

## ON FARM DEMONSTRATION AND KNOWLEDGE EXCHANGE

- new technology demonstration and training
- protocol validation by end users

## ON FARM LABORATORY SERVICES

- on-farm sampling, processing and storage
- developing on farm diagnostic tests
- environmental monitoring
- precision agriculture data collection hub
- UAV imaging, hyperspectral and crop sensors
- data handling and real-time interpretation





I head up the detection and surveillance technologies team at Fera. A plant virologist and molecular biologist by training, in recent years I have focused on the application of post-genomic technologies to provide solutions to detection, identification and diagnosis of plant diseases. The research of the team is focused in two areas, firstly on the development of tools for use in centralised laboratory facilities or at the point of decision making either by non-specialist users or as stand alone in-field automated solutions. Secondly, on the use of non-targeted methods (e.g. next generation sequencing) for the detection and characterisation of unknown disease causing agents. I maintain an interest in virology in particular the interaction between viruses and plant hosts and the evolution of virus species.

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A cyclone based air sampler for trapping particulate matter from air and depositing dry into micro-centrifuge tubes for further analysis. The unit is battery powered to enable it to be run remotely and can be programmed for different timing and periods of collection, each collection is deposited in a separate tube. Examples are the sampling of spores from air-borne plant pathogens, enabling an understanding of timing and quantity of spores captured when linked to Genie III or qPCR or the diversity of spores when linked to Minlon technology. The key advantage of a multi-vial cyclone compared with traps containing sticky tape is the availability of material for down-stream analysis.





Genie III is a hand held, battery powered DNA amplification device for running Loop mediated AMPlification (LAMP) assays. LAMP, like PCR enables sensitive and specific amplification of target genes in hosts or pathogens, for example, detection of pathogens in plants or the detection of resistance genes. The key advantages of LAMP is that little sample pre-processing is required prior to amplification and results can be achieved in less than 20 minutes, making it ideal for in-field testing.

The MinION is a next generation sequencing device based on nano-pore sequencing that can be run by connecting to a lap-top with a fast internet connection enabling data analysis in the cloud. The MinION sequencer can be used to generate de-novo sequence from samples in a highly parallel fashion. Examples could be profiling soil microbes, transcriptomics in host-plant interactions or characterising the causal agents of disease. The key advantage of MinION are that it can generate long sequence reads compared with other platforms potentially making sequence assembly simpler and can be run without direct access to significant computer infrastructure.



Lateral Flow Devices (LFD) are an infield test format similar based on the same chemistry as pregnancy testing kits. Lateral flow devices can be used to detect and quantify levels of proteins or other molecules where specific antibodies (or potentially other binding ligands such as aptamers) are available. Examples could be detection of pathogens or quantification of proteins associated with resistance traits. The LFD reader enables estimation of the intensity of detection lines on LFDs of most relevance to quantitative tests.



I am a Senior Research Associate in the Crop Protection Group in the School of Agriculture, Food and Rural Development at Newcastle University, UK. I have held Post-doctoral research positions at Durham University and the University of York, which have enabled me to pursue my interests in plant secondary metabolism and in particular, how plants respond to and detoxify xenobiotic compounds such as herbicides. My current project at Newcastle University involves investigating the basis of herbicide selectivity in crops and competing weeds.

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Rapid evaporative ionization mass spectrometry (REIMS) can be used to identify molecular markers responsible for sample differences. The knife hand-held sampling device produces a vapour containing small molecules from the surface of the sample which is then analysed by mass spectrometry. Possible applications include phenotyping, authenticity testing and screening for traits. The key advantages of REIMS that there is no sample preparation or chromatography required, allowing rapid analysis of large sample sets.





The Acquity QDa mass detector performs ultra-performance liquid chromatography enabling the separation of small molecules from complex mixtures and the identification and quantification of individual molecules of interest using both optical and mass detection. Example applications include detection of pesticides in plants and quantification of chemicals linked to enhanced nutritional properties. The mass detector enables identification of specific molecules that would usually require the use of large specialist instrumentation.

The PCR instrument enables the amplification of DNA/RNA for downstream applications. The resulting amplicons can be separated using the Sub-cell GT Cell and visualised using the UVP GelDoc. Down-stream application include identification of genes and other sequences via Sanger sequencing or cloning into vectors for expression as recombinant proteins.





I carried out my PhD thesis at the National Institute of Agricultural Technology (INTA) and at the Institute of Biochemistry and Molecular Biology (Argentina). During that time I studied the pathology produced by the Epinotia aporema granulovirus (EpapGV) on its host Epinotia aporema, a major pest of soybean in Argentina. I also carried out the first molecular and functional study of a putative envelope-fusion protein of the Epinotia aporema granulovirus (Epap-F) involve in cell colonisation

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The iBlot and associated equipment are used during immunoblotting for the detection of individual proteins in complex mixtures using specific antibodies. Proteins are extracted from samples, separated on a gel by SDS-PAGE using the Mini-PROTEAN Tetra Cell and then transferred to a membrane using the iblot dry blotting system. Applications include detection of proteins associated with stress responses. The advantage of the iblot dry blotting system over conventional wet blotting systems is the speed of transfer whilst maintaining reproducibility and reliability.



I combine advances in ecological network analysis with DNA-metabarcoding to examine the impacts of environmental change on species-interactions and ecosystem functioning. I am currently studying the consequences of altered network structure on fungi, plant and animal populations, mainly within forests and agro-ecosystems.

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The qPCR (Light Cycler) and associated equipment (Qiacube and Nanodrop) are for the amplification and quantification of DNA/RNA using real-time or quantitative PCR. Examples could be monitoring the up or down regulation of transcripts or the detection and quantification of pathogens in plants or soils. The key advantage of qPCR is that it is a highly sensitive and specific, closed-tube, real-time system for the accurate detection and quantification of DNA targets.



Catherine's research involves investigating plant responses to environmental stresses. This is important for the discovery of plant health biomarkers, such as black-grass herbicide resistance, which are being developed as a diagnostic in-field tool-kit for informing weed management.

A second aspect of Catherine's research is the effect of plants on their soil environment, which can in turn alter plant health. Different plants can harbour specific soil microbiomes, thought to be linked to plant health.

Understanding how plants are linked to their specific microbiomes may be used to engineer soil microbiomes for improved crop health.



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## Asset Champion – Dr James Kitson



I am a postdoctoral research assistant in Darren Evans' Network Ecology Group. I develop and use DNA barcoding tools to detect species interactions. Specifically I am interested in the interactions between plants, their insect herbivores and the insect parasitoids that exploit the herbivores. The aim is to more fully understand how these aspects of ecosystems are structured and to use this knowledge to enhance biological control of pest and invasive species.

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William's research involves investigating how plants respond and adapt to their environment, with a particular focus on the role of cell walls – the carbohydrate-rich casing that surrounds almost all plant cells. Cell walls are protective barriers that provide support and regulate growth, but they also display remarkable plasticity and are a dynamic interface between the plant and the outside world.

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The MM400 ball mill (homogenizer) is essential for rapid and consistent sample processing of a wide variety of plant samples. The mixer mills are highly versatile and can handle a wide range for materials - ranging from relatively soft organs like leaves or tubers, to very tough material, such as wood. Most analytical techniques require that samples are first disrupted such that molecules of interest can be extracted. It is vital that homogenisation is consistent between samples and experiments. We have two Mixer mills available so that if necessary, in field processing can be accurately reproduced in a lab setting.



The stereo microscopes are an important asset in terms of monitoring samples and selecting materials or processing. For example, they can be used for visually checking for disease or the physical state of plant organs and tissues prior to downstream analysis. These observations are important to ensure that selection of materials is as consistent as possible.



The aim of my current research is to understand the adaptive responses to stress in crops and deliver knowledge and tools to aid breeding for increased resilience to environmental stress conditions. This involves developing high throughput technology and methodology for phenotyping using imaging sensors and use these to fully exploit our ability to perform high throughput genotypic analysis.

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Stomata opening and closing regulates the leaf temperature, with temperature rise under stress conditions and vice versa and thus, the concept of Infra-red thermography (thermal imaging) has tremendous potential for plant stress evaluation as water loss occurs through stomata. Instead of using porometer and gas analyser's for point measurements and evaluating stress in plants, infrared thermography can provide give a better indication of crop stress (pre-visual) under both glasshouse and field conditions. We will facilitate stress detection (using thermal imager) in different crops using normalised techniques which will help in further biotic and abiotic stress quantification using other assets available.



The Handy PEA chlorophyll fluorimeter consists of a compact, light-weight control unit encapsulating sophisticated electronics providing the high time resolution essential in performing measurements of fast chlorophyll fluorescence induction kinetics.



My research interests lie in the related domains of precision farming in arable and horticultural crops and high-resolution digital soil mapping. I have worked with a wide variety of crops (cereals, grapes, apples, and kiwifruit) in Australia, New Zealand, North and South America and Europe. My particular research interest at the moment is in the development of spatial decision support systems for agricultural production systems.

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This is a 3-band Visible NIR hand held active optical sensor. It emits light and measures the reflectance in the Red, Red Edge and Near Infrared bands. Typically it is used to assess reflectance from plant material. Changes in reflectance in red-NIR section are associated with plant health and photosynthetically active biomass.

The sensor has an in-built GPS so all data are geo-referenced. It is intended for plot scanning so can average measurements over short (1s) to long (1min +) timeframes.

It is non-specific – it indicates if a plant has higher or lower vigour but not why i.e. cannot differentiate between biotic and abiotic stress effects on plants. The display indicates NDVI or NDRE values however the downloaded data includes the band (R, RE, NIR) information.





### Professor of Food & Society

- Interests in all areas of food and society, including those areas which require transdisciplinary collaboration between the social and natural sciences
- Translating the results of research into actionable policy recommendations

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### Social Science Research

- Identify barriers to, and facilitators of, agri-food technology adoption by farmers and other stakeholders.
- Bridge gaps between agri-food policy needs and scientific evidence
- Identify emerging societal risks to sustainable agri-food production



## Asset Champion – Mr Steven Hall



I am manager of the Institute of Agri-Food Research and Innovation and co-ordinate the Agritech Centres based at Newcastle (CHAP and CIEL). If you would like further information on Newcastle's research capability or CHAP funded equipment please contact:

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Lab to Field Demonstration units have been created to be fully functional laboratories with unique design functions that will allow a whole host of scientific equipment to be deployed in the field. They also can be used as a platform for scientific demonstrations at trade shows and training events. The trailers are small enough to be deployed in remote areas and are self sufficient in power and communications.



A state of the art laboratory has been created at Newcastle Universities' Cockle Park Farm in Northumberland. This lab will be the base for the many crop scientists we have at Newcastle and its primary function is to compliment our remote activities using the demonstration units.