

INFO BRIEF

Whey Valorization for a Sustainable Future: Opportunities and Pathways in the Circular Bioeconomy

Ursulla Wandili, Betty Mohe, Salma Omollo, Betty Mahinda, Catherine Kilelu

Peter Ongalo (Layout and format)

May 2025



Supported by the
Ministry of Foreign
Affairs of Denmark

Key Messages

- The circular bioeconomy provides Kenya with a transformative framework to shift from a linear “produce-consume-discard” model to one that regenerates, reuses, and maximizes biological resources for sustainable growth.
- Whey valorization stands out as a strategic pathway within this transformation, turning a widely wasted by-product into high-value products that support food security, climate resilience, and economic diversification.
- Life cycle assessments and sector analyses show that redirecting whey from waste streams to productive uses can significantly reduce greenhouse gas emissions, improve resource efficiency, and unlock new market opportunities.
- Scaling up whey valorization requires a systemic approach that combines policy reforms, research and innovation, targeted investment, and inclusive governance to ensure equitable participation and benefit sharing.

Overview

The dairy industry in Kenya is crucial for ensuring food security and nutrition, promoting economic development, and supporting rural populations livelihoods. The industry is growing, with increased processing of diverse products such as yogurt and cheese. However, a major challenge confronting the expansion in processing in the sector is increasing side streams such as whey, a nutrient-rich byproduct produced during the manufacturing of cheese and Greek yogurt.

Whey is composed of approximately 94% water (6% total solids), 4.5% lactose, 0.8% protein, and 0.7% minerals contributing to its health benefits for muscle growth and recovery. The method of production determines whether whey is classified as sweet or sour. Sweet whey is generated using rennet enzyme to coagulate milk for hard cheeses such as cheddar or Swiss. In contrast, sour whey is created when acid or acidic bacteria are employed to coagulate milk for soft cheeses like mozzarella or cottage cheese.

Traditionally, whey has been regarded as waste, resulting in environmental pollution and financial losses. The principle of waste-to-resource, known as valorization, presents a viable solution for achieving sustainability in dairy processing. Recently, whey has gained recognition as a valuable valorization product, improving the economic opportunities for both dairy processors and farmers, and thus aiding the progress of the circular bioeconomy. The circular bioeconomy signifies a shift from conventional linear production and consumption patterns to a more circular model, fostering sustainability within the dairy sector.

The partners of the VALORISE project, including the African Centre for Technology Studies (ACTS), Roskilde University, Danish Technical University, Arla Foods in Denmark, Egerton University, the International Center for Tropical Agriculture, along with various stakeholders from the dairy sector and research institutions, stressed that the effective utilization of whey is essential for achieving sustainability and fostering economic growth within the industry.



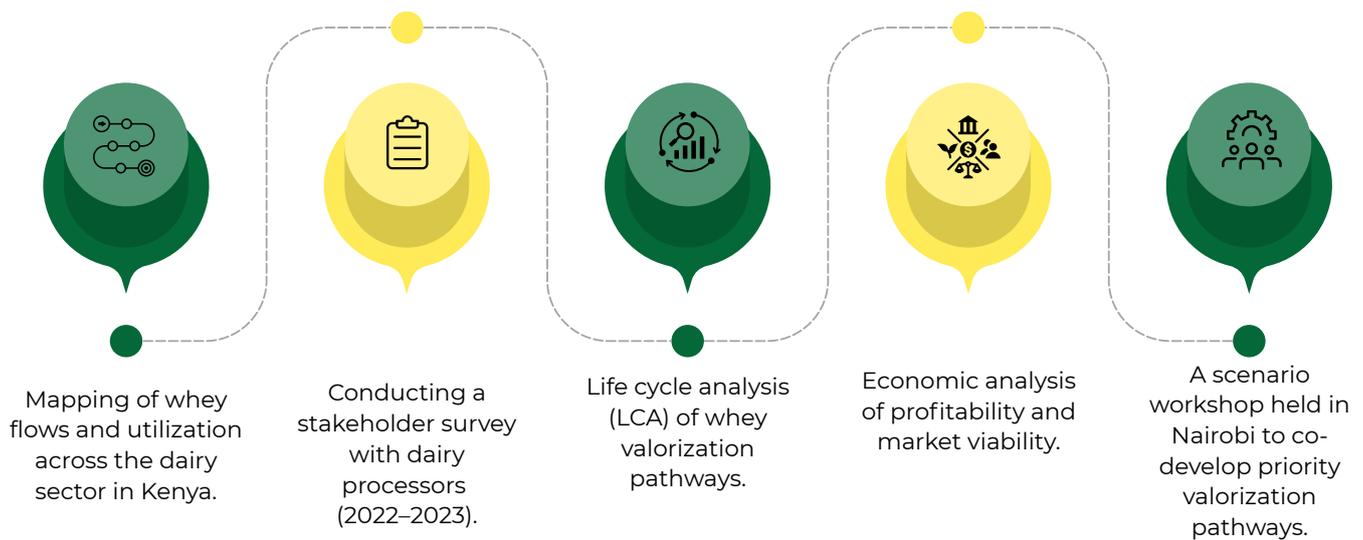


Figure 1: The VALORISE Project – Research Activities and Scenario Workshops.

Key Findings: Pathways, Evidence, and Emerging Opportunities

Understanding the Landscape: Waste, Resource Potential, and Missed Value

Kenya's dairy sector processes thousands of tonnes of milk annually, yet a significant portion of the resulting whey remains unused. A sector-wide survey conducted under the VALORISE Project in 2022-2023 revealed that around 80 percent of whey generated by processors is not valorized, with about 40 percent routinely discarded. This practice reflects the absence of collection systems, high transportation costs, limited market demand, and a lack of awareness of whey's potential applications.

Whey is far more than a waste product. Comprising 94 percent water and containing valuable proteins, lactose, and minerals, it can serve as a feedstock for multiple high-value industries. However, its mismanagement has environmental costs. Unprocessed whey discharged into waterways raises the biochemical oxygen demand, resulting in oxygen depletion and aquatic ecosystem degradation. Additionally, the decomposition of organic matter in whey releases greenhouse gases, exacerbating climate change.

Life cycle assessments conducted through the project demonstrate the transformative impact of whey valorization. Each kilogram of whey redirected into productive use can reduce greenhouse gas emissions by up to 1 kilogram of CO₂, decrease phosphorus pollution by 1 gram, and protect around 6 square metres of land from contamination. Even modest interventions, such as redirecting 10 percent of Kenya's estimated 25,000 tonnes of whey annually into food production, could lead to substantial environmental gains, including the avoidance of 6,000 tonnes of CO₂ emissions and the conservation of approximately 3,000 hectares of land. These figures highlight the untapped potential of whey as a driver of environmental sustainability and economic opportunity within a circular bioeconomy framework.

Valorization Pathways: Strategic Options for Transforming the Sector

The VALORISE Project identified four strategic pathways through which whey can be transformed from a disposal problem into a resource that underpins Kenya's transition to a circular bioeconomy. Each pathway offers distinct economic, social, and environmental benefits and presents varying levels of technological complexity, investment requirements, and policy needs.

1. Animal Feed and Livestock Productivity

Among the most immediate and practical options for whey valorization is its use as animal feed. Its high nutrient content, including proteins, minerals, and lactose, makes it a cost-effective supplement for livestock diets, particularly for pigs and poultry. With whey available at approximately KES 2–5 per litre, compared to KES 150 per kilogram for conventional protein feed, its integration into feed systems can significantly reduce production costs and enhance profitability.

Moreover, incorporating whey into livestock feed reduces nutrient-rich wastewater discharge, mitigating the risk of water pollution and contributing to more sustainable farming practices. Stakeholders consistently identified this pathway as a “low-hanging fruit” that could be scaled relatively quickly through cooperative-led collection systems, public–private partnerships, and targeted extension services.

2. Food and Beverage Innovation

Whey proteins possess exceptional nutritional and functional properties, including high digestibility, superior amino acid profiles, and the ability to improve texture and shelf life. These attributes make them ideal ingredients for a wide range of products, from fortified yoghurts and protein beverages to infant formulas, baked goods, and nutritional supplements.

Integrating whey-derived ingredients into food systems can simultaneously address two critical challenges: enhancing dietary quality and expanding economic opportunities. By developing value-added products that cater to urban markets, health-conscious consumers, and vulnerable populations, Kenya can strengthen food and nutrition security while generating new revenue streams for dairy processors. This pathway directly aligns with national nutrition strategies and supports Sustainable Development Goals (SDG) 2 (Zero Hunger) and SDG 3 (Good Health and Well-being).

3. Biotechnology and Pharmaceutical Innovation

Beyond food and feed, whey offers significant potential in biotechnology and pharmaceuticals. Bioactive peptides extracted from whey exhibit antimicrobial, anti-inflammatory, and immunomodulating properties, making them valuable components in nutraceuticals, probiotics, and drug delivery systems. These applications are part of a rapidly expanding global market driven by demand for functional foods, personalised nutrition, and health-enhancing products.

However, realizing this potential requires overcoming substantial barriers. Investments in advanced processing technologies, regulatory harmonization, skilled workforce development, and strengthened research capacity are essential. Despite these challenges, the long-term payoff could be transformative, positioning Kenya as a competitive player in the global bio-based health industry.

4. Sustainable Manufacturing and Green Transitions

Emerging technologies are enabling whey's conversion into biodegradable films, packaging materials, and other bio-based products, contributing to the global shift away from petroleum-based plastics. Incorporating whey into sustainable manufacturing supports Kenya's commitments under its climate change and circular economy strategies while reducing plastic pollution.

Although this pathway is still in its infancy domestically, international examples demonstrate its feasibility and commercial potential. Strategic investments, pilot projects, and policy incentives could enable Kenya to capture this emerging market and establish itself as a leader in bio-based innovation in Africa.



Highlights from a VALORISE Scenario Workshop held on March 2025 in Nairobi, Kenya.

Stakeholder Perspectives: Priorities, Barriers, and Enablers

Insights from a multi-stakeholder workshop held in March 2025 provide a nuanced view of sector priorities and systemic challenges. Participants, representing dairy cooperatives, processors, researchers, policymakers, and private sector actors, consistently ranked animal feed and milk substitution applications as the most viable short-term opportunities. These options require relatively low capital investment, offer quick returns, and have established demand.

At the same time, stakeholders emphasized the importance of laying the groundwork for higher-value applications in biotechnology and biomaterials. Achieving this will require coordinated policy support, research collaboration, infrastructure investment, and public awareness campaigns to increase market acceptance of whey-derived products.

Participants also highlighted key systemic barriers: regulatory gaps, limited quality standards, inadequate financing mechanisms, and logistical challenges in collection and transport. Addressing these barriers will require a systems approach that integrates technology development with policy reform, capacity building, market development, and inclusive governance.

Equally important is ensuring that women, youth, and smallholder farmers, often excluded from high-value segments of the dairy sector, are actively included in emerging value chains and benefit equitably from new opportunities.

Implications of the Findings

The VALORISE Project shows how whey valorization can turn Kenya's dairy sector from a waste-intensive system into a driver of sustainable growth. Once seen as a disposal problem, whey can now fuel new value chains, from nutrient-rich feeds and functional foods to bio-based materials, while cutting emissions, improving water quality, and supporting climate goals.

This shift has the power to spark innovation, attract investment, and create jobs, especially in rural areas where dairy is central to livelihoods. It also opens space for more inclusive growth, where smallholders, women, and youth benefit from emerging opportunities across the bioeconomy. Achieving this vision will require aligned policies, strategic investments, research, and collaboration across government, industry, and communities, transforming whey from waste into a catalyst for a circular future.



More highlights from a VALORISE Scenario Workshop held on March 2025 in Nairobi, Kenya.



References

1. Kenya National Dairy MasterPlan <https://kilimo.go.ke/wp-content/uploads/2024/08/DMP-VOL-I-SITUATIONAL-ANALYSIS.pdf>
2. Circular Bioeconomy for the Kenyan Dairy Sector <https://valorise.acts-net.org/>
3. African Centre for Technology Studies <https://acts-net.org/>
4. Roskilde University <https://ruc.dk/en>
5. Danish Technical University <https://www.dtu.dk/english/>
6. Arla Foods in Denmark <https://www.arla.com/contact-and-help/denmark/>
7. Egerton University <https://www.egerton.ac.ke/>
8. VALORISE survey of dairy processors in Kenya, 2022-2023 <https://valorise.acts-net.org/wp-content/uploads/Salma-Omollo-stakeholder-workshop-presentation.pdf>

Contact information

For more information, please contact Simon Bolwig (PhD), Project Lead at bolwig@ruc.dk
Catherine Kilelu (PhD), Project Coordinator at ckilelu@acts-net.org

For more information on the project see: <https://valorise.acts-net.org>



Contact Us

African Centre for Technology Studies

Email: info@acts-net.org

Website: www.acts-net.org

2nd Floor, Konza Technopolis Complex

P.O. Box 45917 - 00100

Nairobi- Mombasa Road,

Konza, Kenya.

Instagram | X/Twitter: @ACTSNET

Facebook | LinkedIn: African Centre for Technology Studies (ACTS)