Shortcomings in LCA when assessing transformations of food systems

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Towards better representation of organic agriculture in life cycle assessment

Hayo M. G. van der Werf[1], Marie Trydeman Knudsen[2] and Christel Cederberg[3]

The environmental effects of agriculture and food are much discussed, with competing claims concerning the impacts of conventional and organic farming. Life cycle assessment (LCA) is the method most widely used to assess environmental impacts of agricultural products. Current LCA methodology and studies tend to favour high-input intensive agricultural systems and misrepresent less intensive agroecological systems such as organic agriculture. LCA assesses agroecological systems inadequately for three reasons: (1) a lack of operational indicators for three key environmental issues; (2) a narrow perspective on functions of agricultural systems; and (3) inconsistent modelling of indirect effects.

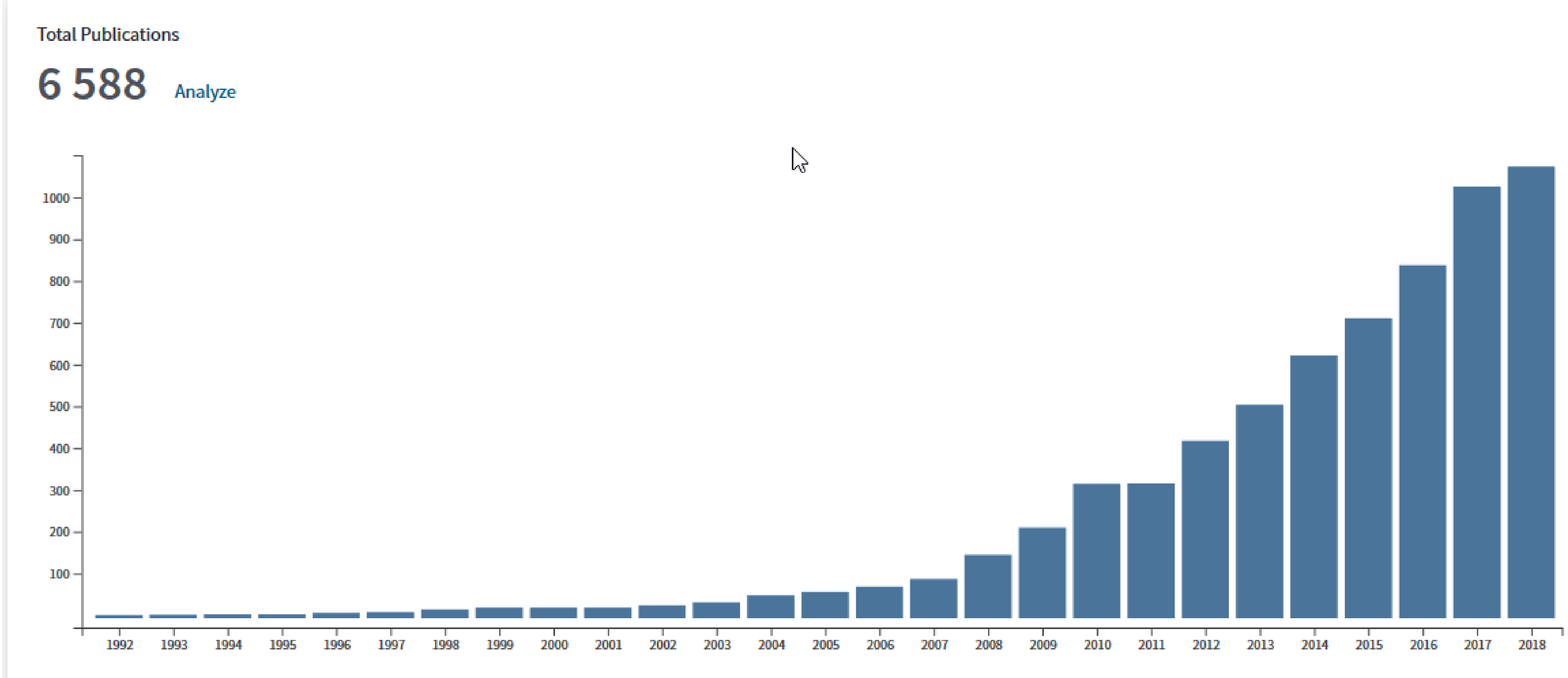
Societal interest in sustainable agriculture and food is great

approaches at multiple spatial and temporal scales[8]. Another example

My talk is about this paper…

…..where we discuss shortcomings in LCA-methodology and studies when it comes to assessing agroecological systems, using organic agriculture as an example

Annual number of peer-reviewed English language papers using LCA to assess agrifood systems for the 1990-2018 period



We argue that LCA assesses agroecological systems (e.g. organic agriculture) inadequately for three reasons

- A narrow perspective on functions of agricultural systems
- A lack of operational indicators for three key environmental issues
- Inconsistent modelling of indirect effects

FIGURE 2 - FAO'S 10 ELEMENTS OF AGROECOLOGY

(Source: FAO, 2018a)

Agroecology is based on applying ecological concepts and principles to optimize interactions between plants, animals, humans and the environment

http://www.fao.org/agroecology/overview/en/

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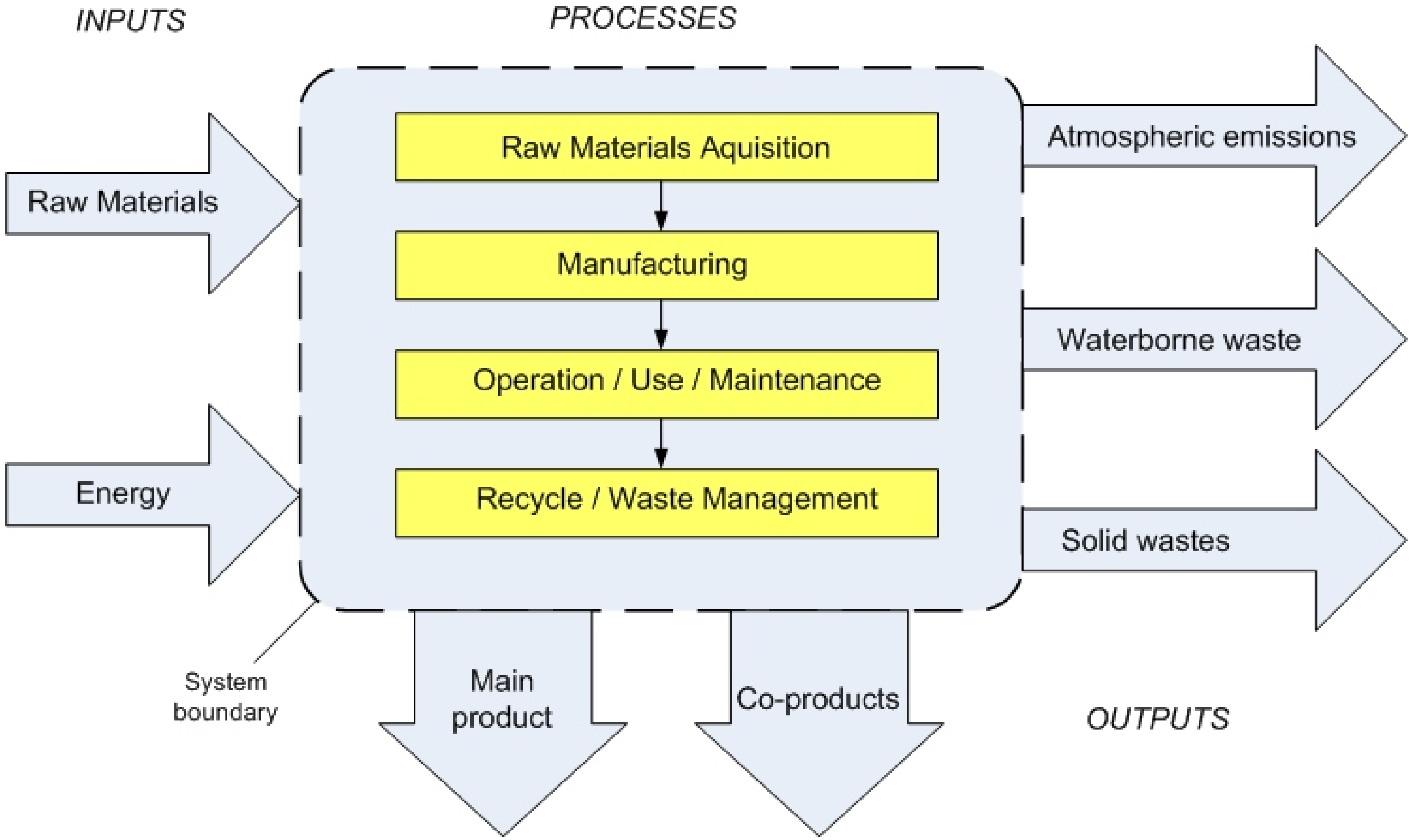
Analysing production system



Life cycle assessment and Ecosystem services conceptual frameworks

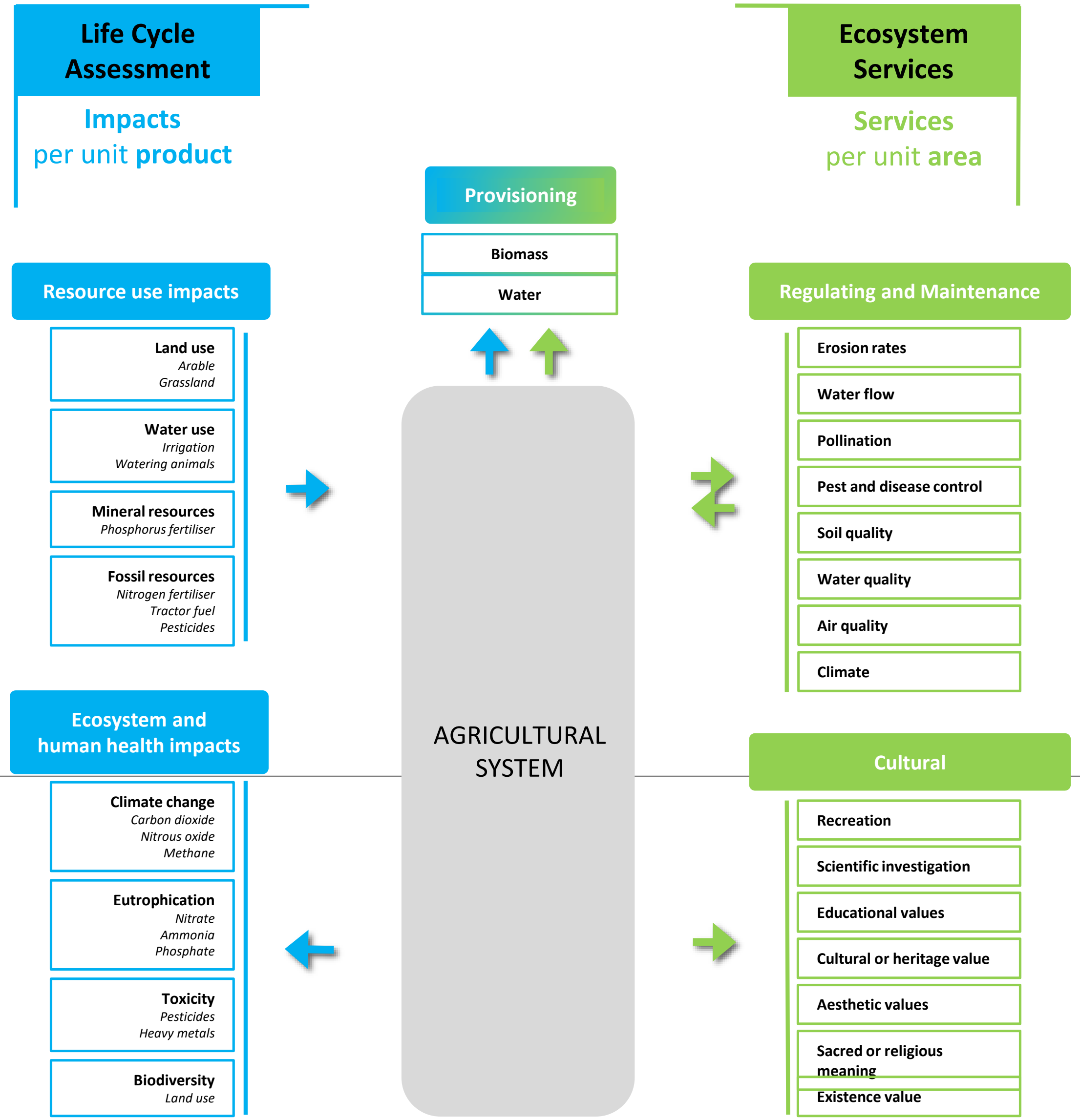


Figure. Life cycle assessment (LCA, in blue) and ecosystem services (ES, in green) conceptual frameworks. The central panel represents an agricultural system, i.e. a farm, or farming territory, including semi-natural habitats. LCA assesses the environmental impacts of the system by considering both on-site and off-site (associated with inputs) resource use, pollutant emissions and land use. Resource use, ecosystem and human health impacts are quantified via a set of indicators expressed per unit product, e.g. kilogram of milk produced. ES assess provisioning, regulating and maintenance and cultural ecosystem services provided by the structure and functions of the system. Other ecosystems supply it with regulating and maintenance ecosystem services. ES are quantified via a set of indicators expressed per unit area, e.g. hectare of land occupied. LCA and ES have common ground, e.g. emissions and sequestration of greenhouse gases are considered in the Climate change impact (LCA) and in the Climate regulation service (ES). This comparison also reveals “blind spots”: LCA ignores ecosystem services other than provisioning, whereas ES does not consider resource use and ignores effects of inputs used in the system.

Landscape effects

High-input intensive agriculture, aiming for high yields of a few crop species, with large fields and no semi-natural habitats.

Agroecological agriculture, supplying a range of ecosystem services, relying on biodiversity and crop and animal diversity instead of external inputs, and integrating plant and animal production, with smaller fields and presence of semi-natural habitats

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IPCC Special Report on Climate Change and Land

On 2 – 6 August 2019 the Intergovernmental Panel on Climate Change (IPCC) met in Geneva, Switzerland, to approve and accept *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* (SRCCL).

Land degradation is a serious and widespread problem, including soil-deteriorating processes such as erosion, compaction, salinization and soil organic carbon losses.

Unsustainable land management in agriculture is a dominant driver
of land degradation.

Assessing and providing information on soil quality impacts – one of most important task for LCA of agrifood?

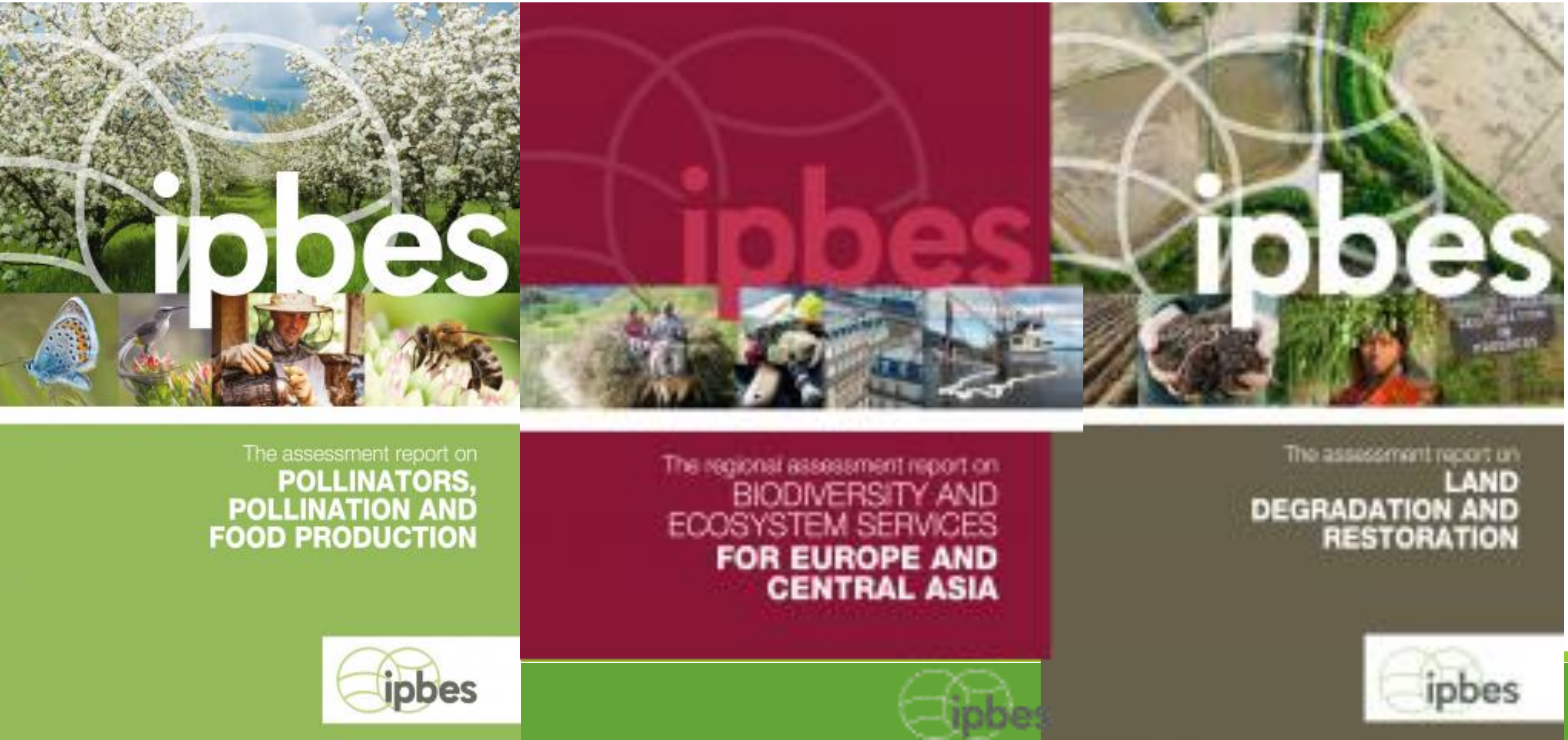
Two adjacent soil samples from Kansas US
Left – cropland annual crops / Right – native grassland (prairie)

- ✓ Soil properties and functions remain little represented in LCA (despite efforts over the last 15 yrs)
- ✓ Model LANCA recommended in the EU-PEF framework but shown to have important limitations
- ✓ Soil quality assessment in LCA (or any method) requires working at local scales
- ✓ Meta-analysis comparing soils in conv and org systems show high soil quality in org soils

2019 – alarming reports about the state of the global food system

May - the IPBES Global Assessment Report on Biodiversity and Ecosystem Services

"Biodiversity – the diversity within species, between species and of ecosystems – is declining faster than at any time in human history" (citation from Summary for Policymakers)



IPBES
Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

intergovernmental body (130 member states) which assesses the state of biodiversity and of the ecosystem services it provides to society

Impacts from pesticide use

Human toxicity

- Risks and effects from handling and use – especially in developing countries
- Risks and effects from spray drift (e.g. neighbours to fields that are sprayed)
- Pesticide residuals in food
- Pesticide contamination of groundwater and surface water - and potentially drinking water

Little or not included in LCA

Ecosystem toxicity

- Direct by killing non-targeted organisms e.g. insects
- Indirect by changing feed sources etc

Partly included only in recent years

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ARTICLE

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The greenhouse gas impacts of converting food production in England and Wales to organic methods

Laurence G. Smith[1,2], Guy J.D. Kirk[1*], Philip J. Jones[3] & Adrian G. Williams[1]

Agriculture is a major contributor to global greenhouse gas (GHG) emissions and must feature in efforts to reduce emissions. Organic farming might contribute to this through decreased use of farm inputs and increased soil carbon sequestration, but it might also exacerbate emissions through greater food production elsewhere to make up for lower organic yields. To date there has been no rigorous assessment of this potential at national scales. Here we assess the consequences for net GHG emissions of a 100% shift to organic food production in England and Wales using life-cycle assessment. We predict major shortfalls in production of most agricultural products against a conventional baseline. Direct GHG emissions are reduced with organic farming, but when increased overseas land use to compensate for shortfalls in domestic supply are factored in, net emissions are greater. Enhanced soil carbon sequestration could offset only a small part of the higher overseas emissions.

Indirect effects of transforming into organic agriculture (or other agroecological systems) – more land is required and thus, more natural ecosystems have to be converted

People who choose e.g. organic food (or other environmental brands) also have other diet patterns due to e.g. ethical concerns, economic effects –
these rebound effects needs to be included

Indirect effects must consider more environmental and sustainabilitity consequences for food systems than merely climate change

Conclusions

Food production major driver of global environmental change
Transformative redesign of agrifood systems based on agroecological principles is needed

Currently, LCA – as a key environmental assessment tool and method – misrepresents agroecological systems, e.g. organic agriculture

Environmental assessment of agricultural systems must adopt a broader perspective, consider negative impacts of pesticides and consider effects on soil health and biodiversity

Agricultural landscape in mid-Halland