Cascading and upcycling for a circular bioeconomy

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Cascading and Upcycling for a Circular Bioeconomy

Crosscutting analysis of CYCLE results from a transdisciplinary and socio-economic perspective.

Crosscutting analysis of CYCLE results showed that while avoiding food losses and transforming co-streams to new products of higher value characterizes the poultry industry case and part of the 'blue' sector, challenges remained in the 'whitefish' area where a higher share of fish resources ends up as rest raw materials not fully utilised.

Cascading and Upcycling potential of selected CYCLE results were investigated, and the crosscutting analysis showed how CYCLE based innovations may enable cascading and valorisation of co-streams and why an upcycling potential exists as well. The main contribution of the crosscutting analysis is in demonstrating feasibility of transdisciplinary research and innovative options for bioeconomic transition towards sustainability.

> *Co-stream values now surpass primary products*

We demonstrated how co-stream values now surpass primary products and provided estimates for potential economic values of selected cascading options CYCLE research contributed to enable. Conclusions drawn indicates that research enabling cascading of food chain co-streams, in the sense that these are processed and utilized for a more profitable purpose than before – may also constitute a potential for industries to 'upcycle' and move further towards a more circular and perhaps eco-efficient bioeconomy. We used cascading theory to conceptualize the basic challenge faced by individual companies aiming to further valorise co-streams. In contrast, we spoke about upcycling when both utility (market value) and resource-economic optimization of products increase: cascading of rest raw materials into higher value products with less total economic impact is upcycling.

Nordic countries share a common vision for a circular bio-economy in spite of different access to natural resources. However, an exploration of policy and strategy documents aiming to advance our bioeconomies indicates unclarity about what is really at stake. Is any new innovation made to exploit biological resources 'bioeconomic' progress? Is the yardstick for such progress monetary profit? Is an aspect of eco-efficiency – at local, regional, national or global scope – a prerequisite to bio-economic progress? To what extent does adding the pre-fix 'circular' make bioeconomic progress more eco-efficient? A transdisciplinary perspective was added to help raise these and other research questions able to help situate CYCLE in a larger context.

The value per kilo of by-products from meat production in general is increasing much faster than the value of meat in total, indicating co-streams are having an increasing significance also in the chicken industry. Similar developments were identified for fish and fish products. Assuming 226.000 tonnes of whitefish rest raw materials are currently unused – cascading or upcycling these to a level between USD 5 and 60 per 5 kg would add between 0.23 – 2.7 billion USD annually to Norwegian society. A valorisation potential from cascading 2nd class carrots into smoothie can

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Is an aspect of eco-efficiency – at local, regional, national or global scope – a prerequisite to bioeconomic progress?

be estimated for the Norwegian carrot co-stream fraction to a level of about NOK 52 million. Finally, the Norwegian chicken co-stream sector may realize NOK 80 million/year through innovations relating to enzymatic hydrolysis. Upscaling this figure to a global level could add up to NOK 28 billion per anno.

The monetary value of the Norwegian food industry implementing a full array of cascading options based inter alia on CYCLE results can be estimated to reach hundreds of millions NOK annually. CYCLE has widened the knowledge base for social actors aiming to contribute towards the goal of a circular Norwegian and global bioeconomy through upcycling, creating higher values with less environmental impact.

In terms of future 'bio-economic' research needs, we identified a need for research on institutional and environmental complexities involved in actually achieving upcycling outcomes. 'Upcycling' remains a theoretical concept and objective at the moment, given also Nordic countries operates in a global market playing by rules of games orchestrated by financial institutions with concerns for monetary governance rather than governing eco-efficiencies.

UNIVERSITY OF COPENHAGEN

NTNU Norwegian University of Science and Technology

VTT

Nofima

NORSØK Norwegian Centre for Organic Agriculture

SINTEF

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CYCLE

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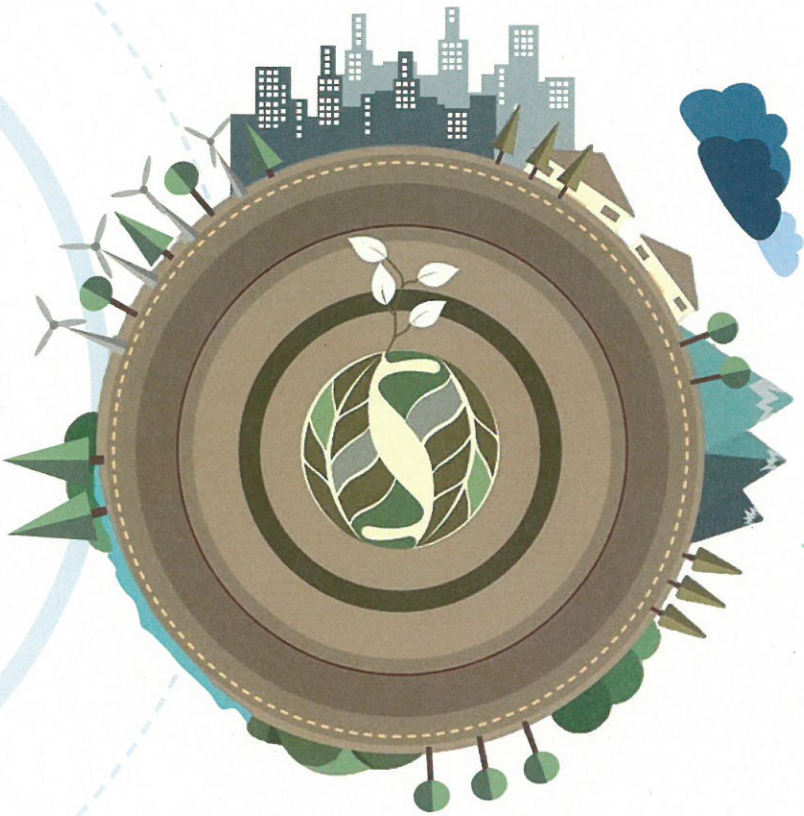

Total utilization of raw materials
in the supply chain for food with
a bio-economical perspective.

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