



Modular On-Farm Biorefinery: From Grass to High-Value Fractions for Feed, Chemicals, and Materials

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Abstract

The Hohenheim on-farm biorefinery concept has a modular design, enabling flexible deployment and adaptation to local conditions. The overall approach involves a fraction-driven valorisation strategy that creates multiple value chains from fresh grass, thereby supporting the goals of the circular bioeconomy. The first pathway is protein-oriented: mechanical pressing and downstream recovery generate a protein-rich fraction that can be used in monogastric animal feed or upgraded for human consumption. This creates new opportunities for utilising grass-derived nutrients in food and feed systems by addressing the issue that monogastric animals cannot usually digest grass directly due to its limited fibre digestibility. The second pathway utilises the sugar-rich brown juice as a versatile substrate for biotechnological and thermochemical upgrading. A key target is 5-hydroxymethylfurfural (HMF), which can be used as a building block for bio-based chemicals and materials. Additionally, the modular design allows for alternative conversion routes to be selected based on market demand, regional infrastructure and local feasibility, creating multiple opportunities for collaboration and scaling up. The third pathway focuses on the solid press cake residue, which can be directed into outlets aligned with fibre and carbon value chains. Promising applications include the production of grass paper and fibre-based materials, biochar, and the use of the residue as reduced-calorie roughage suitable for ruminants and horses. Together, these pathways demonstrate how a modular on-farm biorefinery can convert grass into valuable components and by-products, providing a practical basis for integrated rural value chains and collaboration between the feed, chemicals, and fibre industries.