

Accounting for co-product use to capture the indirect effects of crop diversification with Life Cycle Assessment (LCA)

Problem

Evaluating whether diversified cropping systems delivering multiple co-products are more sustainable than the specialised ones (reference) they replace requires looking at the use of all co-products along the value chain to the final user.

Solution

Substitutional LCA consists of expanding the boundaries of the system under study to include co-product use according to the market. This ensures comparable results and highlights potential trade-offs between environmental impacts.

Benefits

Farmers and actors of the value chain can quantify and communicate the sustainability performance of their products in comparison with a benchmark.

Practical recommendation

- Map the system: describe all physical and energy flows for every step of the value chain, including use of all co-products. This means asking farmers about their cropping practices, and asking the industry about energy and materials used for crop processing into final products and the destinations of all co-products. E.g. High energy hemp and durum wheat blended pasta from a diversified rotation (Figure 1).

Applicability box

Theme

Assessment, cropping system, value chain

Agronomic conditions

Any

Application time

Any

Required time

For the sponsor of the study: from 2 days to 1 week to collect data, a few additional days to discuss feedback. For the LCA practitioner: two weeks to two months depending on data availability

Period of impact

A few years if production systems and related markets are unchanged

Equipment

Field logbook for cropping practices records and contacts with downstream stakeholders for data collection

Best in

Any production system

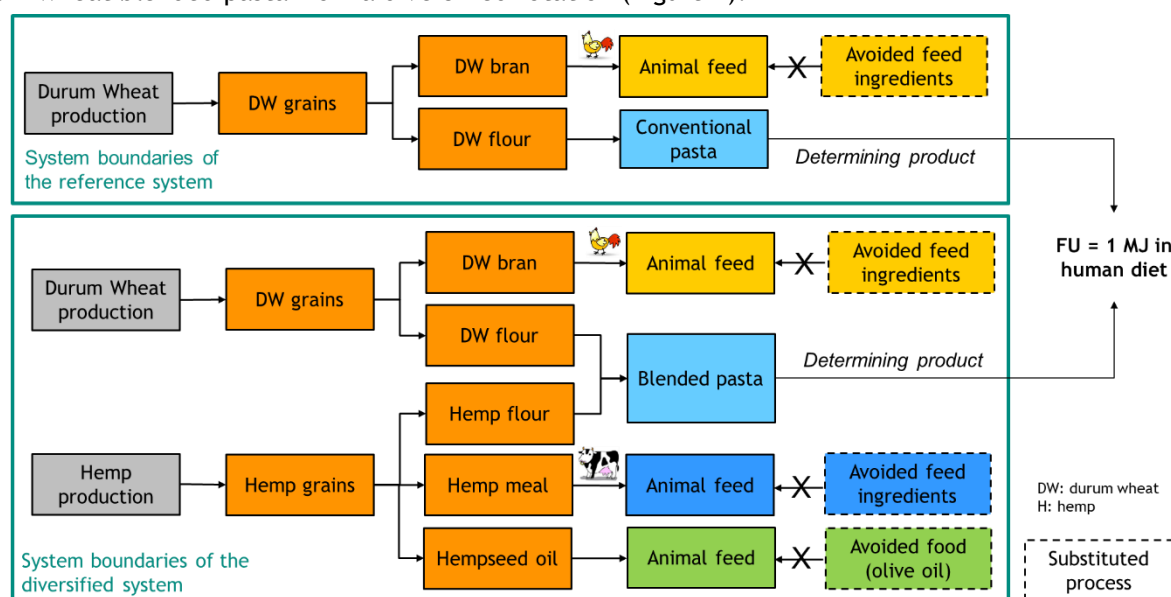


Figure 1: System boundaries of the compared systems (FU: functional unit, DW: durum wheat, H: hemp, impacts of processes with dotted lines are subtracted from the results)

- Define a benchmark: Which reference system will you be comparing against? E.g. Classical durum wheat pasta (from conventional or organic farming) (Figure 1)
- Collect data for crop production (cropping practices, inputs, outputs), processing (energy and material for milling and pasta processing) and distribution (packaging and transports) for both systems using, if required, databases for the reference system
- An LCA practitioner (from a research institution or a private company) then calculates impacts and highlights hotspots and potential improvements. E.g Blended hemp pasta show lower impact than classical pasta per MJ delivered to human diets (Figure 2). This is due to (1) lower emissions for crop production from the diversified system and (2) emissions savings associated with processes substituted thanks to the use of milling coproducts (wheat bran, hemp meal and hempseed oil).
- Communication on the sustainability of the product can be made, targeting actors of the value chain and final consumers

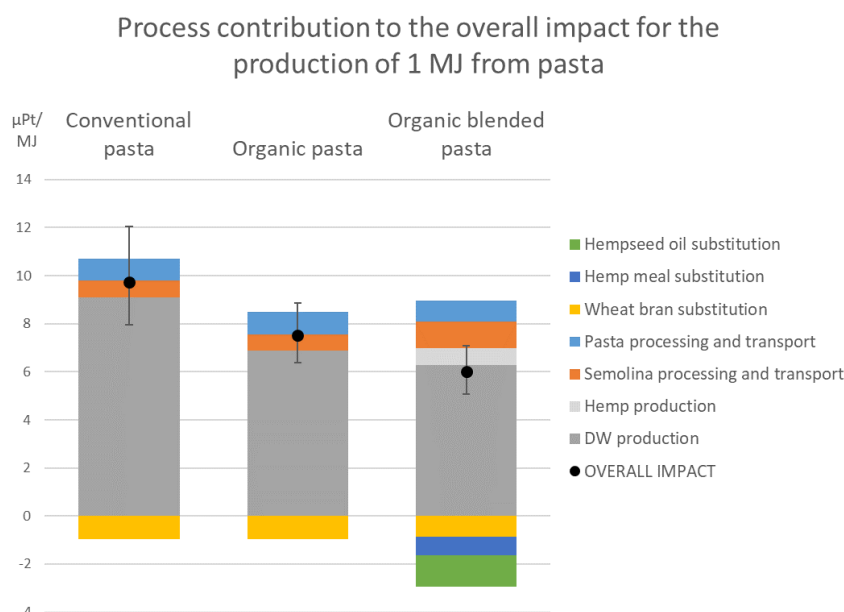


Figure 2: Process contribution to the overall impact (i.e. all environmental impacts aggregated into a single score according to Sala et al. 2018) of the production of 1 MJ from conventional and organic pure durum wheat pasta and blended hemp-durum wheat pasta; DW: durum wheat; $\mu\text{Pt} = 10^{-6}$ Points; whiskers represent the confidence interval of the population at $p=0.05$

Further information

Further readings

- Earles, J., Halog, A., 2011. Consequential life cycle assessment: a review. *Int. J. Life Cycle Assess.* 16, 445-453
 - Sala S, Cerutti AK, Pant R (2018) Development of a weighting approach for the Environmental Footprint, Publications Office of the European Union, Luxembourg, ISBN 978-92-79-68041-0
 - Van Stappen F, Mathot M, Decruyenaere V, Loriers A, Delcour A, Planchon V, Goffart JP & Stilmant D 2016. Consequential environmental life cycle assessment of a farm-scale biogas plant. *Journal of Environmental Management*; 175: 20-32
- Weidema, B., Frees, N., Nielsen, A.-M., 1999. Marginal production technologies for life cycle inventories. *Int. J. Life Cycle Assess.* 4, 48-56.

About this practice abstract and DiverIMPACTS

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DiverIMPACTS: The project is running from June 2017 to May 2022. The overall goal of DiverIMPACTS - Diversification through Rotation, Intercropping, Multiple Cropping, Promoted with Actors and value-Chains towards Sustainability - is to achieve the full potential of diversification of cropping systems for improved productivity, delivery of ecosystem services and resource-efficient and sustainable value chains.

Project website: www.diverimpacts.net

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