PhD Position (36 months) – Drought Stress and AI-Based Modelling UKUDLA Programme (African-German Centre of Excellence for Food Systems and Data Science)

Joint Doctorate: University of Hohenheim, Stellenbosch University & University of the Western Cape.

We invite applications for a fully funded PhD position within the UKUDLA Programme, addressing challenges at the food–water–climate nexus. The doctoral project focuses on drought stress physiology, nutrient dynamics, and digital agriculture in viticulture, combining field experimentation, controlled studies, remote sensing, and AI-based data integration. The research aims to develop predictive, data-driven models linking vine water status and nutrient responses to berry composition and wine quality under climate change.

About UKUDLA
UKUDLA is a collaborative, transdisciplinary initiative committed to training the next generation of research leaders at the **intersection of data science and food systems** in Africa. The network supports capacity strengthening through multi-institutional partnerships, dynamic training opportunities, and a strong focus on impactful, applied research.

Doctoral Project
Multi-scale analysis of drought stress effects on vine physiology, metabolism, and wine quality in Chenin Blanc using remote sensing and AI

The PhD candidate will:

- Investigate vine water relations, osmotic adjustment, and drought physiology
- Quantify potassium (K) and nitrogen (N) uptake dynamics under water stress
- Apply proximal and remote sensing methods
- Use machine learning and AI methods for stress classification and prediction
- Integrate physiological, metabolic, and wine quality datasets across seasons

Research will be conducted through multi-year field trials in South Africa and controlled experiments in Germany.

Hypothesis
Graded drought stress induces coordinated and measurable changes in vine water relations, nutrient uptake (potassium and nitrogen), osmotic regulation, and primary and secondary metabolism at both leaf and berry levels. These processes result in distinct metabolic reprogramming pathways that ultimately determine grape composition and wine sensory quality. The magnitude and structure of these responses are modulated by rootstock genotype and nutrient-use efficiency and can be non-destructively detected, quantified, and predicted through the integration of multi-source proximal and remote sensing data using AI-based modelling approaches.

Brief Description of the Project

This project examines how graded drought stress affects vine physiology, nutrient dynamics, and metabolic expression in Chenin Blanc, and how these responses translate from plant function to grape and wine quality. The central premise is that drought drives coordinated adjustments in vine water relations, potassium (K) and nitrogen (N) uptake, and osmotic regulation, triggering tissue-specific metabolic reprogramming in leaves and berries that shapes wine chemical and sensory attributes. These responses are strongly influenced by rootstock genotype and can be quantified and predicted using digital phenotyping and artificial intelligence.

The research combines multi-year field experiments in Stellenbosch with controlled pot trials in Hohenheim, allowing both ecological relevance and mechanistic insight. Vine water status and drought intensity are assessed using a multi-scale sensing approach, integrating soil and atmospheric measurements with proximal and remote sensing for continuous, non-destructive monitoring of plant stress.

Physiological responses, including water status, gas exchange, and osmotic regulation, are linked to K and N nutrition and rootstock-dependent uptake efficiency. Metabolic profiling at leaf, berry, and wine levels is combined with wine chemical and sensory analyses to establish links between drought intensity, metabolic signatures, and quality outcomes.

Finally, AI- and machine-learning-based models integrate multi-year datasets to identify key drought-response drivers and predict grape and wine quality, supporting data-driven strategies for climate-resilient viticulture.

Supervision and Training

The doctoral candidate will be jointly supervised by senior researchers at University of Hohenheim, Stellenbosch University and University of the Western Cape.

The PhD will be embedded in an interdisciplinary, international research environment with structured training in:

- Plant physiology and viticulture
- Digital phenotyping and remote sensing
- Data analysis, modelling, and scientific publishing

Funding

- Duration: 36 months
- Mobility: 24–30 months in South Africa; 6–12 months in Germany
- Funding scheme: UKUDLA Programme
- Monthly stipend: €1,800 during the research stay in South Africa and €1,300 during the research stay in Germany
- Research budget: Up to €20,000 for consumables
- The position is fully funded and does not require teaching obligations.

Eligibility and Required Qualifications
Hold a Master's degree (or equivalent) in Viticulture, Agronomy, Plant Physiology, Agricultural Engineering, Environmental Sciences, or a related discipline. Demonstrate strong interest in climate adaptation, digital agriculture, sensing technologies, and data-driven modelling. Have experience in field or experimental research; quantitative data skills are advantageous. Hold German citizenship (mandatory requirement of the UKUDLA Programme). Meet doctoral admission requirements of the partner universities

Application Documents

- Motivation letter (max. 2 pages) describing research interests and suitability
- Curriculum vitae
- Academic transcripts and degree certificates
- Contact details of at least two academic referees

Start Date
Flexible – as soon as possible

Equal Opportunity Statement
We are committed to equal opportunity, diversity, and gender equality. Applications from qualified women and candidates from underrepresented groups are particularly encouraged.

Scientific Context and UKUDLA Alignment
This PhD contributes directly to UKUDLA priorities by:

- Addressing water scarcity and climate resilience in agriculture
- Promoting digital innovation and AI-based decision support
- Strengthening South–North academic collaboration and capacity building
- Supporting sustainable, high-value food production systems