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Slug Patch Prediction Maps

How farmers, scientists and technology experts worked together to predict where slugs will strike

The challenge of managing slugs

The grey field slug *Deroceras reticulatum* is one of arable farming's biggest pests estimated to cost the industry **£43.5M** every year. Since the withdrawal of metaldehyde, growers have had only one remaining chemical option for slug control – ferric phosphate pellets – making more targeted and sustainable management increasingly important.

One of the biggest challenges in controlling slugs is knowing where and when they will strike meaning that – prior to SLIMERS – there was no reliable way for farmers to target them precisely.

SLIMERS – Strategies Leading to Improved Management and Enhanced Resilience against Slugs – brought together farmers, scientists and technology experts to tackle this challenge. The project combined biological research, farmer-led monitoring, artificial intelligence and soil mapping to develop a patch prediction model capable of forecasting slug hotspots within arable fields.

The aim was to help farmers target slug control more precisely, reduce slug pellet use and improve sustainable crop protection.

This knowledge guide outlines how the patch prediction model was developed – from farmer-collected field data and biological modelling through to machine learning tools and field validation.

"The patch prediction maps developed through SLIMERS enable farmers to make more informed and precise decisions about where treatment is needed and reduce slug pellet applications by as much as 50% which will save arable growers £6M a year!"

Tom Allen-Stevens, managing director of the British On-Farm Innovation Network (BOFIN) and SLIMERS project lead.

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Understanding slug behaviour, patch formation and location

Scientists at Harper Adams University, led by Professor Keith Walters, had long known that slugs do not spread randomly across fields. Instead, they form distinct patches influenced by soil texture, moisture levels and environmental conditions.

Developing further understanding of exactly how and where these patches form became a key focus for the research team.

Slugs are highly vulnerable to drying out because they cannot regulate body moisture efficiently. As a result, they naturally move towards areas of soil with favourable moisture conditions.

The researchers identified that soil composition plays a major role in determining where these patches appear, with slugs favouring the areas with more moisture retentive soils. For example silt-dominant soils were associated with higher slug risk, with the relative proportions of the clay and sand fractions fine tuning both the locations of patches and their stability over time. In clay dominated soils fine tuning occurs through the relative levels of silt and clay.

Researchers also discovered that extreme weather could temporarily disrupt this behaviour.

During periods of prolonged rainfall leading to soil waterlogging:

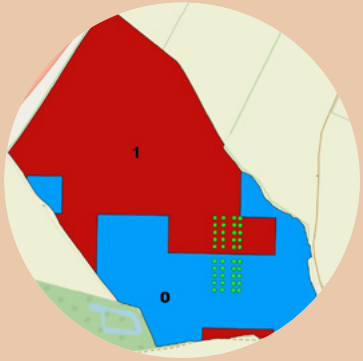
- Slugs move unpredictably
- Patches break down
- Slug distribution becomes more random
- Then, as soils dry, patches reform again in predictable areas.

Understanding in detail, how slugs responded to the dynamic interactions between these and other environmental and weather factors, and how this complex biological system worked, was essential before accurate forecasting could begin.

The Slug Sleuths

The team of 28 Slug Sleuth farmers and agronomists played a vital role across the SLIMERS project but particularly with the development of the biological and patch prediction models. Over the three years of the project they:

Developed project protocols with researchers
Farmer-scientist collaboration from the start of the project led to robust farmer-friendly protocols which can be replicated in future research.



Tested the patch prediction model
In autumn 2025 the triallists were given slug risk maps produced by a forecasting model together with data from existing soil scans taken for other crop management purposes. The farmers were asked to only treat the areas identified as 'hotspots' while continuing to monitor slug populations and collect data via the app.

Monitored slug populations to develop understanding of slug behaviour
The triallists used a network of slug traps placed in precise, pre-defined positions across one of their fields and carried out weekly counts through each autumn (with some adding extra assessment in early winter).

They also recorded crop establishment, slug damage and weather conditions using the BOFIN Triallist app. In the first two years of the project the farmers faced several challenges ranging from inclement weather making data collection difficult, to traps being moved by inquisitive local wildlife! However, their persistence paid off and the farmers provided researchers with detailed field-scale datasets covering different soil types, climates and cultivation systems across the UK.

SLIMERS has proven that farmer-led projects can generate complex datasets robust enough to support advanced biological modelling and machine learning systems. The quality of the data collected by the Slug Sleuths proved critical to the project's success.

"By working with farmers from the start, the developments we have made have been more significant and impactful. I have no doubt our farmers collected data to the same level of accuracy as trained technicians."

Professor Keith Walters, Harper Adams University

Using AI to measure hidden slug damage

One of the challenges during the Slug Sleuths' data collection was measuring and quantifying slug damage accurately. While feeding damage above ground is visible, much of the most important damage happens below the soil surface when slugs consume germinating seeds before crop emergence.

To tackle this, Freddie Allen-Stevens of InsightML was enlisted to develop a machine learning approach that linked slug populations with crop establishment patterns.

Instead of trying to score visible damage directly, Freddie and Keith decided to focus on measuring wheat plant populations over time. The hypothesis was that healthy crops would show rapid establishment, while slug-damaged areas would show delayed or reduced emergence.

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Using thousands of field images collected by the Slug Sleuths, Freddie developed:

- A wheat population model
- A Virtual Quadrat system

The Virtual Quadrat allows software to define a consistent measured area within field photographs, removing the need for a physical frame while ensuring consistency between images.

Integrated into the BOFIN Triallist app, the system links directly with the wheat population model. During SLIMERS it enabled farmers and researchers to consistently quantify slug damage through reduced crop emergence rates.

What is the Virtual Quadrat?

- An AI tool to define a metre square area
- Ensures accuracy and consistency in data collection
- Applications across all areas of research where a physical quadrat is impractical

What is the plant population model?

- An AI tool to count specific crop plants within a set area
- Can determine between wheat and arable weeds including black grass
- Potential applications across agriculture for data collection and decision-making

"By combining farmer-collected field images with machine learning, we were able to create a scalable way of measuring crop establishment and hidden slug damage."

Freddie Allen-Stevens, InsightML

Developing the biological and forecasting models

The data collected by Slug Sleuths in the first two years of the project was the critical resource that enabled the development of a unique biological model. This established, for the first time, the complex behaviour of slugs reacting to both medium term weather conditions and the variation of soil characteristics across arable fields. It shows that there is a two-stage process to the formation and location of slug patches, which enabled us to subsequently build a risk forecasting model for slug damage to field crops.

Once the biological system behind slug patch formation was understood, the next challenge was developing a practical approach to using the forecasting model, which was both reliable and commercially viable on farm.

During the research stages, detailed manual soil sampling and analysis were used to understand the link between slug patch formation and soil characteristics. However, these methods were not commercially viable, leading the team to explore the use of existing farm soil scan data instead.

The forecasting model developed by Keith and the SLIMERS team combined:

- Soil scan data
- Calibration models
- Biological forecasting algorithms
- Geospatial mapping tools

Two different forecasting approaches were investigated:

- A binary model predicting whether slug populations would exceed a treatment threshold selected by the user
- An abundance model predicting actual slug population density

The system was then tested by 16 Slug Sleuth farmers during autumn/winter 2025-26. The farmers were asked to target slug pellets to the predicted hotspot areas while continuing to monitor slug populations across the wider field. Analysis showed that targeting only hotspot areas reduced slug pellet use by an average of 50%.

Reducing slug pellet use in this way across the industry would deliver a total saving of £6M to arable growers. This is based on the PUSSTATS figure of 2300t of ferric phosphate applied per year at a cost of £5/kg.

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Despite relatively low slug pressure during the testing season, the results successfully demonstrated that the model works under commercial conditions. The work also showed that farmers are happy to use it and that it fits in with modern commercial equipment.

"We met with some glitches in the early days when constructing it, but now have a forecasting model that I am really confident in."

Professor Keith Walters,
Harper Adams University

Why patch treatment matters

Precision targeting of slug hotspots could:

- Reduce slug pellet use
- Lower input costs
- Reduce environmental impact
- Extend the lifespan of existing chemistry

What happens next?

The successful development of the patch prediction model marks an important step towards more sustainable slug management in UK agriculture.

By combining biological understanding, farmer-led monitoring and artificial intelligence, the SLIMERS project has demonstrated that slug hotspots can be predicted and targeted more precisely.

Researchers hope to continue refining the models using additional field data and wider on-farm testing.

Farmers are able to generate slug prediction maps for free via the InsightML portal. Plans are also underway to make them available via existing commercial precision application systems. For up-to-date information on how to access the maps (and links) visit www.slimers.co.uk

The wider implications extend beyond slug control alone. The AI tools and virtual quadrat technology developed during the project may also have applications in:

- Monitoring crop establishment
- Identifying and quantifying weeds
- Broader ecological and environmental monitoring

Above all, the project has demonstrated the enormous gains that can be made when farmers, scientists and technology innovators work together to find solutions to agriculture's challenges.

What the farmers say

100% of Slug Sleuths said they were 'likely' or 'very likely' to use slug prediction maps in future

"Using the findings from SLIMERS research, together with new technical developments, we can predict slugs' activity more accurately than before. This means we will be able to use more targeted treatments which has the potential to be less damaging to biodiversity."
Charles Paynter, Slug Sleuth (Bedfordshire)

"Through SLIMERS I've learned that slug issues can be controlled in a more environmentally friendly way."
Richard Cross, Slug Sleuth (Nottinghamshire)

"Pellet applications are costly and time consuming, so anything that can reduce applications is good."
Tom Jewers, Slug Sleuth (Suffolk)

Further reading

If you'd like to learn more, the following papers give more detailed background on the biological research that underpins the development of the patch prediction model:

Spatial aggregations of the grey field slug *Deroceras reticulatum* are unstable under abnormally high soil moisture conditions (2024)

A predictive model and a field study on heterogeneous slug distribution in arable fields arising from density dependent movement (2022)

Stability of patches of higher population density within the heterogenous distribution of the grey field slug *Deroceras reticulatum* in arable fields in the UK (2020)

About SLIMERS

Strategies Leading to Improved Management and Enhanced Resilience Against Slugs (SLIMERS) was a three-year £2.6M research programme involving more than 100 UK farms and six partners.

BOFIN (British On-Farm Innovation Network) led the consortium which included partner organisations UK Agri-Tech Centre (technical lead), Harper Adams University, John Innes Centre, Agrivation, Fotenix and Farmscan Ag.

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