# FAR FLUNG *Fungi*

## Mushroom research from around the world

## Statistical modelling for precision agriculture: A case study in optimal environmental schedules for Agaricus bisporus production via variable domain functional regression

Panayi E, Peters GW, Kyriakides G. 2017. PLoS One 12:e0181921.*

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### What's it about?

Sensor network technologies are not just evolving in industrial and home environments, but also increasingly used for precision agriculture. New technologies are driving sophisticated control of nutrition, irrigation, pest and disease control and harvest management in everything from massive broadacre cotton farms to high-tech glasshouses, and everything in between.

Mushroom farming is no exception. The previous MushroomLink magazine featured an article on Mycionics. This company is not only developing robotic harvesting units but also systems that provide detailed maps of $CO_2$ levels, humidity, temperature, moisture and airflow across sectors of individual beds.

Collecting all this big data is all very well – but how can you use it?

This is the focus of the Panayi *et al* paper – using sensor data to optimise environmental conditions within a mushroom farm. Detailed data was gathered on compost type, pH, moisture content, air temperature, oxygen and $CO_2$ levels, evaporation rates and growing time. Data was recorded at 30 minute intervals over 92 growing cycles in a modern, shelf system mushroom farm.

The researchers then used complex statistical modelling to understand the impact of key environmental conditions on yield, developing models that aimed to find the optimum growing conditions for mushrooms.

One of the issues faced was the variability in the total growing time for each crop. They therefore expressed growing time as a proportion of the total time, rather than in days after casing.

### What was concluded?

The researchers developed a mathematical model that could predict the optimal level of each environmental variable during the growing period. This included how different factors (temperature, humidity etc) interacted with each other to produce effects on yield.

A cost function was then added to account for additional energy, labour, wear and tear of the device etc. required to change the physical environment to the new environmental condition.

The aim of the system as a whole was to allow a grower to select the combination of controllable environmental conditions most likely to optimise yield on their farm, while taking into account uncontrollable drivers such as local conditions and costs.

In the case of the farm used to develop this model, one of the key findings was a clear impact of oxygen concentration on total yield. The results showed that a lower oxygen level (approximately 20%) was beneficial on the first two-thirds of the growing process, while normal oxygen levels (21%) contributed to increased yields in the final third of the cycle.

For temperature, higher temperatures (potentially up to 21°C) were beneficial over the first half of the cycle. During the second half, warmer temperatures were only beneficial if the growing time was extended.

The mathematics presented in this paper are extremely complex. It is certainly not something that could be readily applied on farm in its current state. However, models such as this could potentially provide the engine room of environment optimisation software, allowing advanced monitoring and control of every part of the growing room.

Mushroom farming has long relied upon grower instinct, and although the advent of Smart Farming cannot replace years of experience, but it might at least allow a few more days off.