

BIOTECH INNOVATIONS IN AGRICULTURAL SUPPLY CHAINS



BY

HUZAIFA ALI01-116221-008

OSAMA IMTIAZ QURESH01-116221-017

BS-SUPPLY CHAIN MANAGEMENT

SUPERVISOR:

MISS AYESHA ZAREEF

***Department of Management Studies, Bahria Business School, Bahria
University, Islamabad, Fall 2025***

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ABSTRACT

This paper discusses the introduction of modular algae biorefineries into the supply chains of agriculture as a sustainable and circular solution to resource management. The study employs a qualitative and analytical approach to research, where secondary data, quantitative modeling, scenario testing, and comparative benchmarking parameters used in pilot studies are published in the scientific literature were used. The suggested system is a farm-based closed-loop bio-technology system that aims to trap CO₂, treat wastewater, and transform biomass into reusable agricultural substances, which will decrease reliance on synthetic fertilizers and low environmental impact. Analytical findings suggest that the model is technically viable, environmentally sound, and consistent with the goals of the circular and regenerative agriculture. Nevertheless, the paper also marks down the practical issues and adaptation strategies needed in the real-life implementation, such as resource specifics to the location, resource constraints, and regulatory factors. With consideration of these elements, the study offers both a conceptual and practical guidelines on the application of modular algae biorefineries at the farm level which has potentials to boost production, increase soil health and mitigate emissions. This study has made an impact to the new discipline of sustainable Agri-biotechnology since it has shown that biorefineries can be integrated into agricultural supply chains in both the developing and developed settings in a scalable manner.