Blight prediction model

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## Introduction

About PLB PLB models: short review reflecting different approaches, from purely empirical to a mechanistic model. No upper boundary in the Irish Rules

Why is there a need for yet another blight model? Biology: Advancements in knowledge, diversification of pathogen population, intensification of potato production (bigger fields and more dense halum) Our ability to measure the weather more accuratly. More accurate weather forecast - But how much? Number of models To move the science availability of replicable tools is a necessity. It is realtively easy to transfer it anywhere. Old ‘disease’ of DSSs in agriculture. This research is to be implemented as a reproducible compendum with an accompanying package for the analsis. The R package will include implemendations of functions used in this project, such as model implementation, weather data processing and interpolation and weather forecast investigation. The model will be implemented as a numer of processes which will allow user to select the componenets htat are applicable for his research. Parameters are stored in separate files.

Adjusting models according to field trials with sever blight pressure? This is a problem in Ireland, because it is hard to reach a profitable decision support different from usual practice.

The knowledge and understanding of climate in the environment where the pest/host interaction dvelops is well known for a long time. However, this interaction was adequately quantified only after simulating these relationships using mathematical models (Magarey et al., 2006). The use of mathematical models to understand and control plant disease epidemics and has a relatively long history (Kranz, 1974; Pietravalle et al., 2003). The computer has enabled pathologists to create, evaluate and use these models more efectively. By introducing meteorological data into these models, potential risk of outbreaks and their frequency and severity under favourable conditions can be estimated (Gommes et al, 2008). This is currently an irreplacable segment of current research in plant disease epidemiology with two main groups of models:  
(a) field models working at microscale (canopy layer); (b) territorial models working at mesoscale. The An empirical approach is often applied for creating territorial models, field models are frequently based on more fundamental approach.

Potato late blight is one of longest known and most serious plant diseases, often a limiting factor in potato production (Fry, 1995; Fry, 2005). Developing accurate models has proven dificult. Empirical models have an addvantage of being les laborious to produce and simpler use and calibration, while more complex models have proven necessary to produce the level of accuracy that growers require (Hartill and Young, 1990). However, limitations with current knowledge of pathogen life cycle and its changing nature due to changes in population structure and weather measuring and forecasting abbilities, require certain level of compromise in the development of the model.

Objectives of this work: 1. Implement the modifications to the IR alghorithm aiming to overcome the inherited shortcomings that come with the use of crude thresholds but would still remain simple. The prameters of the Irish Rules have been found to be too conservative in operational use. The modification was propoesed although it is necessary to determine if this modification is resulting in a forecaster that is usefull and economically significanty different from the usual practice, accross differnet climatic zones of the Island of Ireland. 2. Implement the validation using the observed potato late blight disease outbreak data. Run a cost benefit anlysis based on difference in accumulated number of treatments accross time and space. Compare the model(s) based on decision threshold

Sporulation is occuring and whether those spores that are produced will be dispersed in the air and we want to know if those sporangia are transported viable or are killed during transport. Solar radiation is lethal to sporangia and most that are in the air will be killed by the sunlight before they reach another location, and subsequentially, how long they might survive on foliage in that location. We do know that on sunny days they don’t survive as well as they do on cloudy days so conceptually we know that the very worst conditions for dispersal ae a sunny morning so that does enhanced release becomes cloudy fairly quickly and midday and that will enhance survival of spores. Wet leaves at night are enabling germination and infection to occur during the night. These factors are put together into an algorithm which includes the amount of sporulation, the survival of this branch and the likelihood that germination will occur on the succeeding evening.This algorithm then provides a Risk estimation.

With the rapid transmission of data and enhanced computing power we can do real time forecasting to provide guidance for disease management in accordance with the IPM principles.

The temperature correlations are strong on the island. Relative humidity correlation is not as strong as temperature, although a general groups - wet, wetish and dry are fairly strongly correlated.

Goals of this work:  
1. Develop a model with sub components easily usable on their own  
2. Evaluate the model:  
a) Disease outbreak data form NI and ROI  
b)

# TODO Check outbreaks who have the same nearest station.   
# TODO Caclualte yearly weather and risk summaries  
# TODO Try to figure out if there is a correlation with patterns of the weather and the climate.   
# This could be interesting when determining the population growth - the increase of the risk over time  
# Probably need to make histograms for all stations to check if all of the data is ok.

# Methods

## Model implementation

## Sporulation

The sporulation is suppressed by light (De Weille, 1963) Add the effect of wind and rain - check norwegian work.

Major influence on sporulation: temperature and relative humidity Light cycle wind Function for sporulation in relation with relative humidity and temperature Observe sporulation during the night and then look into conditions for infection

Multiplication factor based on the sporulation from the night before Sporulation stops at noon or when the conditions are not fulfilled any more

## Infection

Starts after 10 hours of sporulation and is assessed untill following day at 12 or untill conditions are not met any more.

## Survival

The spores of the pathogen are ….by the sunlight (De Weille, 1963, Mizubuti et al, 2000, Skelsey 2017).

##Validation Do we want to test the sensitivity or do the calibration? Calibrating the model based on the data is misleading practice - because of the agronomy data has could have hiden variables that are not acounted for and could skew th biological principles behind the model.

Model was evaluated using …2…. sets of historical late blight outbreak data. The outbreak data spanned a 12-year period (2003-2014) and consisted of the date and coordinates of …..number of outbreaks… late blight outbreaks from across Northern Ireland. The outbreak data are collected and blight samples are send each year by blight scouts as part of the Agriculture and Horticulture Development Board (AHDB) Potatoes “Fight Against Blight” campaign (<https://potatoes.ahdb.org.uk/>). The coordinates of locations were found using geocoding function of ggmap package (Reference, ).

Additional validation will be implemented based on the difference in number of treatments recomended by the model and

#Weather forecast <http://www.agrometeorology.org/files-folder/repository/gamp_chapt5.pdf> Measure certainy of decision with regards of steps in time. Run simulations with individual variables from the forecasted data (Kim, 2018) Include spraying conditions evaluation - Detlefsen. CART/SLD, was first developed by Gleason et al. (23) and then adjusted by Kim et al. (30). CART/SLD has inputs of wind speed, dew point depression (the difference between air temperature and dew point temperature), air temperature, and RH.

# Dissucion

Necessary to establish upper temperature limit due to possible effect of the climate change  
In the course of developent of hte present model a number of simplifications has been made to find an optimum balance between mimicking the life cycle of the pathogen and the scarcity of the weather network.

Sustaining the activity may hinge upon continued dialogue and collaboration between the four core groups – Meteorologist, Research Officer, Extension Officer, Farmer