Development of a novel and effective post-harvest decision support system (DSS) for stored cereals to minimise mould spoilage and mycotoxins in food

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Project Description: UK grain production represents a value of £2 Billion in ex-farm gate value. Post-harvest losses and rejection due to fungal spoilage and mycotoxin contamination often represents between 5-10% of this value, especially in wet harvest years. This has significant impacts on food/feed chains where rejection has occurred. It is thus critical that during grain drying and post-harvest storage, nutritional quality is conserved for down-stream processing. This is important economically for farmers and for the grain trade and processing industries. The problem is that while there is a significant focus on pre-harvest disease control, post-harvest losses due to fungal spoilage and mycotoxins have received less attention although they can result in rejection and thus significant economic losses. This PhD project is thus going to contribute in the development of a rapid and reliable Decision Support Systems (DSS). This could be effectively utilised as a management tool that will be beneficial for minimising such losses of raw material quality post-harvest.

The DSS system will draw information from different scientific areas including the need of better knowledge of the mycobiome at harvest in both dry and wet years. Studies at Cranfield have previously identified that because cereals are respiring, changes in CO2 can be a very early indicator of poor hygiene due to initiation of mould growth and increased risks of mycotoxin contamination, especially related to zearalenone, ochratoxin A, and T-2 and HT-2 toxin (in oats) (Garcia-Cela et al., 2018). Studies are needed to evaluate the initial mycobiome, and kinetic changes during drying and storage. Our data has also previously shown that dry matter losses of <1.0% can result in an exceedance of the prevailing legislative limits for these and other toxins (Garcia-Cela et al., 2019). The student developing this project will work with the **hypothesis that by identifying and quantifying both the mycobiome and the mycotoxin profile** (as part of the fungal metabolome) **at harvest, using a combination of CO2 measurements in store and linking this to biological models on boundary conditions for growth and mycotoxin production, it will be possible to develop an integrated post-harvest DSS for improved management of stored cereals and reduce waste streams.**

Objectives
The main objectives are to (a) examine harvested cereals in different parts of the UK including N. Ireland and quantify mycobiomes to identify dominant toxigenic and spoilage moulds and the mycotoxins produced by these species in relation to weather conditions at harvest; (b) examine the use of infra-red CO2 sensors which could be used for monitoring on-farm grain stores and in silos; (c) integrate CO2 measurements with boundary temperature x moisture content models for growth/mycotoxin

production in cereals destined for food and feed use (wheat/barley/maize/oats); (d) testing of integrated real-time system in small and pilot scale grain silos with different stored cereals with initial safe, intermediate and poor moisture contents and sampling in different positions in three dimensions to both identify and quantify the initiation of spoilage mould activity (mycobiome analyses) and the mycotoxins (free and conjugated (masked) mycotoxins); and (e) examine the cost-benefit analyses of such a DSS tool for improved post-harvest management of cereals and minimisation of post-harvest losses.
This approach will have wider beneficial effects for both the sustainable and organic grain sectors and improve post-harvest management of these economically important grain food/feed chains.

References:

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