Potential ecotoxicity impact assessment
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Is ecotoxicity part of the air quality? How can that be measured in product chain context?
How do plant protection products affect air quality via product chain?

Ecotoxicity impact assessment in LCA
How ecotoxicity is forming in LCA? - Figure 1

- Chemicals induce ecotoxic effects that could be measured with the ecotoxicity impact assessment in LCA per functional unit of the final product
- Chemicals are used in different steps of the product chain, e.g. plant protection products (PPP) in the crop production in a field or industrial chemicals in the production of food packing materials
- Ecotoxic effects include fate of the emitted chemical to different environmental compartments (air, water, soil), and exposure and effect of organisms in that environment

= ecotoxicity footprint

Life cycle assessment (LCA)
Definition of goals and scope
Inventory analysis (LCI)
Impact assessment (LCIA)
Interpretation

Figure 2. LCA is done in the following steps. LCI = life cycle inventory analysis, LCIA = life cycle impact assessment.

Ecotoxicity impact assessment and PPP
How ecotoxic effects induced by PPP usage can be measured in LCA? - Figure 3

- PPP are chemicals that induce ecotoxic effects on a field usage
- In our study – Formula a
- PestLCI 2.0 (Dijkman et al. 2012) is used to model emission fate
- SETAC consensus LCIA model Usetox (Rosenbaum et al. 2008, Usetox 2010) is used to calculate impacts for active ingredient (= characterization factors, =LCIA)
- Quantitative result is a potential ecotoxic pressure (= impact score, CTU as an unit) that is describing the potentially affected fraction of species in the environment induced by the active ingredient usage

Formula a. Potential ecotoxicity in life cycle assessment is calculated via the following formula using PestLCI and Usetox:

\[ IS = \sum \text{CF} \times \text{M} = \text{EF} \times \text{XF} \times \text{FF} \times \text{M} \]

\[ IS = \text{impact score (potential ecotoxicity, CTU = PAF m3 \text{ d/kg)} \]

\[ \text{CF} = \text{ecotoxicological characterization factor} \]

\[ \text{M} = \text{emission} \]

\[ \text{EF} = \text{exposure factor (toxicity)} \]

\[ \text{XF} = \text{factor (bioavailability factor)} \]

\[ \text{FF} = \text{fate factor (substance emission into environment parts)} \]

PPP effects are part of the air quality:
- Directly - emissions can be drifted to the air and affect organisms there
- Indirectly - emissions can be drifted via air to the other environments

- In LCA context, PPP effects are part of the total product chain impacts.
- We are able to raise the understanding of food ecotoxic background not depending where production of farm inputs or raw materials or processes take place, in many cases food chains are global.
- It is important to push responsibility for global environmental problems such as climate change and chemicalization.

Consequently, the aim is to change the processes towards to sustainable development.

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Figure 1. Forming of potential ecotoxicity in LCA. Circle illustrates the substance of our study.

Figure 3. The relative potential impacts of PPP emissions can be evaluated in LCA by modelling the fate of active ingredient in air, water, and soil and their exposure and effects on organisms. PestLCI and Usetox are used in our studies.

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