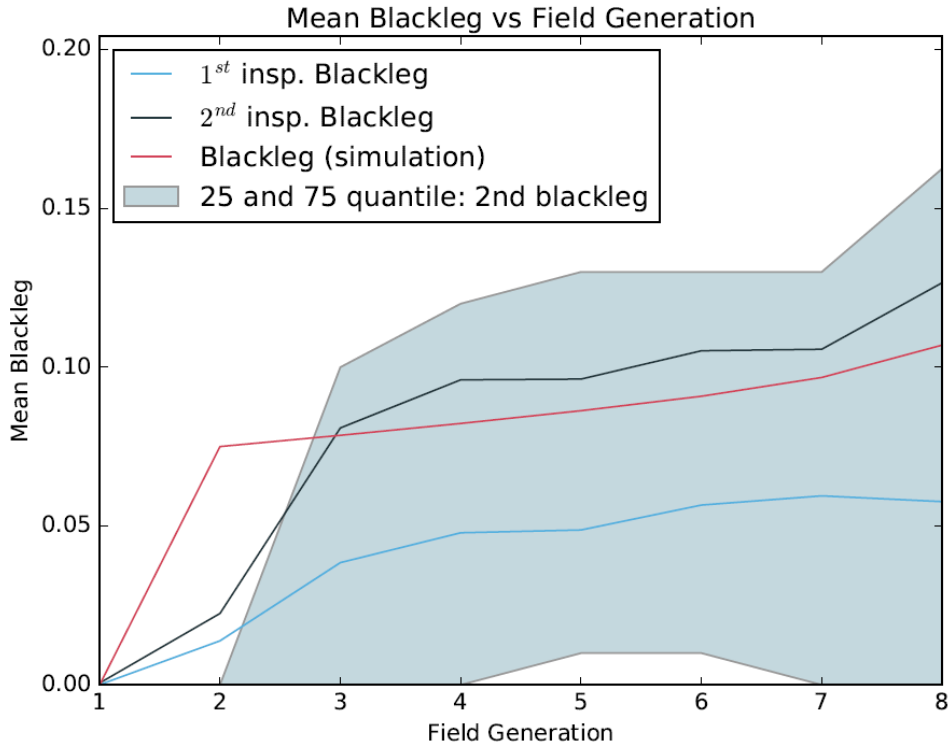
Effects of potato blackleg on farm management strategies

Potato blackleg is a bacterial disease caused by the *Pecto-bacterium* and *Dickeya* species and it is the major cause of potato seed downgrading and rejections in Northern Europe. My 10-week summer research project supervised by Prof Adam Kleczkowski and Dr Jessica Enright (University of Stirling) and Prof Gerry Saddler (SASA) was focused on identifying the optimal farm management strategies which are available to farmers and how sensitive they are to economical or epidemiological changes.

Interestingly data collected by SASA shows that, over the past fifty years, the number of pre-basic growers has been decreasing whilst the total area farmed by pre-basic farms has been increasing. This trend points to a significant change in the typical pre-basic farm: farms are becoming larger and there are fewer and fewer of them. In the first part of my project, I analysed the SPUDS data set which records the presence of blackleg in all of the (anonymised) pre-basic farms in Scotland between 2009 and 2015. I discovered that there is a significant positive correlation between farm size and the relative proportion of blackleg present. This finding is important because it suggests the presence of a strong interaction between the market structure and the prevalence of the disease.

Our conjecture is that potato blackleg disease might be driving the changes in the potato farming market structure. To understand the effects of blackleg on the optimal farm management strategies, I constructed an original mathematical model of the system. This model describes both the epidemiological and economic dynamics at play: it simulates the spread and build-up of the disease within a farm and it predicts the different profits accrued by the farmers by growing their potatoes for differing lengths of time. The model was parameterised by fitting the predicted values to the observed blackleg data from the SPUDS data set. The results of the model outline two management strategies which are represented by combinations of optimal crop rotation length and optimal initial investment at the beginning of a rotation. The first strategy consists of decreasing the size of the initial stock acquired by farmers and by growing the stock for a seven year period whereas the second strategy warrants a shorter rotation length and a heavy increase of the initial investment required when purchasing microtubers. If the disease pressure is low, the best choice is to adopt the first strategy, however, under a higher disease pressure, the best choice is the second strategy. As is customary in game theory, if we assume farmers to be rational agents, we may expect the entire market to behave according to one of the two differing strategies. The model shows that it is however possible to maintain the optimal farm size low if either the price of sale or the husbandry expenses (hygiene) are increased.



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The studentship has allowed me to apply my analytical skills to an important real world problem and it has exposed me to the many intricate mathematical problems that arise from plant pathology. I have learned about potato blackleg disease and how it affects farms throughout Scotland and I have had the chance to work with a real-life data set against which I could test my model. It has been an invaluable experience that has given me the confidence to pursue my career with the knowledge that my work can have a positive impact on the world we live in.

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