these issues will be improved over time, which would enable tightening up of targets.

While the UK overcomes these challenges, we propose that a Pesticide Use Reduction (PUR) Program is set up to enable the monitoring of pesticide use. This is based on key learnings and reflections from the positive experiences of the Toxics Use Reduction (TUR) approach in the US, as described in the report.

The proposal for a set of reduction targets aims to:

i. Create simple, generic and long-term policy goals while maintaining flexibility in policy tools and measures;
ii. Establish a framework based on clear and tangible policy goals that include transparent assessment and monitoring procedures for risks;
iii. Overcome regrettable substitution by having joint goals of food production, environmental protection, biodiversity and human health, avoiding siloed solutions; and
iv. Establish a supporting mechanism of both monitoring and innovation to ensure risk reduction can be measured accurately – and ensure more sustainable solutions are adopted by farmers and consumers alike.

Table 1 suggests how the targets may be structured based on broad classes of substances that is both holistic and clear. It suggests that a combination of both class-based targets and targets for individual substances could be used.

Table 1: Model of a class-based targets for pesticide-use reduction

	Class	Target for 2030	Examples of substances
1	**Acutely toxic pesticides** • WHO Class 1 a; • WHO Class 1 b; or • GHS H330	Eliminate use	Abamectin Aluminum phosphide
2	**Chronic health hazard**, including: • IARC known or probable, • EPA known or likely probable carcinogen, • EU GHS Group 1 CMR • EU EDC (known/probable) or Carcinogen Group 2 AND Reprotox. Group 2	Reduce use by at least 50% overall, without increasing the use of any pesticide listed for reduction.	Carbetamide Glyphosate Mancozeb
3	**Environmental hazard**, including (see e.g. PAN HHP list for definitions): • Very bio-accumulative • Very persistent in water, soils or sediments • Very toxic to aquatic organisms • Highly toxic to bees	Reduce use by at least 50%, without increasing the use of any pesticide listed for reduction.	Cypermethrin
4	**Internationally banned, restricted or otherwise listed** • Stockholm Convention on POPs • Montreal Protocol • Rotterdam Convention • Other related conventions	Eliminate use	Carbetamide
5	**Pesticides that were not registered for use in the UK before 1 Jan 2021 but registered for use in other jurisdictions and do not meet any of the above criteria**.	Eliminate use	Paraquat
6	**Substances that have an equivalent level of concern**	Case-by-case basis	Case-by-case basis

In addition to the hazard-based classes for Pesticide Use Reduction, indirect but quantifiable targets may also be considered, as they may create incentives and provide a vision that is consistent with public values and objectives.

Examples of targets to help advance Pesticide Use Reduction could include:

- Percentage of farms adopting Integrated Pest Management (IPM) or organic standards in new environmental land management schemes (ELMS in England)
- Change in approvals for bio-controls to speed up the process
- Number of farms/facilities that exceed the UK pesticide use reduction targets
- Percentage of UK farmland largely organic (or certified organic)

Key Recommendations:

Designing Pesticide Reduction Targets

- Urgently develop and adopt measurable pesticide reduction targets along with indicators to track progress. Targets should be:
  - » Outcome-based and clearly defined and measurable
  - » Aimed at reducing both pesticide use and pesticide-related harms
- Given the current UK's lack of accessible and standardised data, reduction targets should initially be based on internationally recognised hazard classes (see table 1 for full list). Recommended targets include:
  - » By 2030, eliminate use of all acutely toxic pesticides
  - » By 2030, reduce the use of pesticides that pose a chronic health hazard by 50%
  - » By 2030, reduce the use of pesticides that pose an environmental hazard by 50%
- The UK should keep pace or exceed regional (EU) pesticide reduction targets
  - » 50% reduction in use and risk of all chemical pesticides and
  - » 50% reduction in the use of highly hazardous pesticides by 2030
- Develop appropriate complimentary targets to track the uptake of Integrated Pest Management (IPM) and other measures that support a reduction in pesticide use. This includes but is not limited to:
  - » Percentage of farms adopting IPM standard as part of ELMS (in England). To ensure this is leading to meaningful impact, actual pesticide use must be monitored on farms who are within the IPM standard to ensure the actions are leading to a reduction in pesticide use
  - » Percentage of farmland certified organic
  - » Systematically substitute hazardous pesticides with safer alternatives, ideally non-chemical methods wherever possible
  - » Set a target for public procurement such as 50% of food purchased for the public sector grown organically
- Include targets as part of a Pesticide Use Reduction Programme, (see table 4 for full detail). This should include:
  - » A living list of pesticide active substances subject to reduction in the UK, established and guided by the Expert Committee on Pesticides (ECP), initially based on hazard classes.
  - » Require farms and other professional users to periodically report all use of pesticides subject to reduction. Data should be publicly available.
  - » Reporting of sales data for pesticide products annually in a publicly accessible and comparable format.
  - » Require farms and other professional pesticide users to develop a Pesticide Use Reduction Plan (PURP) to identify opportunities to transition from the use of listed pesticides to safer alternatives. Where farmers already have a detailed IPM plan under ELMS (or any other farm subsidy, agri-environment scheme or certification scheme) a PURP would be included in their IPM plan.
  - » Defra should prioritise research, development and support for innovation for safer alternatives to pesticides listed for reduction.
  - » Defra should present a progress report to parliament annually, with the Office for Environmental Protection (OEP) responsible for scrutinising and ensuring the government meets its targets.

Supporting Pesticide Reduction Targets

- Make the data collected and published in PUSSTATS useable. All professional pesticide sales and use data should be reported, including:
  - » geographical level, ideally at field or district level
  - » reported in a standardised manner, including area applied, weight and volume
  - » published at least every six months
- Monitor and publish data on harms, including environmental and health impacts of pesticides, at a national level. This will require improved post-approvals monitoring of pesticide impacts.
- Work with the Department of Health and Social Care to better track and monitor the human health harms of pesticides and other chemicals in our environment
- Introduce a pesticide tax or levy, with full revenue reimbursed to support training and uptake of IPM and other pesticide reduction measures. Ensure that the levy amount is set such that those pesticides presenting the largest environmental or human health hazards, carry a substantially higher price.

1. LESSONS FROM EUROPEAN EFFORTS ON PESTICIDE USE REDUCTION TARGETS

Experiences from regional and national systems offer various insights as to how the UK may wish to create national targets and indicators for a reduction in pesticide use and harms.

1.1 Regional level

In 2009 the EU adopted the Sustainable Use Directive[2], focused on tackling pesticides:

> *"This Directive establishes a framework to achieve a sustainable use of pesticides by reducing the risks and impacts of pesticide use on human health and the environment and promoting the use of integrated pest management and of alternative approaches or techniques such as non-chemical alternatives to pesticides."*

To achieve the objective of the Sustainable Use Directive (SUD), each Member State's National Action Plan (NAP) was supposed to:

a. propose measurable goals, targets, and indicators to decrease the potential and proved effects of pesticide use on humans and the environment;
b. stimulate the expansion of Integrated Pest Management (IPM) and alternative approaches or methods to reduce reliance on pesticides.[3, 4]

In addition, Member States were required to report their experience and progress towards the targets over time.

Several NAP reviews found that only a few of countries identified useful targets and indicators (some of which are discussed in later sections).[3, 5, 6]

At the overall regional level, the European Commission observed that whilst the majority of Member States established comprehensive systems for the training and certification of operators and a range of measures for water protection and the safe handling and storage of pesticides, there were some key omissions:

- **Outcome-based targets** were needed as part of a longer-term strategy to reduce the risks and impacts of pesticide use.
- **Enforcement of IPM** was low, and there was limited evidence that IPM principles are systematically applied.[3]

Additional analysis was provided by the European Court of Auditors, who identified several trends regarding the EU system as a whole. Notably, the Court of Auditors "examined whether the Commission and Member States measured the risk and environmental impacts of PPP use and found that **data collected and made available was not sufficient to allow effective monitoring**. Available EU statistics on PPP **sales are aggregated at a too high level to be useful** and those on the agricultural use of PPP were not comparable." [7]

Additionally, in 2017 the Commission observed a lack of consistency in data collection on pesticide use across the EU. To address this, Harmonised Risk Indicators (HRI 1 and HRI 2) were established by the European Commission in 2019 to calculate trends of aggregated risks of pesticide use in agriculture across the region[8]. A harmonised risk indicator is a "hazard-based" approach[9], which estimates potential risks from pesticide use. The two HRIs set by the EU are calculated using:

1. Detailed, harmonised, and up-to-date statistics on sales and use of pesticides,[10] and;
2. Information on active substances, including categorisation, e.g. if they are "low risk" active substances, candidates for substitution, or other active substances.[11]

In order to calculate harmonised risk indicators to reflect the relative risk of using plant protection products (PPPs), (which contain different categories of approved and non-approved active substances), weighting factors are applied. HRI 1 measures the quantities of PPPs sold in Member States, and HRI 2 measures the number of emergency authorisations[3].

The European Commission included two pesticide reduction targets in the Farm to Fork Strategy in 2020. These targets aim for a 50% reduction in use and risk of all chemical pesticides and 50% reduction in the use of highly hazardous pesticides by 2030[12]. Target 1 is measured using HR1 based on a three-year baseline average, and target 2 will be measured using sales data of highly hazardous pesticides ('candidates for substitution'). The Farm to Fork Strategy is integrated as part of the EU Biodiversity strategy for 2030.

Summary at the regional level:

- Only a few countries identified useful targets and indicators
- Outcome-based targets were identified as a need
- Enforcement of IPM was low
- Data collected and made available was not sufficient to allow effective monitoring
- Pesticides sales data was aggregated at a too high level to be useful

The evolution of the EU approach to pesticide use reduction targets since 2009 highlights the importance of both quantifiable, outcome-based targets, and robust data collection systems.

A look at some of the national efforts can shed additional light on what the UK should consider in establishing its pesticide use reduction targets.

1.2 National targets and indicators

Following the 2009 EU Directive discussed above, many of the national targets and indicators proposed by States had notable weaknesses or were not ambitious enough[3,5,6]. Overall, National Action Plans seemed to have had minimal effect on creating a common or systematic approach to tackling the sustainability of pesticides across the EU, although the Harmonised Risk Indicators are viewed by some as a positive step forward[4].

Recent articles find that a direct comparison of efforts between Member States is challenging. "A direct assessment of policy targets proves difficult, as most European countries do not publish or monitor data on risks – or environmental and health impacts of utilised pesticides on a national level – which is a major weakness of current policies."[13] Although some articles conclude that National Action Plans have been largely ineffective in reducing pesticide use, this does not address how pesticide use may have increased *without* the direction of travel articulated in NAPs. Nevertheless, some lessons can be learned from national approaches.

Notably, no National Action Plan of EU Member States formally or explicitly identified good practices despite being obliged to identify them under the Sustainable Use Directive (SUD). The European Commission took the initiative to identify aspects that *could* have been described by Member States as good practices under the SUD. These include training, equipment, digital monitoring tools and restriction of use to professionals.

While the European Commission did not take the initiative to recommend good practices regarding pesticide use reduction targets and indicators, the efforts of several Member States were noted positively.

1.2.1 By country

Denmark

The European Commission identified Denmark as one of three countries that set "useful targets" [3].

Denmark established targets for:

- A 40% reduction in the Pesticide Load Indicator (PLI) and;
- A 40% reduction in Pesticide Load (PL) from substances of very high concern by the end of 2015, compared to 2011.

The Danish NAP defines the PLI as an indicator of the potential total load on health and the environment based on the environmental and health characteristics of pesticides based on sales data.

Denmark was also one of three countries that the European Commission identified as setting clearly defined, high-level, outcome-based targets. This 40% reduction corresponds to a target value of 1.96 for the PLI, which was approximately 3.25 in 2011, illustrating the quantitative nature of the Danish metric.

Whilst successful in achieving a 40% reduction (as measured by sales from 2011-15), efforts in Denmark resulted in a significant but lower reduction in use (28%) (as measured by spray records). One factor in this was the 'hoarding effect' – explained below. The Danish approach was grounded in the desire to ensure that more hazardous pesticides were priced higher, (with an accompanying tax), to protect water resources and for other reasons driven by culture and norms.

Denmark's experience illustrates the benefit of internalising costs associated with the intrinsic hazards of certain pesticides, which is enabled by their system of quantifying use. Danish Pesticide Load (PL) values contribute to risk-specific taxes applied to pesticide products and have an impact on the overall cost of these products[8]. Pesticides causing the highest load on human health and the environment are the most expensive[14]. Complementing these taxes are Denmark's Pesticide Research Program and targeted inspection efforts under its NAP.

Independent analyses of the evolution of the Danish tax scheme have identified the following lessons:

- Key drivers include the Danish **green tax reforms** of the 1990s and Danish cultural value for having untreated tap water from groundwater sources.
- A reimbursement mechanism (the **full revenue of the pesticide tax is reimbursed to the agricultural sector** – primarily through reduced land value tax) has eased resistance of farmers and agricultural organisations to the pesticide tax.
- The reform of the tax – **adjusting the amount for pesticides with largest environmental load to carry a substantially higher price levels** – was implemented to incentivise significant reduction in use, (as compared to earlier schemes).[15]

Danish authorities provided information in 2019 describing the role played by the tax scheme in promoting pesticide use reduction:

> *"An evaluation of the pesticide tax has been carried out, which shows that the tax has yielded the expected results as regards the use of substitute substances; that the objective of reducing pesticide impact by 40%, which is equivalent to a PBI (pesticide impact indicator) of 1.96 based on sales figures has been achieved; but that, according to the farmers' pesticide spraying records, there has been no corresponding decrease in pesticide use. The difference between the sales figures and the actual use results from, amongst other factors, the 'hoarding effect', which has persisted since the 2013 tax adjustment. In view of this uncertainty, coupled with the anticipated decrease in the number of pesticides as a result of the forthcoming re-consideration of several active substances in the EU, as well as the technological progress in that area, the parties to the Agreement have agreed to re-assess the objectives and the pesticide tax scheme in 2020, and, on that basis, to determine whether it is necessary to make any adjustments to the objectives and the pesticide tax. In particular, the parties to the Agreement wish to examine whether to promote new technologies (e.g. closed systems) and whether to adjust the pesticide tax."* [16]

Germany

The European Commission also identified that Germany had set "useful targets" [3]

Germany set national level targets "relat[ing] to the area of plant protection, operator protection, consumer protection and protection of the environment" with more specific targets and indicators for forestry, horticulture, home gardens and allotments, operator protection and food safety, amongst other uses. [17]

At the national level Germany established this environmental target:

- "by 2023, there must be a 30% reduction in the risks that using plant protection products entails for the environment (base: average value for 1996 – 2005)"

In 2017, the Commission reported that Germany had already met a 30% risk reduction target with respect to aquatic and non-target organisms compared to the 1996-2005 baseline.[18] This baseline is further back than Denmark's, and so could represent a more ambitious target, despite the lower figure.

In addition, Germany established targets to increase the update of "integrated plant protection". It set a target of **establishing guidelines for all crops and sectors by 2018, with 30% of agricultural land meeting these guidelines by 2021 and 50% by 2023**.[19] It also has a target of **20% of agricultural land to be organic**, which was reported to be only 6% as of 2018.[20] The German metric was criticised in the past for not considering risk to human health as part of its target scheme. The latest NAP provides that the adverse impacts to operators, workers, bystanders and residents must be "further reduced," however this is only quanitifed in terms of the provision of certain equipment, not health outcomes or substances linked to adverse health impacts[19].

A 2018 position paper by the German Environment Agency (UBA) provides a helpful critique of the previous German targets, although some of the points may now be outdated with subsequent revisions of the NAP and associated targets[21]. The UBA paper states in general that the "minimising use" requirement of the NAP has been ineffective due in large part to the lack of incentives, legal requirements, and effective monitoring. **Further, the paper notes the crucial role of clear policy targets, pointing to Denmark and France as good examples in this regard.** Financial support is repeatedly highlighted as critical component to success. For example, the authors note the need to "cushion" the economic costs to farmers.

France

The European Commission identied France as the third example of “useful targets” [3]. France set a target for:

- A 25% reduction in plant protection product (PPP) use by 2020, and
- A 50% reduction in use by 2025, compared to 2015.

France was also identifed by the European Commission as setting clear, high-level, outcome-based targets.

France was the only EU Member State to specify monitoring use of active substances of particular concern, setting targets for 53 specific substances.[22] France monitors the quantities of active substances classified as carcinogenic, mutagenic and toxic for reproduction that are sold each year.

France has sought 50% reduction in pesticide use for many years. In 2008, it established a 50% reduction target by 2018 if possible. While it was unsuccessful in reducing pesticide use, **it did spur important developments in research and demonstration farms**, as discussed below. In practice, pesticide use (based on sales) increased 5% from 2008-2014. Levels in 2019 and 2020 are approximately the same as levels in 2011, although they did decline from ~84,000,000 kg in 2018 to ~60,000,000 kg in 2019-20.[23]

Recognising this, the government has recently made certain structural adjustments, which indicate lessons learned (Ecophyto II+, the French NAP).[24] These include:

- **The value of a phased approach**. The first phase of the Ecophyto II+ plan aims for a 25% reduction by 2020 through mainstreaming and optimising currently available techniques. Then a reduction of 50% by 2025, based on far-reaching changes to production systems and sectors, supported by medium- and long-term policy determinants, and by scientific and technical advances.
- **Enabling innovation for safer alternatives**. Under Ecophyto II+, an emphasis is placed on scaling up positive results from previous efforts, including through technical assistance, financial support, a comprehensive research agenda, and certification schemes (for low PPP use), among others.
- **Comprehensive indicators based on use and sales**. The plan will be monitored at national level through the use of a set of indicators for use intensity (number of unit doses, treatment frequency index), quantity (amount of active substances sold), risk, impact, and changing practices. The indicators and targets in terms of results will be established by priority and/or by action under the Plan.
- Policy and governance. The **alignment and mainstreaming of the pesticide use reduction efforts under Ecophyto II+ with public health policies** is highlighted. While an inter-ministerial element existed under previous efforts, the Ecophyto II+ plan broadens the composition of the strategic orientation and monitoring committee, to more explicitly include human health.
- Finances, including **taxes**. Discussed further below, the levies imposed by the use of taxes have significantly increased funding available for the promotion and adoption of safer alternatives.

In several ways France has adopted measures similar in approach to Denmark. It has adopted indicators that are based on both treatment frequency and total load/risk for human health and the environment. France’s most recent plan is to be monitored at national level through the use of “**a set of indicators for use intensity (number of unit doses, treatment frequency index), quantity (amount of active substances sold), risk, impact, and changing practices**.” In addition, the French pollution levy (i.e. tax scheme) was also revised to “make it more effective and incentivised by **targeting the products which are most dangerous** to health and environment.” [24]

National level observations:

- A major weakness of many national policies is lack of published data on pesticide risks, environmental and health impacts
- Identifying and setting targets for good practices has been identified as important
- Clearly defined, high-level, outcome-based targets have been identified as particularly effective
- Internalising the costs associated with hazardous pesticides can be a welcome intervention, when the cost is reinvested into IPM and pesticide reduction research
- Even when targets have not been reached, there is evidence it has directly spurred action to find alternatives and solutions.

1.2.2 By type of indicator

<u>Generic quantitative indicators</u> [3,5,6,8,25]

Treatment Frequency Index
Before the PLI, **Denmark** introduced treatment frequency index (TFI) in 1986 which is calculated as total number of active substances, or pesticide applications, on a hectare of land per growing season divided by the standard dosage per active ingredient [5,8]

Because the TFI only represents frequency of pesticide treatments, (and not toxicity or pesticide-related harms), it is not a true risk indicator [8]. The PLI was intended by Denmark to be used together with the TFI after the former was developed.

Both France and Luxembourg focused on quantitative use reduction targets, although the latest revision of France's NAP does mention hazard and risk-based indicators as well.

Hazard and risk focused targets and indicators [3,5,6,8]

Denmark, Germany, and Sweden identified useful indicators in their initial NAPs: SYNOPS risk PLI, SYNOPS risk indicator, and risk index for health and environment respectively. Most of the 2019 revisions of the NAPs focused on reducing risk [3].

Pesticide Load Indicator
Denmark created the **pesticide load indicator** (PLI) to address shortcomings of only using the TFI. The PLI represents the potential total load on human health and the environment a pesticide presents based on risk characteristics of the pesticide[14]. PL is expressed as pesticide load per unit of commercial product (kg, L, etc.)[8]. PL values consist of three sub-indicators: human health (PLHH), ecotoxicology (PLECO), and environmental fate (PLFATE). Each sub-indicator can be expressed independently, or as an average PL value. These sub-indicators and PL average reflect the relative risks associated with a pesticide, and are used to create reduction targets.

TFI and PL used to be calculated solely from pesticide sales data, which did not account for effects such as stockpiling. Farmers are now required to report use data to Danish authorities with more detailed information, which reflects use in the growing season rather than calendar year. This level of detail helps to avoid over-aggregation of data, providing more specific and accurate risk information that may be seasonal or otherwise timebound. A combination of TFI and PL provides detailed information for authorities to find geographic or temporal "hot spots" of risk and use where targeted monitoring may be effective [8].

SYNOPS Risk Indicator
The SYNOPS risk indicator model was developed by **Germany** to assess environmental risk. The model uses information on pesticide use, crop stage, application technique, location, soil type, and other variables to calculate Predicted Environmental Concentrations (PEC) [8]. PECs are compared to known toxicity values, and Exposure Toxicity Ratios (ETR) are calculated for target organisms. The indicator was created to assess risk on a local or regional level, but not necessarily at the national level.

The **Netherlands** developed Environmental Yardstick for Pesticides (EYP), which multiplies PEC values to pesticide toxicity to produce Environmental Impact Points [8]. This technique is not widely used as it only assess environmental impacts.

Norway's Pesticide Risk Indicator (PRI) is a rating system used to assess pesticide use risks for humans and the environment, and a method for taxation of pesticides[8]. For human health, products are rated low, medium, high, or very high risk based on information on product labels. The model also considers special exposure risks to pesticide users and includes multipliers for different ways of handling a pesticide (i.e. mixing and spraying). Environmental risks are calculated by considering effects on a number of target organisms, bioaccumulation, leaching potential, and persistence.

Creating targets around purely quantitative indicators, such as weights of active ingredients or number of doses, may not correspond with potential health risks[6]. Researchers have noted that the extreme situations are unlikely to be captured by purely quantitative indicators:

> *"A unique dataset applied to pesticide use by Swiss farmers in winter wheat and potato production, demonstrates that on average the two most important quantitative indicators show a significant correlation with pesticide risks as expressed by the Danish Load Indicator. However, they have almost no explanatory power for extreme risks (e.g. most intensive use patterns for pesticides with unfavorable toxicity profiles). Results remain stable over a range of aggregation levels, from application to farm-level indicators of pesticide use. These findings render the commonly used, quantitative indicators ineffective to reduce potential environmental and human health risks of pesticides and, in the worst case, lead to misinformed market-based pesticide policies consequential to National Action Plans."* [26]

Behavioural targets and indicators [3,6,27]

The original Directive from the European Commission considered IPM to be a cornerstone of moving towards sustainable use of pesticides, and member states are obligated to promote low pesticide pest management[3]. The Directive includes eight IPM principles that professional pesticide users must follow[8]. However, criteria were not created to determine compliance with IPM, and systematic implementation is difficult to measure. Public support for this method of pesticide reduction was varied among Member States[4]. To address these weaknesses, the European Commission organised a series of courses called Better Training for Safer Foods (BTSF) focused on strengthening assessment of lower-risk pest controls, best practices in use of pesticide application equipment, and IPM implementation.

When setting pesticide reduction targets, the UK may want to consider targets and indicators for the uptake of IPM, with pesticide use as a last resort. The UN Food and Agriculture Organization (FAO) defines IPM as "an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides." [28]

1.3 Complementary efforts to support innovation toward more sustainable solutions

Past experiences illustrate that targets and indicators alone are unlikely to be sufficient to reach their objectives. **Supporting systems must be established to promote innovatation**, **including research, development, deployment and adoption of safer alternatives.** Farmers will require financial, technical, political and consumer support to ensure more sustainable solutions are adopted.

In addition to the example of **Denmark,** discussed above, **Norway** also applied a system of taxation based on certain hazardous properties of pesticides. Pesticides are grouped into seven pesticide tax classes based on a combination of human health and environmental ratings.

In addition, **France** and **Sweden** have applied tax schemes for pesticides to reduce use and promote more sustainable alternatives. France has increased levies on the pesticides that are most hazardous to human health and the environment to provide **nearly twice the funding for pesticide use reduction efforts**. This extra €30 million was used as financial support to farmers to enable a significant reduction in the use of pesticides. A second tax increase provided €50 million to fund organic agriculture. It also leveraged other sources of funding, raising an additional €42 million.[24]

A recent study of these four countries concluded that:

> *"(1) overall, the effectiveness of pesticide taxes is limited, but if a tax on a specific pesticide is high enough, the application and the associated risks will be reduced significantly;*
>
> *(2) in all countries, hoarding activities have been observed before a tax introduction or increase. Therefore, short-term effects of taxes are substantially smaller than long-term effects;*
>
> *(3) differentiated taxes are superior to undifferentiated taxes because fewer accompanying measures are required to reach policy goals;*
>
> *(4) tax scheme designs are not always in line with the National Action Plan targets. Low tax levels do not necessarily lead to a reduction of pesticide input and differentiated taxes do not necessarily lead to fewer violations of water residue limits."*[29]

The European Commission's action to prioritise the updating of the data requirements and assessment methodologies is reported to have increased the number of approved lower risk active substances, such as bio-pesticides and micro-organisms. Better Training for Safer Food courses were provided to strengthen the expertise of the assessment of lower-risk pest prevention methods [3].

Horizon 2020 (now Horizon Europe[30]) was an EU program created to support research and innovation of sustainable knowledge and technologies. The Commission provided €159 million to support research on safer pest control chemistries, emerging plant health risks, and decision support systems [3]. €6 million was also earmarked for other IPM and sustainable farming efforts. Currently there are over 260 projects related to pesticides.[31]

2. PESTICIDE USE IN THE UK

Following the UK's withdrawal from the EU, the country finds itself at a crossroads with competing interests. While the EU's legislation has helped to eliminate the use of several pesticides of concern, there is a risk of reauthorisation of some of these pesticides, and an uncertainty over whether and to what extent the UK will continue to meet EU standards for pesticide use. Of particular concern is to what extent the UK will be able to ensure it has the institutional capacity to provide timely and effective governance of pesticides.

2.1 Use of Highly Hazardous Pesticides

Among the following classes of Highly Hazardous Pesticides (HHPs), there are the following number of pesticides approved in the UK (see Table 2). Very few (four) pesticides are evaluated to have both an environmental hazard criterion and chronic health hazard criterion. More (seven) substances have both acute toxicity and environmental toxicity concerns.

Table 2: HHP classes approved in UK

Hazard class	Number of substances
Acute toxicity	
WHO class 1a	0
WHO class 1b	4
GHS H330	8
Chronic health	
IARC Carcinogens	0
IARC Probable carcinogens	1
EU GHS Carcinogens	1
EU GHS Mutagens	0
EU GHS Reprotox	5
EU EDC or EU Carcinogen Group 2 and EU Reprotox.	11
US EPA Carcinogens	0
US EPA likely probable carcinogens	19
Environment	
Persistence e.g. Very persistent in water (half-life > 60 days), soils or sediments (half-life > 180 days)	8
Bioaccumulation e.g. Very bio-accumulative (BCF >5000) or KoW logP >5 (BCF values supersede Kow logP data)	3
Toxicity to aquatic organisms e.g. Acute LC/EC50 <0,1 mg/l for Daphnia species	9
Toxic to pollinators e.g. (<2 µg/bee) according to U.S. EPA as listed by FOOTPRINT data	19
International Instruments	
Montreal Protocol on ODS	0
Stockholm Convention on POPs	0
Rotterdam Convention on PIC	1

2.2 Vulnerable groups

Across the UK, certain groups encounter greater risk of adverse impacts due to pesticides. In addition to farm and amenity workers, rural, urban and agricultural communities often face the likelihood of higher exposure due to their proximity locations where pesticides are applied. Other groups are at heightened vulnerability due to their gender or period of development, such as children and women of reproductive age. Socio-economic factors often place minorities and migrant communities at greater risk of pesticide exposure, particularly farm workers and their families. In addition, such communities may not be appropriately informed of hazards and risks, exacerbating the risk of exposure, while also facing challenges in securing redress and remedies in the case of dangerous or exploitative working conditions. A recent study in the US looked at how to tackle the disproportionate effects from environmental pollutants (including pesticides) on Black, Indigenous and people of colour, as well as communities of low-income[32].

Reducing exposure to pesticides for those most vulnerable, is critical to reducing the risks of pesticides in the UK. There is a concern that the benefits of risk reduction may not be equally distributed across the country, where marginalised and underserved communities continue to face unacceptable risks that are poorly captured and quantified. **Systematically substituting hazardous pesticides with safer alternatives – ideally non-chemical pest control methods wherever possible – should be the primary approach to protecting vulnerable protecting workers and communities.**

3. ESTABLISHING INDICATORS OF PROGRESS

A robust baseline is fundamental to understanding where progress is being made in reducing the use of pesticides in the UK. At present, the usage data in the UK is not adequate to quantify pesticide use reduction in a reasonable manner. The current data in the UK published by PUSSTATS has a time lag, does not cover all the areas of pesticides used regularly (e.g. agricultural, amenity, and amateur), provides no detailed information at useful geographical levels, relies on self-reporting, only identifies individual active substances and classes of pesticide, and does not provide information on product usage. For the amenity use of pesticides it relies on a non-obligatory user survey carried out every couple of years.

Some current approaches from outside the UK may be useful in determining the path forward.

Sales trends under EU Harmonised Risk Indicators

The 2009 Sustainable Use Directive (SUD) called for the establishment of EU-level harmonised risk indicators to compare progress among EU Member States. Based on information reported to it through 2016, Eurostat identified several challenges in analysing pesticide use data reported to it by national governments.[33] These challenges included the lack of harmonisation of data for crops and the time period for reporting, claims of confidentiality, and the units of reporting. While the same issues may not arise given the different mechanisms between regional (EU wide) and national reporting, ensuring appropriate aggregation and confidentiality at the national level may still be an issue nationally, including within the UK.

With a lack of progress under the 2009 SUD, a 2019 amendment was crafted to restart the process (2019/782/EC). EU member states are now required to calculate harmonised risk indicators. This includes identifying trends in the use of certain active substances, and identifying priority items, such as active substances, crops, regions, or practices that require particular attention. Good practices that can be used as examples in order to achieve the objectives of the SUD, are also included.[34]

Following the 2019 amendment, the European Commission calculated the evolution of two Harmonized Risk Indicators (HRI) retrospectively. In 2021, the Commission published updated EU Harmonized Risk Indicators for pesticides for the period 2011-2019 for the EU[34]. Harmonized Risk Indicator 1 (HRI 1) measures the use and risk of pesticides. HRI 1 is based on data on pesticide sales as required under the Regulation concerning statistics on pesticides (EC No 1185/2009). It is calculated by multiplying the quantities of active substances placed on the market in plant protection products by a weighting factor.

Active substances are grouped into four categories, and weightings applied to each category are intended to reflect policy on the use of pesticides and to support the goals of the SUD. The four groups are: (1) low-risk active substances; (2) all approved active substances, other than those in Groups 1 and 3; (3) more hazardous active substances; and (4) active substances that are not approved. The four groups are divided into categories, as described below:[34]

Group	Category	Description
1. low-risk active substances	A	micro-organisms
	B	chemical active substances
2. all approved active substances, other than those in Groups 1 and 3	C	micro-organisms
	D	chemical active substances
3. more hazardous active substances, e.g. carcinogens,	E	based on the classification of these active substances as regards their carcinogenic, repro-toxic and endocrine disrupting properties
	F	
4. active substances that are not approved	G	active substances that are not approved

Together groups and categories enable an overall risk indicator to be calculated. HRI 1 “shows a [pesticide risk] decrease of 21% since the baseline period in 2011-2013, and a 4% decline compared to 2018, which was unchanged compared to 2017.” In addition, the individual groups allow for certain trends to be illustrated. For example, the Commission notes that “noteworthy trends in 2019 are the continued, and accelerating, growth in the sales of pesticides containing non-chemical active substances and the notable decrease in the quantity of the more hazardous pesticides placed on the market.” [34]

Commentators have noted the welcome the efforts of the EU on Harmonised Risk Indicators. They note that:

> *"Given the difficulties in comparatively assessing the harmful effects of pesticides across the EU, the 2019 calculation of the Harmonized Risk Indicators represents excellent progress. As soon as possible, detailed data for EU Member States should be calculated, and clear and compulsory targets should be set. Without such comparable metrics, it would be difficult to compare different countries' evolution or allow the potential and systematic transfer of good practices with proven positive impact."* [4]

The HRI 1 approach does require particular attention to whether robust and reliable sales data can be generated nationally, as well as ensuring that the appropriate weighting factor is applied to different groups of substances.

However, the European Court of Auditors observed the need for further improvements, stating that "neither indicator shows the extent to which the directive has been successful in achieving the EU objective of sustainable use of PPPs." [35] They recommended that the Commission should:

> *"(1) check that the Member States convert the general principles of integrated pest management into practical criteria and that they verify them at farm level, allowing them to be linked to payments under the common agricultural policy in the post-2020 period;*
>
> *(2) improve statistics on PPPs when revising the legislation to make them more accessible, useful and comparable; and*
>
> *(3) to assess the progress made towards policy objectives, improve the harmonised risk indicators, or develop new ones, taking account of the use of PPPs."* [35]

PAN Europe also emphasised the need to introduce use indicators (not just risk), including collecting data from farmers.[36]

In developing the UK pesticide use reduction target, the UK should take these observations into account.

3.1 Toxics Use Reduction

In the United States, a useful model of Toxics Use Reduction (TUR) has emerged at the state level, which has served as a model for a transition to safer alternatives to toxic chemicals. The Massachusetts Toxics Use Reduction Act (TURA) established a system to implement reporting requirements on the use of industrial chemicals. Although the law does not apply to pesticide use, the system could be applied to agriculture. At a high-level, the mechanism consists of:

- A living list of toxic chemicals that is regularly updated based on the recommendations of an independent scientific body (the Science Advisory Board) regarding the inclusion of various chemicals of concern.
- A requirement that certain facilities in Massachusetts that manufacture, process, or otherwise use listed chemicals must report on their use of these chemicals annually. Reporting requirements depend on various criteria, including the quantity of the chemical used (manufactured, processed, or otherwise used), as shown in the list of reporting thresholds below (Table 3). This complements reporting requirements for the U.S. Toxics Release Inventory (TRI), which has certain similarities with the Pollutant Release and Transfer Registers (PRTRs) found in Europe and elsewhere, including the fact that neither apply to the agricultural sector.

Table 3: Reporting thresholds under the Massachusetts Toxics Use Reduction Act (TURA)

Substance activity or type	Reporting threshold weight
Manufacture	25,000 lb
Process	25,000 lb
Otherwise used	10,000 lb
Higher Hazard Substances	1,000 lb
Certain types of substances, such as persistent, bio-accumulative, and toxic (PBT) substances (by virtue of complementary legislation and/or other specific circumstances)	100 lb, 10 lb or 0.1 g, depending on chemical

- Businesses with reporting obligations are required to develop a "plan" to reduce their use of toxic chemicals every two years. Facilities work with a substitution expert (so-called "planner" or Toxics Use Reduction Planners (TURPs)) to find potential opportunities to eliminate or reduce toxic substances. Toxics Use Reduction (TUR) is achieved through six techniques, including safer substitution and product reformulation. While they are required to develop the plan, they are not required to make reductions.

- Governmental and independent implementing agencies play key roles in reviewing TUR plans, providing confidential technical assistance to facilities to help them achieve reductions, and providing research, training, and financial assistance to both businesses and communities to enable future reductions.
- Businesses subject to TURA pay an annual fee to support efforts. This fee supports the services provided by the implementing agencies, including support to identify and use safer alternatives. Facilities pay a base fee determined by number employees, plus a flat per-chemical fee for each listed chemical used above threshold. The maximum fee that a given facility may pay is also determined by number of employees.

Since 1990, the TURA program's requirement of systematic reporting and periodic alternatives assessment has produced **measurable results in terms of toxics use reduction, improved worker health and safety, improved environmental performance, and cost savings.** Requiring businesses to conduct such planning has led them to identify opportunities for improvement that they might not otherwise have identified.

Over the first 10 years of the program, 1990 to 2000, Massachusetts companies subject to TURA reduced toxic chemical use by 40% and on-site releases by 90%. From 2000-2020, Massachusetts companies reduced toxic chemical use by 75%, waste by 67% and releases by 97% (2020 Information Release). Reducing or eliminating use of toxic substances in a facility also reduces potential release of substances into the environment. From 1990-2016, Massachusetts companies reduced hazardous chemical use by 40%, onsite releases by 90% and waste by 72%.

Efforts to reduce just one chemical, trichloroethylene (TCE), demonstrate the value of the approach. From 1990 to 2020, TCE usage and release was reduced by 95% and 97%, respectively.

Businesses have financially benefited from the TURA program. A 2008 survey of TURA files found that 41% achieved financial savings. In addition, 51% have experienced improved worker health and safety; 33% achieved improved compliance with other state or federal regulations; 29% achieved improvements in production efficiency; and 21% achieved improved product marketing because of the TUR planning and implementation process.[37, 38]

The basic principles of TUR and the mechanism established under TURA could be applied to pesticides. Steps that could be taken include:

- The establishment of a list of pesticides to be reduced by users;
- A scientific body to regularly update the list of pesticides;
- Requiring farmers and other pesticide users to report regularly on their use;
- For users individually or collectively to develop a plan to reduce their use, (as part of IPM plans), including assessment of potential alternatives and indicating where research and development is needed to overcome challenges;
- Support of governmental and independent agencies with technical and financial assistance; and
- Fees to support the described mechanism, financial and technical support.

4. CONFIGURING PESTICIDE USE REDUCTION TARGETS IN THE UK [39]

4.1 Targets based on volume and other risk-based considerations

UK pesticide reduction targets could be based on volume. Volumetric reduction targets could be for various classes, individual active substances, or avoid the question of classification and specify reductions for all pesticides. Implementing volumetric reductions would require robust reporting systems, where the experience of Denmark and other countries may be useful.

Some classes discussed above are defined by risk-based parameters. For example, the criteria used by PAN for the inclusion of pesticides as being highly toxic to bees is based on the criteria of being toxic at an exposure of less than 2 μg/bee. Thus, potency, which may be considered a risk-based criterion, is part of the determination as to whether a substance qualifies for inclusion in the class. This may be the case for other hazard categories, although potency is not currently considered for carcinogenic and reprotoxic substances.

However, evaluating progress toward risk-based reduction targets present several challenges. Exposure predictions are often unrealistic and imprecise, and do not account for the interaction of different active substances, e.g. the cocktail effect[40]. Without a robust system of reporting volume of use, it would be a challenge to estimate the risk reduction. Further, the intrinsic hazards of pesticides are not equal, and thus equivalent volume reductions for two different substances or formulations would not be the equivalent reduction in risk. It appears that the most reasonably certain means of making risk-based reductions in pesticide use is through reducing the hazards encountered by workers, farming and other communities, and consumers across classes of concern on a percentage basis.

4.2 Targets based on hazard classes

In the UK, pesticides are found to be registered for use across numerous classes of concern. These include broad categories such as acute, chronic (health) and environmental toxicities.

In addition to these classes, other classes may be developed. For example, neonicotinoid or organophosphate or endocrine disrupting pesticides would be examples of such classes. Such a grouping may be useful if there is a particular high priority hazard in the UK, such as protecting pollinators or the neurodevelopment of children, for example.

A challenge with such groupings is determining which authority (or authorities') classification to use, if the UK has not made one of its own. The UK could include foreign or international authorities' classification such as International Agency for Research on Cancer (IARC), EU institutions, the US Environmental Protection Agency (EPA), among others. **Adopting internationally recognised classifications would likely save the UK Government both time and money.**

In the case of IARC, there may be resistance to its classification forming a basis for regulatory or quasi-regulatory decision making. Less politically sensitive, and more ideologically aligned may be US EPA. The US EPA has categorised more substances as potentially carcinogenic than the EU and IARC combined. However, an 'any and all of the above' approach to authorities, including any OECD member, EU institution or UN agency/body, would be the ideal approach. Where multiple assessments have been performed, a collated approach could be performed to arrive at a UK classification, which could also work with the UK's diminished capacity outside of the EU.

4.3 Targets for individual substances or circumstances

Along similar lines of prioritising certain concerns, specific substances may also be targeted for reduction to a greater extent than the category in which they fall. In the UK, there may be certain pesticides for which specific targets are desired. Or there may be certain locations where higher concentrations of people (e.g. urban centres) warrant stricter levels of protection, and therefore less use. These substances may be given a more ambitious target for reduction, or alternatively a lower target for use reduction than would otherwise apply by virtue of extenuating circumstances, such as certain uses that may be required for public health protection.

For such reasons, it might be desired to create targets specific to these substances. However, the obvious risk for targeting individual substances is the high likelihood of regrettable substitution, where a different pesticide with similar or perhaps even different hazards is used as an alternative. While protecting human heath from cancer through reductions of one pesticide, the alternative to that pesticide may be may toxic to aquatic organisms or present other concerns. Thus, targets should ensure that the process of substitution takes into account the hazard profile of alternatives.

4.4 Configuring targets based on specific uses

Several countries have adopted bans or restrictions on the sale of pesticides to certain individuals (e.g. amateurs, home gardeners, etc.). Others have restricted or banned the use in certain areas, such as playgrounds or other public spaces. Whether such use-specific measures would have a demonstrable and significant effect on pesticide use reduction is very context specific.

4.5 Configuring targets based on global treaties

Several different global instruments apply bans, restrictions or other measures to specific substances to help reduce the adverse impacts of hazardous substances, including pesticides, on human health and the environment. One chemical listed under such international treaties is found to be registered for use in the UK. The chemical, carbetamide, is listed under the Rotterdam Convention on Prior Informed Consent (PIC). It is also classified in the EU as toxic to reproduction and may be included under a chronic health class of pesticides for use reduction, if such as class is created by the UK and with inclusive criteria that covers such reprotoxins.

As the treaty regime for chemicals and wastes evolves, additional substances may become listed under international treaties that are not covered at present. While there are no pesticides under the Stockholm or Montreal Conventions used in the UK, having a list that includes these Conventions among other related conventions (including both present and future, yet to be developed instruments) would help ensure that global minimum standards are applied in the UK.

5. RECOMMENDATIONS FOR MEASURING PROGRESS IN THE UK [6,39]

Based on the experiences of the past several years with pesticide use reduction targets, a recent study concluded that "A new holistic and simple policy framework is needed to improve current pesticide policies." [6] The following proposal is offered in this spirit. Building on the author's criteria for pesticide use reduction targets, the following proposal aims to:

1. Create simple, generic and long-term policy goals while maintaining flexibility in policy tools and measures;
2. Establish a framework based on clear and tangible policy goals that include transparent assessment and monitoring procedures for risks;
3. Overcome regrettable substitution by having joint goals of food production, environmental protection, biodiversity and human health, avoiding siloed solutions; and
4. Establish a supporting mechanism of both monitoring and innovation to ensure risk reduction can be measured accurately— and ensure more sustainable solutions are adopted by farmers and consumers alike.

5.1 Establish indicators to understand trends in the use of certain substances of concern and the adoption of safer alternatives to inform future decision-making

Given the lack of data on pesticide use, the UK may wish to establish a Pesticide Use Reduction (PUR) Program to enable the monitoring of pesticide use, reflecting the positive experiences of the TUR approach described above. Such a system may consist of the elements described in Table 4.

Table 4: Examples of a mechanism for monitoring pesticide use reduction

1	Create a living list of pesticides to be subject to use reduction efforts in the UK (listed pesticides) to track the use of and seek reduction where possible
2	Establish an independent scientific body to keep the above list current, and to otherwise provide technical guidance as requested (or establish as part of the Health and Safety Executive (HSE) or Expert Committee on Pesticides (ECP) remit).
3	Require farms and other pesticide users to report usage of listed pesticides periodically (methodology below). Reporting should not be limited to quantity used and persons employed. Data should be publicly available.
4	Require reporting of sales data for pesticide products in real-time in a publicly accessible format.
5	Require farms and other pesticide users to develop a Pesticide Use Reduction Plan (PURP) to identify opportunities to transition from the use of listed pesticides to safer alternatives. It makes most sense for this to form the bulk of an IPM plan. This should also ensure that smaller operations are provided technical and financial assistance if needed. Plans should be publicly available.
6	Establish an independent institution, (or establish as part of the remit of DEFRA, the Environment Agency or another government body), to research, develop and support safer alternatives to listed pesticides.
7	Resource DEFRA or other governmental authorities to be responsible for monitoring, compliance, and enforcement. Establish Advisory Council to approve recommendations from the Scientific Advisory Board

5.2 Craft quantifiable targets based primarily on hazard classes

Table 1 provides one example of how the targets may be structured based on broad classes of substances that is both holistic and clear. To balance these interests, a combination of both class-based targets and targets for individual substances could be used. Quantification of reductions at the user-level, along the lines of the Danish approach might be useful to examine in further detail.

It is important to note that in this proposed approach, farmers and other users would not be required to make any specific reduction. The only requirement is the production of plans that would be subject to scrutiny, (public ideally). It is expected that through the planning process and with the development of effective innovation systems (below), the costs of alternatives would become less than the incumbent conventional pesticide of concern. While the lack of concrete obligations to reduce has drawbacks, without precise data at present on usage and implications it does not appear feasible to craft more specific, binding obligations for reduction for individuals. One way to partially address this would be to require the user to include justifications in their plans as to why they had not met the overall reduction target, which could be scrutinised.

Employing this holistic approach of broad classes complemented by individual targets would avoid the situation of regrettable substitution (where one pesticide of concern is replaced by another pesticide of similar or different concern), whilst also providing targets specific to certain substances and concerns when needed. This approach also draws on the classifications developed by international authorities, which may benefit the UK, given the limited number of pesticides evaluated by national authorities themselves, a situation expected to persist for many years. The more ambitious target would apply, unless otherwise specified by the appropriate body.

For example, the reduction of the use of glyphosate may result in the introduction of different herbicides with different hazardous properties, such as bromoxynil, or vice versa. Glyphosate raises human health (cancer) concerns, whereas bromoxynil (and structural analogs) raise concerns for the environment, namely their toxicity to aquatic organisms and persistence. The situation of possibly replacing one with the other could be avoided with the inclusion of language that requires reduction overall for the class, without increasing the use of any substance that falls into any of the classes of concern.

In addition, there is a risk that a pesticide of concern may not meet any of the criteria but may be of concern for various other reasons. To continue with the example of glyphosate, paraquat is a likely replacement herbicide, but is currently prohibited from use in the UK. If the UK were to change its position on paraquat, this would present a challenge to the scheme outlined below. The WHO does not classify this substance as acutely toxic and it is unlikely to meet any of the chronic health endpoints listed in Table 2. To avoid this situation, class 5 could be employed, to avoid regression on standards of protection below what was in place before the UK's withdrawal from the EU.

Finally, there is a challenge for substances that have since been banned or restricted by the EU for which the UK has either followed suit or may wish to do so in the future AND do not meet the criteria for classes 1-5. A catch all (so-called class 6) for those substances, which would be more like an individual substance-based reductions, could allow for Pesticide Use Reduction targets to be developed. The case of chlorpyrifos could have been one such example. Chlorpyrifos was authorised for use in the EU until its authorisation was revoked as of 16 Feb 2020 with a grace period of approximately two months to cease all remaining uses. While the UK had ended the use of chlorpyrifos in 2016, several years ahead of the European Union, it could have been a laggard, and thus falling out of the class 5 deadline which is based on the UK's establishment of its own regulatory regime for pesticides following its withdrawal from the EU.

Alternatively, class 5 and 6 could be merged to form one class with the date closer to today. This would address the hypothetical chlorpyrifos example above; however, this would introduce other concerns. First, politically, the sovereignty over regulation that led to the UK's withdrawal on said date may be a sensitive point. Second, there would also be the situation of new pesticides that may be authorized in the coming years that do not meet the classes 1-4, for which Pesticide Use Reduction targets are deemed appropriate. Thus, in the model below classes 5 and 6 are separated.

Table 1 (repeated from executive summary): Model of a class-based targets for pesticide-use reduction

	Class	Target for 2030	Examples of substances
1	**Acutely toxic pesticides** • WHO Class 1 a; • WHO Class 1 b; or • GHS H330	Eliminate use	Abamectin Aluminum phosphide
2	**Chronic health hazard**, including: • IARC known or probable, • EPA known or likely probable carcinogen, • EU GHS Group 1 CMR • EU EDC (known/probable) or Carcinogen Group 2 AND Reprotox. Group 2	Reduce use by at least 50% overall, without increasing the use of any pesticide listed for reduction.	Carbetamide Glyphosate Mancozeb
3	**Environmental hazard**, including (see e.g. PAN HHP list for definitions): • Very bio-accumulative • Very persistent in water, soils or sediments • Very toxic to aquatic organisms • Highly toxic to bees	Reduce use by at least 50%, without increasing the use of any pesticide listed for reduction.	Cypermethrin
4	**Internationally banned, restricted or otherwise listed** • Stockholm Convention on POPs • Montreal Protocol • Rotterdam Convention • Other related conventions	Eliminate use	Carbetamide
5	**Pesticides that were not registered for use in the UK before 1 Jan 2021 but registered for use in other jurisdictions and do not meet any of the above criteria**.	Eliminate use	Paraquat
6	**Substances that have an equivalent level of concern**	Case-by-case basis	Case-by-case basis

In addition to the hazard-based classes for Pesticide Use Reduction, indirect but quantifiable targets may also be considered, as they may create incentives and the provide a vison that is consistent with public values and objectives. In addition, the number of farms or facilities that meet certain standards of Pesticide Use Reduction made be a useful barometer for progress under the Pesticide Use Reduction targets overall.

Examples of targets to help advance Pesticide Use Reduction could include:

- Percentage of farms adopting Integrated Pest Management (IPM) or organic standards in new environmental land management schemes (ELMS in England)
- Change in approvals for bio-controls to speed up the process
- Number of farms/facilities that exceed the UK pesticide use reduction targets
- Percentage of UK farmland largely organic (or certified organic)

5.3 Establish robust innovation systems to promote and invest in sustainable solutions

Farmers must be supported through research and development as well as financial assistance and technical advice (independent from pesticide sales) if they are to increasingly adopt safer and more sustainable alternatives. Fees collected through the TURP Program or otherwise could support various efforts, such as the research and development activities coordinated by the independent institution to identify viable alternatives. The TURP Program need not be the only source of funding for innovation, as many other financial mechanisms could be designed to support innovation – such as levies on the most toxic substances. To support the adoption of safer alternatives, financial resources could be provided to support demonstration and deployment, leading to eventual adoption. To promote adoption of safer alternatives, researchers would use comprehensive assessments to understand safety, feasibility, and cost effectiveness of alternatives to pesticides of concern. The final point is critical to convince farmers of the potential benefits of transitioning to safer alternatives. To enable safer alternatives to develop economies of scale where needed and to rebalance the so-called playing field, taxes should be employed.

5.4 Provide a periodic review

A periodic review of the Pesticide Use Reduction targets should be undertaken to adjust efforts as needed to achieve objectives, as well as integrating good practices that may be identified. Reviews at the middle and toward the end of target periods may be useful in this regard.

In terms of scrutiny, the new Office of Environmental Protection (OEP) could be responsible for ensuring the Government is on track to meet the targets.

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