Informing Policy to Protect Our Trees

As more and more plants are imported into the UK, the risk of the arrival of new emerging plant diseases which could threaten UK woodlands and crops is greater than ever. Prof. Gilligan and colleagues at the Department of Plant Sciences in the University of Cambridge have been modelling the spread of such diseases. Their model is currently being used as an important tool to identify optimal control strategies, inform policy changes and protect national and international plant life in the face of old and emerging plant diseases.

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On a walk through British woodland you may marvel at the grandiose trees, in all their tall, beautiful, green splendour, or perhaps you take them for granted, they have always been there, after all. But on closer inspection, you may notice black leaves, dead side shoots and dark lesions – evidence of a plant pest at work.

In fact, these are key symptoms of ash dieback (or 'Chalara') caused by a fungus (*Hymenoscyphus fraxineus*). It was first detected in a nursery tree imported from mainland Europe in February 2012 but by October, it was discovered in natural woodland. Considering ash trees account for 20% of the UK's trees and is a major hardwood for the UK's £1.4 billion timber industry, important questions arise about the implications of this pest for the environment, the economy and society.

How does the disease spread? How long is the incubation period before symptoms arise? Are there any resistant trees? Would culling or letting the disease run its course be a more effective control strategy? How will this impact the timber economy? What are the consequences for the wildlife ash trees support? With so many factors to consider, identifying the best strategy to control the epidemic presents a big challenge, particularly at the early stages of an emerging epidemic where there are many 'unknowns'.

Prof. Chris Gilligan and his group at the Department of Plant Sciences in the University of Cambridge specialise in analysing the factors that influence and control the spread of plant diseases. Using a combination of experimentation, mathematical modelling and historical data from previous plant pest epidemics, the group have proposed and refined numerous models over the last 15 years. In 2004, the group proposed a model to identify control measures for the disease rhizomania which was causing root decay in sugar beet, a major UK crop. This model was later refined to become one of the first to predict the spread of plant disease epidemics in time and space. It was subsequently linked to economic models, making it a powerful tool in identifying the most cost-effective control strategies in tackling epidemics.

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What does the model mean for ash dieback?

The Department for Environment, Food and Rural Affairs (DEFRA) commissioned Prof. Gilligan's group to predict the anticipated spread of ash dieback across the UK. Using their pioneering modelling techniques and software, the team summarised their research data in a report which DEFRA used extensively to produce the 'Chalara Management Plan'. This guidance document determined how the Forestry Commission and practitioners of land management should respond to suspected cases of ash dieback. The threat to one of Britain's major tree species also led to significant media interest and Prof. Gilligan was interviewed by the BBC, bringing the ash dieback problem to the foreground.

Prof. Gilligan's work has been far reaching, extending to other plant diseases both locally and internationally. For example, DEFRA have also used the group's models to predict where in the UK oak processionary moth, whose caterpillars ravage oak trees, and ramorum disease of larch will have the most impact, informing sampling and control measures. On the international scale, the group collaborated with the US Department of Agriculture to aid control of both sudden oak death and citrus canker, helping inform policymakers of the risks. The group's current work extends into Africa protecting food crops. The models are currently being used to predict the spread of cassava disease throughout East Africa and to identify options to control it. The group is also working in collaboration with the UK Met Office and colleagues in African institutes to predict the spread of new strains of stem rust- a virulent pathogen of wheat.

One of the latest versions of the model is in the form of a website 'WEBIDEMICS' (WEB-based Interactive Demonstration of Epidemiological Modelling Informing Control Strategies: www.webidemics.com), enabling worldwide access to the model. It functions as a freely available toolbox allowing users to modify various parameters including the infection rate, weather conditions and control measures. These factors make the model more realistic and enable users to make more accurate predictions of the outcome for various control measures, helping the user identify the optimal strategy to implement. Importantly, the adaptability and user-friendliness of the toolbox means it can be used by a range of experts of different backgrounds to study numerous 'what-if' scenarios before making an informed decision on policy or guidance documents.

The success of the modelling approach has also had widespread impact on the monitoring of the UK's plantlife and is expected to play a key role in the future as new diseases emerge. Recently, a tree infested with oriental chestnut gall wasp was identified for the first time in the UK in Kent in June 2015 and Prof. Gilligan was a member of the first-response team. He also chaired The Independent Tree Health and Plant Biosecurity Expert Taskforce which considered the current and emerging threats to the UK's trees and plants. Alongside an advisory group spanning industry, DEFRA, the Forestry Commission, and Border Force, this interdisciplinary taskforce made a number of recommendations that have been accepted by the UK Government and are being acted upon to minimize the risk of plant pests and diseases. It is reassuring to know that the Gilligan group's pioneering epidemiological models form the basis of protecting our crops and woodlands for the future.

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For more information...

www.plantsci.cam.ac.uk/directory/gilligan-chris

www.webidemics.com

www.bio.cam.ac.uk/impact