

myclimate The Climate Protection Partnership

LCA of rice: Confidence intervals for avoiding wrong conclusions

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Overview

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About myclimate: Who we are

- non-profit foundation in Zürich
 - founded in 2002, ETH-Spinoff,
 - 33 employees
- goal: climate protection
 - climate protection measurable, efficient
 - sustainable development
- broad basis
 - association (500 members)
 - board of trustees (science, economy, politics, NGOs),
 - patronage committee
 - globally active





About myclimate: Solutions for climate protection





Goal and Scope

Goal

- General: Comparison of rice products
- Specific: Are there significant differences in the carbon footprints?

Functional unit:

- 1kg processed rice in dry condition (as it is available in the store)

Considered rice products:

- conventional and organic rice from Italy
- conventional rice from USA
- upland rice from Switzerland (Canton of Ticino)



System boundary

System characterisation of the rice production process





Life Cycle Inventory

Data collection:

- Italian rice cultivation: Blengini & Busto (2009)
- US-Rice cultivation: ecoinvent report No 15b. (Kägi & Nemecek 2008)
- Swiss upland rice cultivation: from local experts in the Magadino region (Canton of Ticino)

Other secondary data:

 ecoinvent LCI database (<u>www.ecoinvent.ch</u>): Provided by the Swiss centre of life cycle inventories.



Impact Assessment

Gobal Warming Potential (GWP) with a time horizon of 100 years according to IPCC 2007 was considered.

Method of ecological scarcity (Frischknecht 2007) for validation (in order to avoid the preference of a product, which has a lower GWP but a higher total environmental impact.

The LCA was performed using the **software EMIS** (Environmental Management and Information System) developed by Carbotech AG (Dinkel 2009).



Uncertainty considerations

Considering the appropriateness of the data being used, errors of the in- and output processes were taken into account.

 according to the pedigree matrix used in ecoinvent (Swiss Centre for LCA 2009). six characteristics: reliability, completeness, temporal, geographic & technological correlation, sample size.



Uncertainty considerations

- Lognormal distribution suited for emissions where the distributions typically are not symmetric
- Advantage of normal distributions:
 - Analytic functions to calculate the error propagation over the process chain if errors are independent of each other, what is mostly the case.
- By using normal distributions the uncertainty of the results can be calculated in seconds instead of hours.
 - Main reason why in EMIS a simplified error calculation using normal distribution function is used.
 - the user gets always an estimation of the confidence intervals of the LCA results.



Uncertainty considerations

Other reasons:

- Virtually any uncertainty estimation is better than no estimation.
- even today there are few LCA studies giving the uncertainties of the results, even if there are leading software tools giving the opportunity to do an error calculation with Monte Carlo simulation.



Results





Results

- Methane main contributor to the GWP (except upland rice).
- Upland rice needs more inputs (e.g. fertilisers, diesel for agricultural machinery) per kg output.
- second highest impact: cultivation or parboiling process for parboiled rice.
- refining and cooking are of lower importance.
- Transport emissions relevant for imported rice from overseas.
- The packaging and its disposal irrelevant (although cardboard boxes (US and Swiss rice) have a lower GWP than plastic bags (Italian rice).
- Results indicate that organic rice has the highest carbon footprint per kg rice followed by parboiled rice and white rice from USA and Italy. Upland rice shows by far the best performance considering the GWP.



Results Global Warming Potential 100a, IPCC 2007 5 4.5 4 3.5 No significant difference kg CO2eq / kg rice 3 2.5 2 1.5 Significantly better 1 0.5 0 rice, IT rice organic, IT rice, USA rice, parboiled, USA rice upland, CH



Discussion

- There is no significant difference between organic and conventional rice
- there is no difference between conventional rice from the USA and Italy, although transport distances vary a lot.
- upland rice shows a significantly lower carbon footprint
- high data uncertainty, especially of the direct field emissions, leads to confidence intervals from 15% (upland rice) to 31% (organic rice).



Discussion

- Comparison on 68% level (standard deviation) illustrates, that upland rice has a lower GWP per kg rice than the other rice product.
- Wrong conclusions cannot be totally avoided. Addressing data uncertainty issues when performing LCA's and including confidence intervals into the presentation of results may minimize the risks of wrong conclusions, however.



Discussion

Other benefits of simplified error analysis:

- error analysis as an indicator of how well the data quality fits the scope of a study.
- For some product comparisons rough data might be enough in order to show significant differences (e.g. upland and conventional rice).
- For more similar products (e.g. conventional rice products), data need to be of much better quality in order to still define significant differences.



Conclusion

- Study highlights importance of inclusion of data quality considerations if results are communicated.
- This procedure is crucial to cultivate the acceptance of LCA and to reduce wrong interpretations.
- Simplified error analysis is helpful for assessing whether data quality fits the scope of the study.
- Limitations such as the assumption that the data errors have a normal distribution.
- Remaining challenge: Communication of uncertainties to consumers (e.g. Product Carbon Footprints), so that they understand the message.

Thank you for your attention!



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