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A material and substance flow analysis of soybean and seaweed-based aquafeed proteins

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Background & Motivation

- The Brazilian soy industry is responsible for deforestation and ecosystem degradation in one of the world's most biodiverse regions (Gibbs et al., 2015).
- In 2015, the Norwegian aquaculture industry imported 362,200 t of Soy Protein Concentrate (SPC) from Brazil (Lundeberg & Grønlund, 2017).
- One way to reduce pressure on terrestrial food production systems is looking towards the ocean for food production (Skjermo et al., 2014).
- With its extensive coastline, Norway is experimenting with macroalgae as a new feedstock for a circular bio-economy (Stévant et al., 2017).

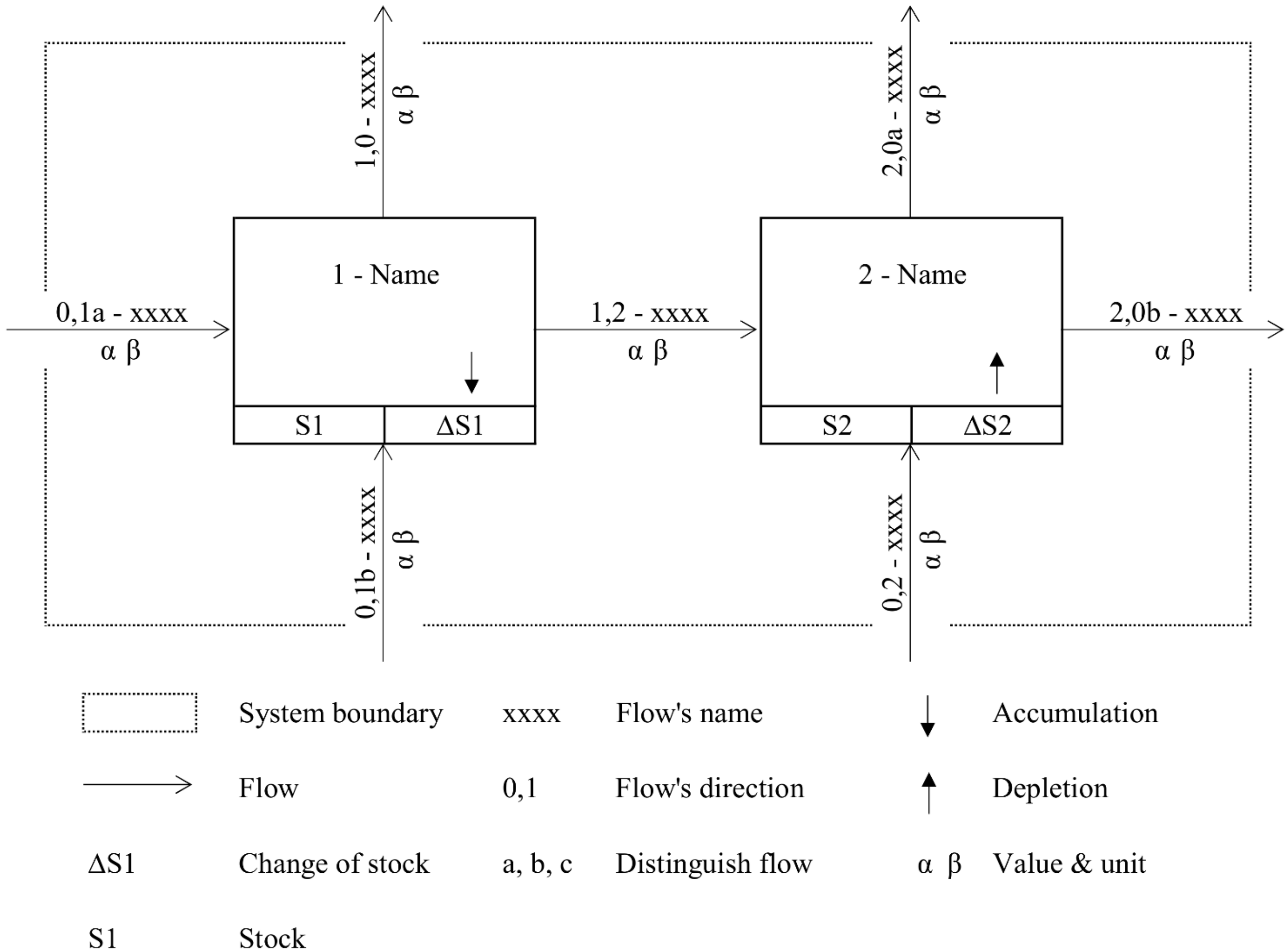
Goal & Scope

1. Comparing the Primary Energy and Phosphorus demands of two protein rich ingredients: Soy Protein Concentrate (SPC) produced and imported from Brazil and Seaweed Protein Concentrate (SWPC) produced in Norway.

2. Increase the understanding of the SPC and SWPC value chains by comparing their environmental efficiencies (across two key indicators) and assess the potential of SWPC as an alternative aquafeed ingredient for the Norwegian aquaculture industry.

Methods

The MFA/SFA methodology



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Methods
System constructions

Soy value-chain

- Cradle-to-customer gate system boundaries
- FU = 1t of SPC (620 kg proteins)

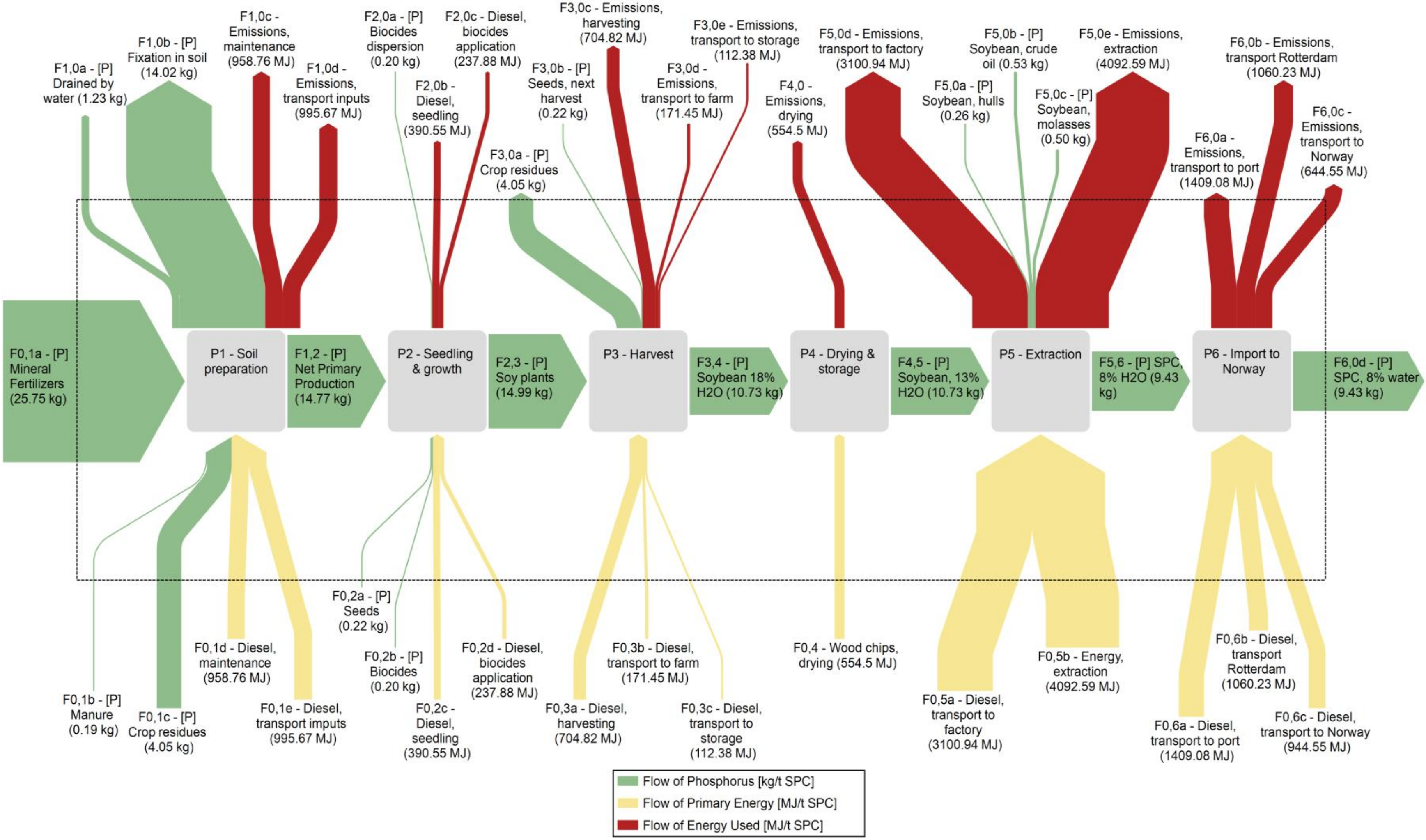
Phase	Main data source
Cultivation	LCA, Da Silva et al., (2010)
Transformation	LCA, Hognes et al., (2014)
Logistic	Skretting, Ewos, Biomar, Caramaru, Selecta, Imcopa

Seaweed value-chain

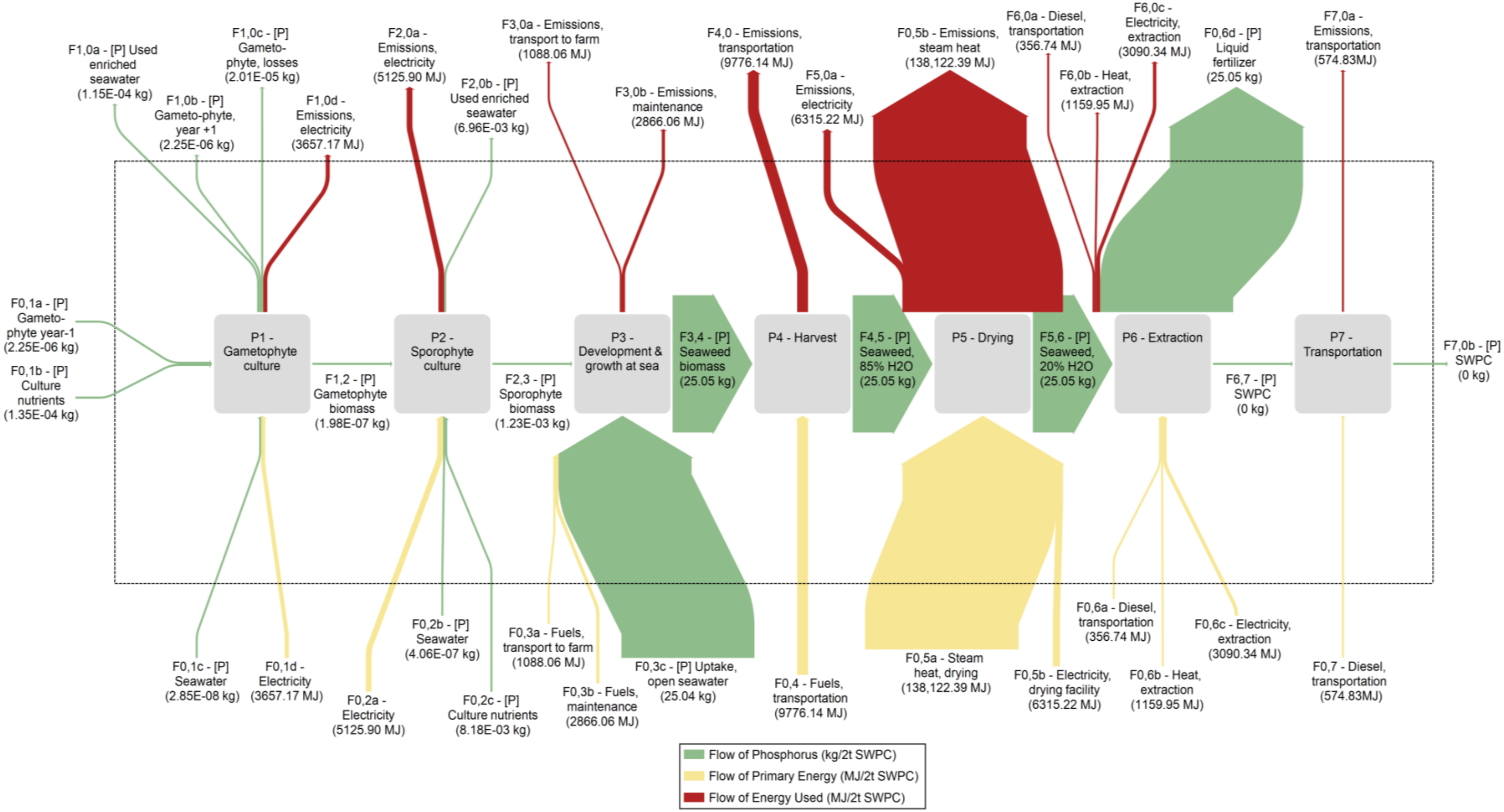
- Cradle-to-customer gate system boundaries
- FU = 2t of SWPC (620 kg proteins)

Phase	Main data source
Cultivation	Hortimare BV
Transformation	LCA, Seghetta et al., (2016)
Logistic	Assumptions

Results
The soy system



Results
The seaweed system

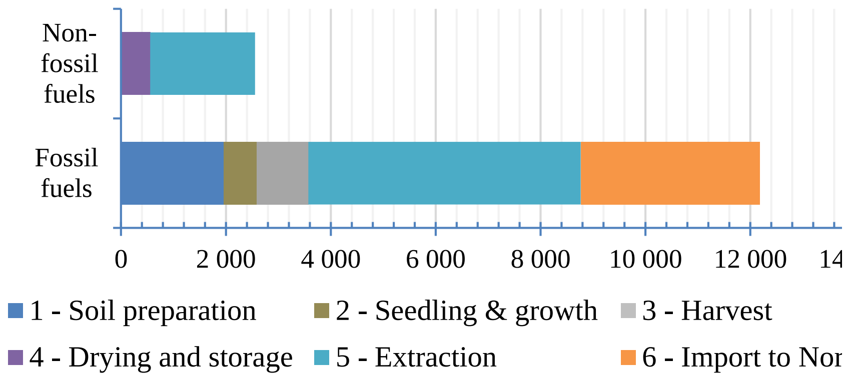


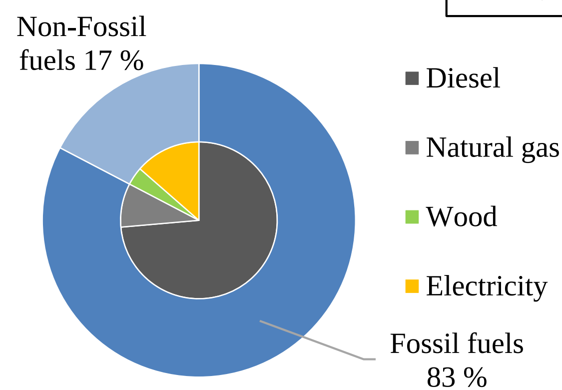
Results

Primary Energy comparison

1. Process CPED of the soy system, displayed per energy types (MJ)

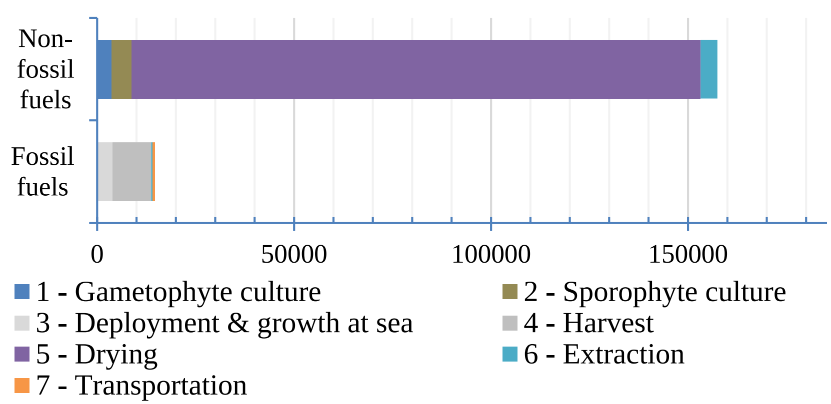
CPED
14,733 MJ

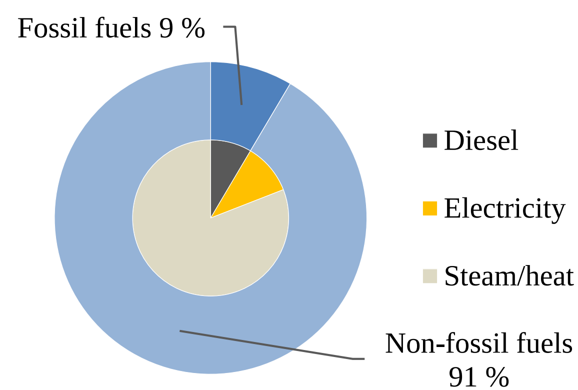




2. Process CPED of the seaweed system, displayed per energy types (MJ)

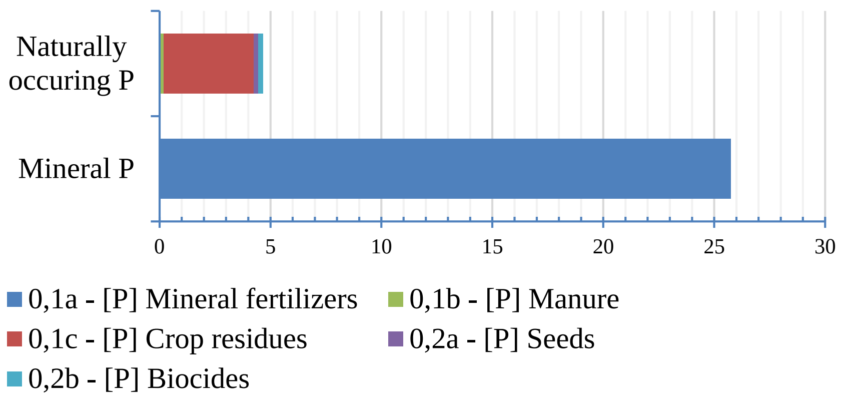
CPED
172,133 MJ

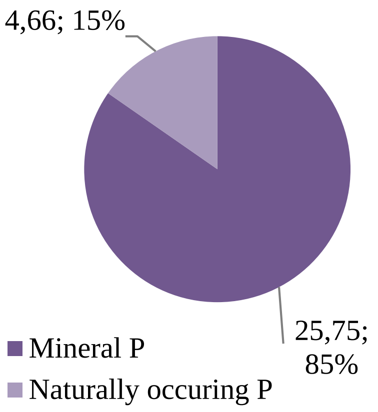




Results
Phosphorus comparison

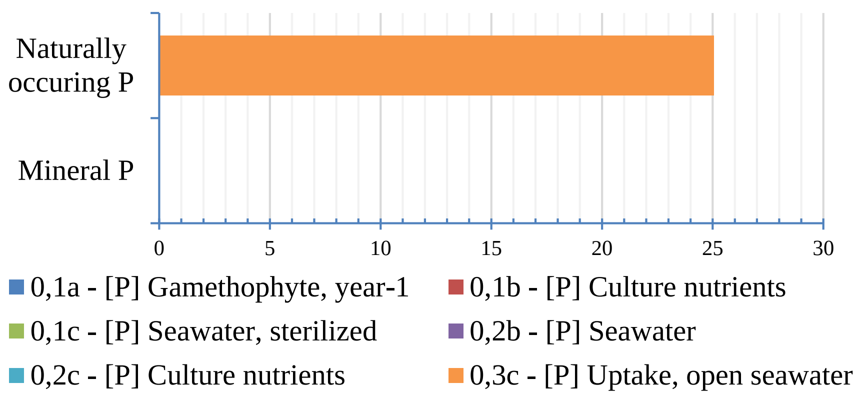
1. Origin of the P flowing in the soy system (kg)

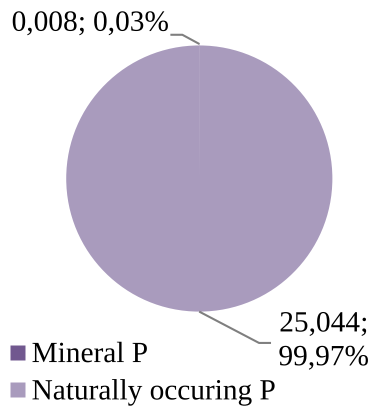




Fossil P demand
25.75 kg

2. Origin of the P flowing in the seaweed system (kg)





Fossil P demand
0.008 kg

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Conclusions

➢ **Based on this analysis, replacing soy with seaweed would:**

- Drastically increase the CPED of aquafeed
- Mitigate fossil P depletion and reduce eutrophication

➢ **Using seaweed is also likely to:**

- Reduce the freshwater footprint of aquafeed
- Reduce pressure on arable land

➢ **Various bottlenecks still impede the adoption of seaweed:**

- Seaweed protein quality, digestibility, and palatability remain untested
- The seaweed value-chain is experimental, its profitability uncertain
- SPC is a well-established ubiquitous ingredient in aquafeed

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References

- Da Silva, V.P., Van der Werf, H.M.G., Spies, A., Soares, S.R., 2010. Variability in environmental impacts of Brazilian soybean according to crop production and transport scenarios. Journal of Environmental Management 91(9), 1831-1839. https://doi.org/10.1016/j.jenvman.2010.04.001
- Gibbs, H.K., Rausch, L., Munger, J., Schelly, I., Morton, D.C., Noojipady, P., Soares-Filho, B., Barreto, P., Micol, L., Walker, N.F., 2015. Brazil's soy moratorium. Science 347(6220), 377-378. https://doi.org/10.1126/science.aaa0181
- Lundeberg, H., Grønlund, A.L., 2017. Fra brasiliansk jord til norske middagsbord. "Framtiden i våre hender" and "Regnskogfondet".
- Seghetta, M., Hou, X., Bastianoni, S., Bjerre, A.-B., Thomsen, M., 2016. Life cycle assessment of macroalgal biorefinery for the production of ethanol, proteins and fertilizers–a step towards a regenerative bioeconomy. Journal of Cleaner Production.
- Skjermo, J., Aasen, I.M., Arff, J., Broch, O.J., Carvajal, A., Christie, H., Forbord, S., Olsen, Y., Reitan, K.I., Rustad, T., 2014. A new Norwegian bioeconomy based on cultivation and processing of seaweeds: Opportunities and R&D needs. SINTEF Fisheries and Aquaculture.
- Stévant, P., Rebours, C., Chapman, A., 2017. Seaweed aquaculture in Norway: recent industrial developments and future perspectives. Aquaculture International 25(4), 1373-1390. https://doi.org/10.1007/s10499-017-0120-7