Project 3_1 Hydrothermal Treatment of Agricultural Waste for High-Value Carbonaceous and Biochemical Products

PC Hub Theme (see list here)
Theme 3: Waste Valorisation – Extraction and Processing Technology
Principal supervisor
Prof Kathryn Mumford (University of Melbourne)
Co-supervisor(s)
Prof Monika Doblin, Dr Bill Lu

The ARC Research Hub for Protected Cropping (ARC PC Hub) is driving a transformation in Australia's horticultural and medicinal agriculture industries by advancing protected cropping (PC) and improving sustainability, crop quality, yield, and reliability. Through cutting-edge research and industry collaboration, the PC Hub addresses critical knowledge gaps to unlock the full potential of PC systems.

Applications are invited for a PhD project investigating the hydrothermal treatment (HTT) of agricultural residues to produce high-value carbon materials, chemicals, and nutrient-recovered liquid products. This project targets candidates with strong technical backgrounds in chemical or environmental engineering, chemistry or materials science, and a keen interest in biomass valorisation.

Agricultural waste streams—rich in lignocellulosic polymers, lipids, proteins, and inorganic nutrients—offer significant potential for conversion into engineered products via hydrothermal carbonisation (HTC). This project will systematically explore how process parameters such as temperature (150–350 °C), pressure (saturated steam to subcritical water), residence time (minutes to hours), solids loading, acidity/alkalinity, catalysts (heterogeneous catalysts, alkali/acid promoters, metal salts), and biomass pre-treatments influence product selectivity and quality.

High-value product pathways of interest include:

- **Functional carbon materials**: mesoporous hydrochar.
- **Chemicals**: levulinic acid, phenolics, organic acids, and intermediates from lignin depolymerisation.
- **Bio-crudes and biopolyols** from hydrothermal liquefaction of lipid- or protein-rich residues.
- **Nutrient-rich process waters** containing soluble N, P, and K suitable for recovery via precipitation, ion exchange, or membrane separation.
- **Hydrochar soil amendments** engineered for improved cation exchange capacity, carbon stability, and water retention.

The PhD candidate will:

- Conduct systematic parametric studies to map reaction pathways and optimise yields of targeted products.
- Employ advanced characterisation (FTIR, GC-MS, LC-MS, XRD, BET, TGA, ICP-OES) to elucidate transformation mechanisms and structure–property relationships.
- Integrate kinetic and thermodynamic modelling to understand conversion behaviour under hydrothermal conditions.
- Evaluate the scalability, environmental performance, and techno-economic feasibility of selected valorisation routes.

The project provides access to high-pressure reactor systems, comprehensive analytical facilities, and strong industry and interdisciplinary research networks.

How to apply

The PC Hub offers a limited number of competitive scholarships.
To apply, please email the following documents to pchub@latrobe.edu.au by **15 February 2026:**

- Application form completed
- Up-to-date CV
- University transcripts

Only shortlisted applicants will be contacted.