THE UNIVERSITY OF SYDNEY

Sydney Institute of Agriculture

AgTech and Food: Industry Capabilities

Drought and Risk Management

Embedding world-leading research on farms and in communities

Expertise

The Sydney Institute of Agriculture has significant experience in improving crop species for drought tolerance and water-use-efficiency for major crops globally - like wheat and legumes.

The Plant Breeding Institute has significant capacity and experience in the genetic improvement of crop species for water-use-efficiency and drought tolerance. Drought adaptive traits are identified, characterized and validated from extensive germplasm collections that include adapted cultivars and wild crop relatives. These traits are pyramided in agronomically superior backgrounds using integrated molecular genetics, plant physiology, high throughput phenotyping and optimized data management. The products are evaluated nationally using genomic estimated breeding values and associated environmental covariates to identify sub-groups of genotypes based on their predicted performance in other grain growing regions of Australia.

A resilient agricultural system builds capacity across a wide range of areas to ensure the ongoing, sustainable and smooth growth of the agricultural sector, to manage risk and withstand the shocks and disruption that often occur. Building economic resilience is critical. Finding ways to improve farm gate returns is a key policy goal of the Australian government. Increasing the profitability of agriculture is often a precursor to improving resilience in other areas. The ability to forecast and prepare for potential future risks, shocks and disruptions to agriculture and to build economic resilience will rely on strong scientific and evidence-based research.

The University of Sydney operates farms in different climatic regions across New South Wales which are used for field-based research to develop technologies at operational scales right up to commercial levels.

Tools and methodologies used

Our researchers use technologies and methods such as:

- plant breeding
- profitability analysis
- farming systems research and analysis
- risk analysis
- seasonal forecasting
- digital technologies
- integrated bio-physical and economic modelling
- drought forecasting and monitoring.
- understanding drought legacies with a combination of field observations in the rangelands, remotely-sensed data on vegetation greenness fraction, manipulative experiments reducing rainfall inputs, and innovative modelling approaches to build ecosystem forecasts under future altered environments.
- evaluation of economic efficiency of irrigated agricultural enterprises, including environmental effects from irrigation such as drought contributing water depletion and salinity.
- market-based instruments for environmental water recovery and the role of the water market in drought mitigation.
- integrated bio-physical and economic modelling of irrigated agricultural enterprises under alternative water availability conditions.

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Case studies

Improving heat tolerance in wheat and chickpeas: Our heat tolerance work is now approaching the stage where germplasm and associated genetic knowledge is incorpoated into plant breeding.

Hybrid wheat for food security:
We are researching hybrid wheat – both the methods to produce hybrids, and also the genetics required so that the hybrids will be successful in commerce.

Integrated genetic solutions to crown rot in wheat: We have produced new wheat genetics, combining many sources of resistance by molecular marker assisted breeding and advanced phenotyping. This trait is now in high-yielding lines.
These lines, and the marker knowledge are being used by commercial breeders for their product development.

Soil moisture nowcasting and forecasting: This approach uses different data streams relates to soil moisture and combine these with process models, geospatial data and data analytics to predict the current and future status of soil moisture. The predictions are made on a daily time step at the sub-hectare resolution and for different depths in the soil profile. The predictions can be used to vary management season to season based on risks associated with drought.

Site-specific crop management and are investigating management zones for drought tolerance: All fields/paddocks can be divided into management zones. We are working on ranking these zone's resistance to drought or alternatively the risk of crop failure under drought conditions. Under this approach by predicting the dry season, it can be determined if a whole paddock or part of a paddock should be sown.

Our experts

Associate Professor Daniel Tan (Research Capability Coordinator): crop agronomy, specialising in crop abiotic stress and farming systems. His specific interests within crop abiotic stress are in physiology, especially high temperature tolerance.

Dr Kedar Adhikari: leads the faba bean breeding program for northern New South Wales and southern Queensland to provide alternative crops to wheat in rotation.

Associate Professor Tiho Ancev: agricultural, environmental and resource economics, economics of precision agriculture, integrated biophysical and economic modelling, productivity and efficiency analysis.

Professor Eddie Anderson: research on supply chains, particularly in relation to contracts and risk.

Dr Helen Bramley: plant physiologist working with plant geneticists/breeders to help uncover the basis of stress tolerance and water use efficiency, and to develop rapid screening methods for these traits.

Associate Professor Thomas Bishop: modelling and predicting the variation of environmental properties in space and time with an emphasis on applying this to soil and water science.

Dr Philip Davies: both a pathologist and plant geneticist and an expert on the root diseases of cereal crops, the impact of which is exacerbated by drought.

Associate Professor Feike Dijkstra: uses ecosystem simulation models to better understand the importance of plant-microbial interactions for carbon and nutrient cycling in ecosystems affected by global change.

Professor Brent Kaiser: expert in pulse legumes, and nitrogen fixation and distribution in these and other crops.

Dr Angela Pattison: researches drought and heat tolerance in cereals and methods plants use to maintain growth during water-stress, with the aim of releasing high yielding lines which cope well in both drought and average seasons.

Associate Professor Guy Roth: research on crop agronomy, plant stress, irrigation, water use efficiency, biodiversity and soil health.

Dr Rebecca Thistlethwaite: key wheat heat tolerance researcher, developing screening methods, and advanced genetic materials.

Professor Richard Trethowan: interested in developing crop cultivars that use water more efficiently and better adapt to increasingly hostile production conditions. Genetic variation for stress tolerance can be introduced into commercial cultivars from ancestral forms of the world's most important food crops.

Dr Floris van Ogtrop: focuses on identifying links between water quality and human, animal and plant health. Also interested in applied statistics for seasonal climate forecasting, hydrological prediction and environmental modelling.

Associate Professor Willem Vervoort: complex models to characterise key landscape, climate and water relationships and to support experimental work.

Professor Glenda Wardle: Expert in long-term monitoring of arid ecosystems and how changing environmental conditions of drought, flooding rains, fire and ferals interact to drive booms and busts in plant and animal populations.

Associate Professor Brett Whelan: improving the efficiency of crop management in terms of input and water use within fields and farms by understanding the natural variability in crop production and identifying site-specific management responses.

For further enquiries contact:

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