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## **Biodiversity, environmental values and LCA: An interdisciplinary perspective**

**Dr. Michael Curran**

Dept. of Socio-Economic Sciences, FiBL

79th LCA Discussion Forum

18th November 2021, Zurich

# FiBL Switzerland at a glance



- Founded in 1973, private foundation
- 190 staff members
- 70 interns, B.A./Master/PhD students, apprentices
- Research on over 200 Swiss organic farms







## Presentation overview

1. Agriculture, biodiversity, ecosystem services and values
2. Agriculture as co-production process of material/non-material outputs
3. Allocation in LCA and non-material outputs
4. Need for new value-led approaches for allocation







**Agricultural systems are multifunctional and co-produce many outputs**



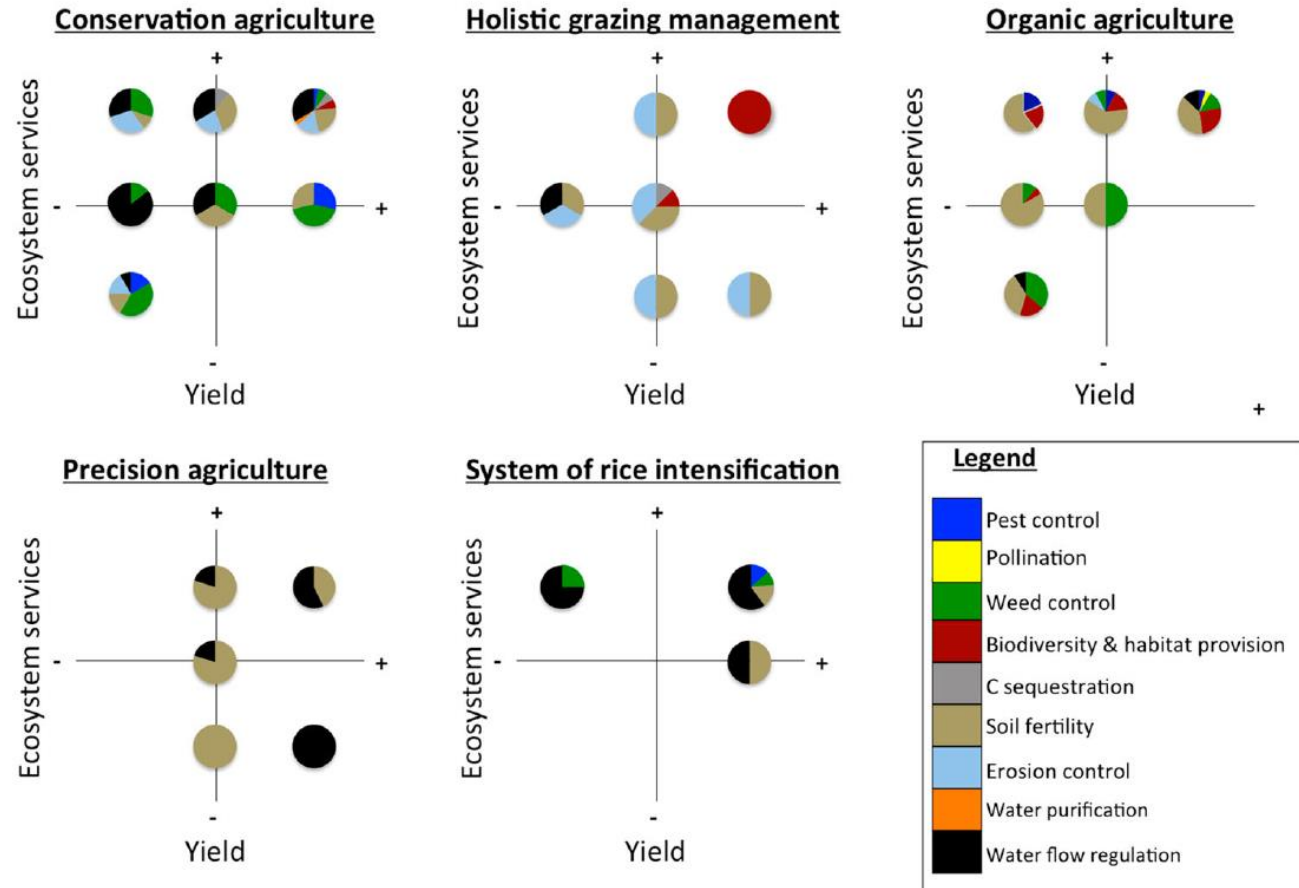
# Agroecology, biodiversity and ecosystem services

- Farming systems are typified by multifunctionality
- Multiple outputs beyond the marketed products
- Valued and non-valued goods and services, material and non-material outputs, public and private goods



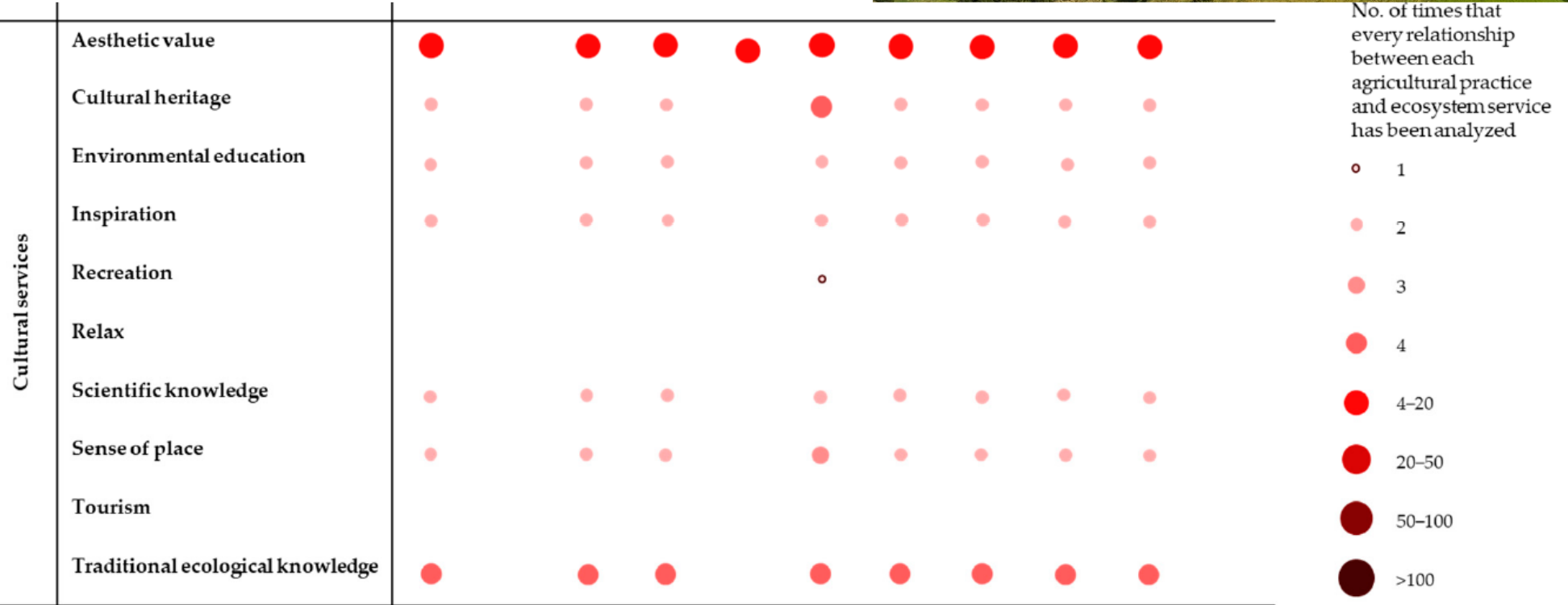
# Agroecology, biodiversity and ecosystem services

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Garbach, K., J. C. Milder, F. A. J. DeClerck, M. Montenegro de Wit, L. Driscoll, and B. Gemmill-Herren. 2017. Examining multi-functionality for crop yield and ecosystem services in five systems of agroecological intensification. *International Journal of Agricultural Sustainability* 15:11–28.

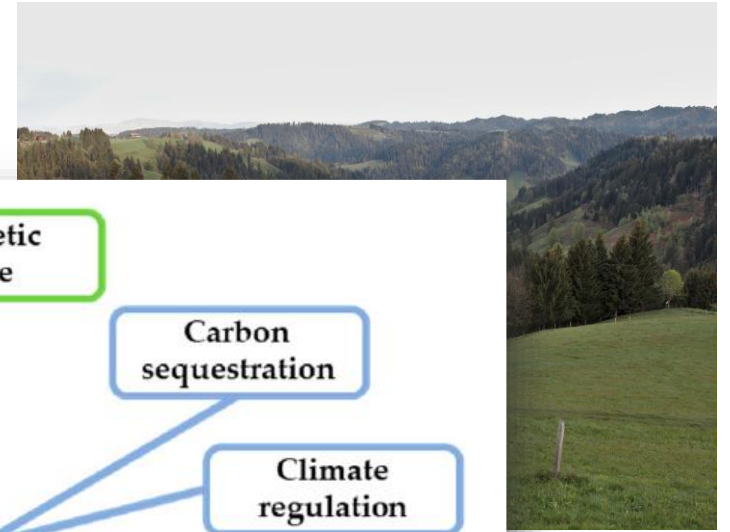
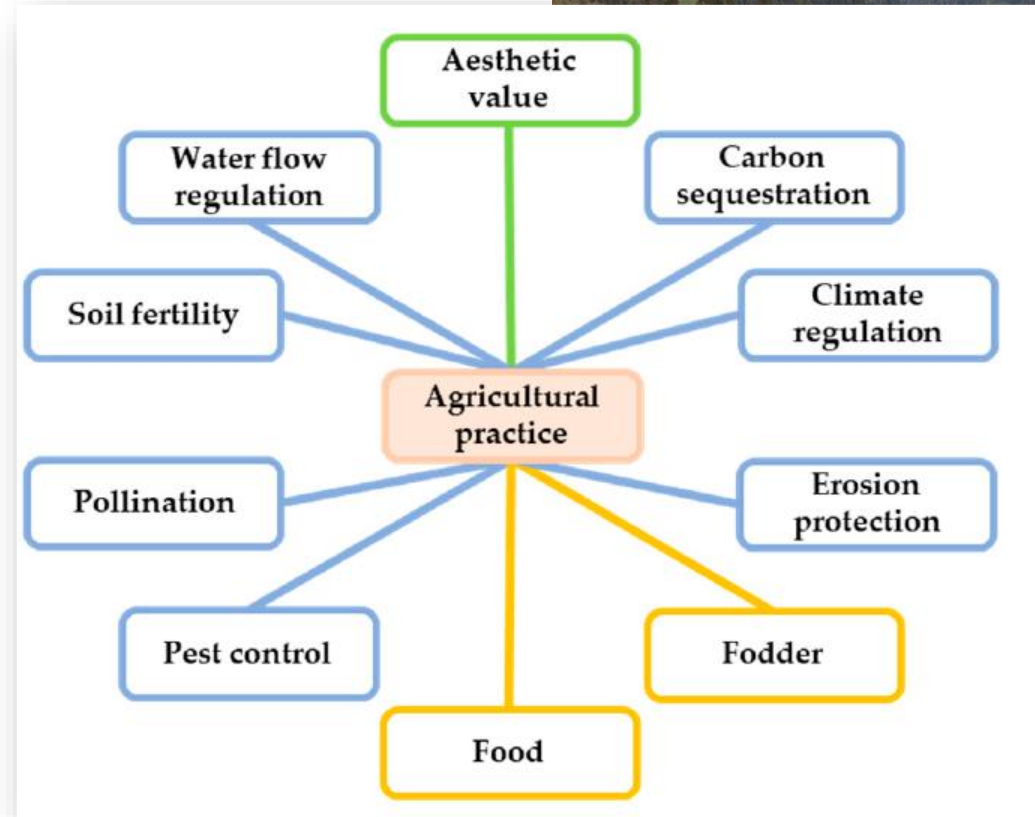
# Agroecology, biodiversity and ecosystem services



Palomo-Campesino, S., J. A. González, and M. García-Llorente. 2018. Exploring the Connections between Agroecological Practices and Ecosystem Services: A Systematic Literature Review. Sustainability 10:4339.

# Agroecology, biodiversity and ecosystem services

- LCA deals with co-production via allocation or system expansion
- Allocation is often unavoidable (particularly in agriculture)
- Substantial non-material outputs (cultural values) poses a particular problem





# Allocation in LCA

- Biophysical allocation is recommended using physical causal relationships
- Criticized as problematic and not better than non-physical, monetary allocation (Mackenzie et al. (2017))
- Cannot deal with non-material outputs (missing causality)

**Table 3:** Distribution (%) of environmental burden to milk with different ways of handling co-product allocation

Burdens	No allocation = 100	Economic allocation	'Biological' allocation	System expansion
Energy	100	92	85	87
Land use	100	92	85	66
Pesticide use	100	92	85	100
Climate change	100	92	85	63
Acidification	100	92	85	60
Eutrophication	100	92	85	60

Cederberg, C., and M. Stadig. 2003. System expansion and allocation in life cycle assessment of milk and beef production. *The International Journal of Life Cycle Assessment* 8:350–356.

Mackenzie, S. G., I. Leinonen, and I. Kyriazakis. 2017. The need for co-product allocation in the life cycle assessment of agricultural systems—is “biophysical” allocation progress? *The International Journal of Life Cycle Assessment* 22:128–137.

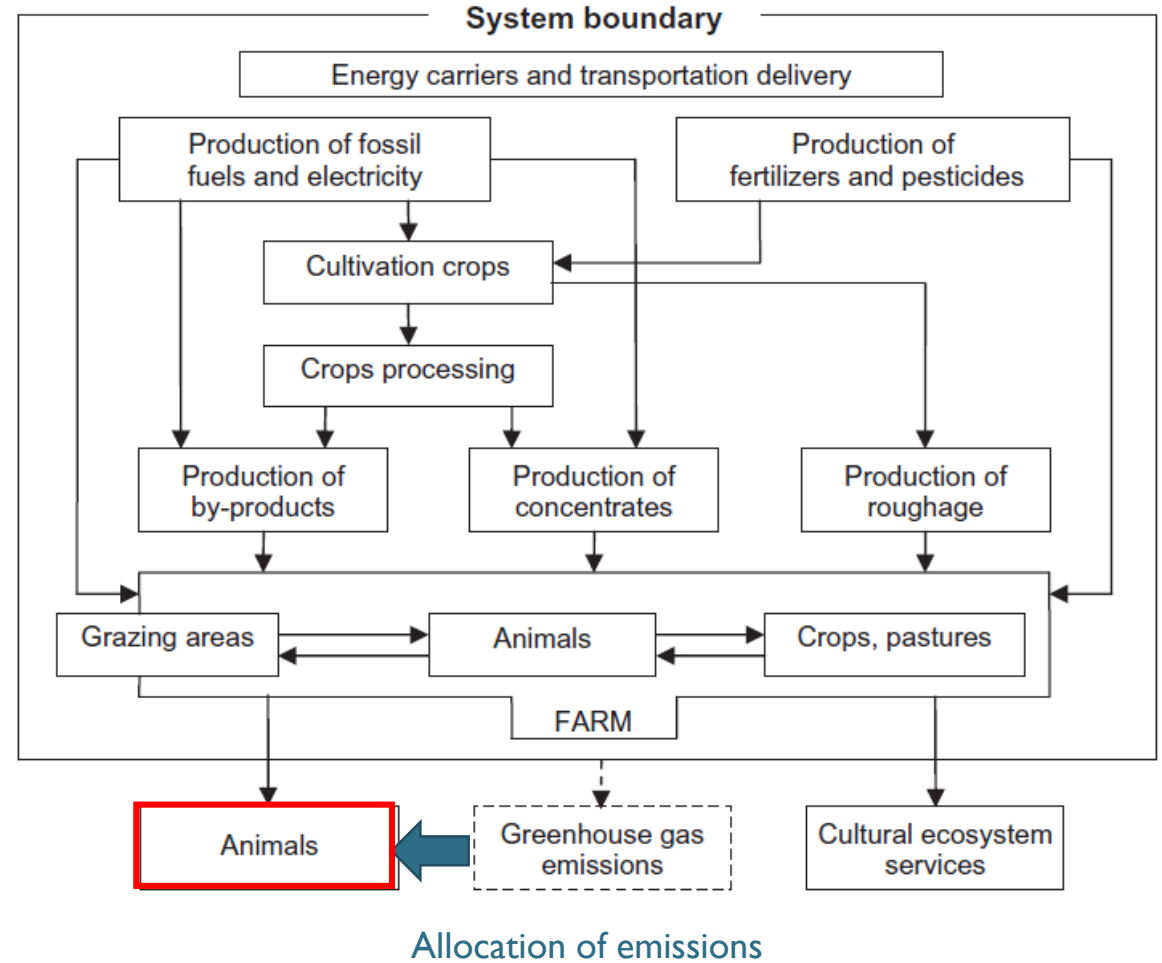
# Allocation in LCA

- Non-physical outputs, if adequately valued, can invert the direction of product comparisons
- Intensive versus extensive grazing systems

Intensive



Extensive





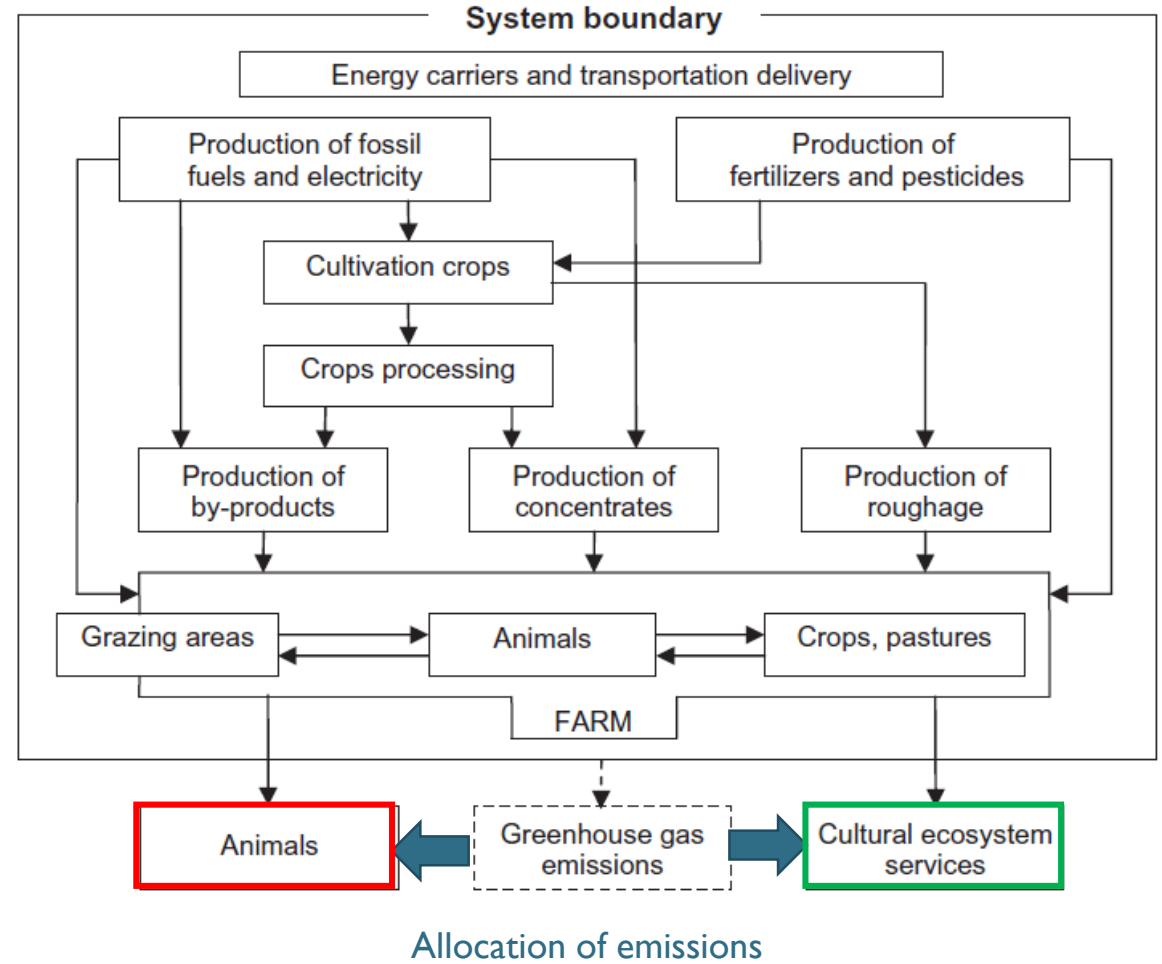
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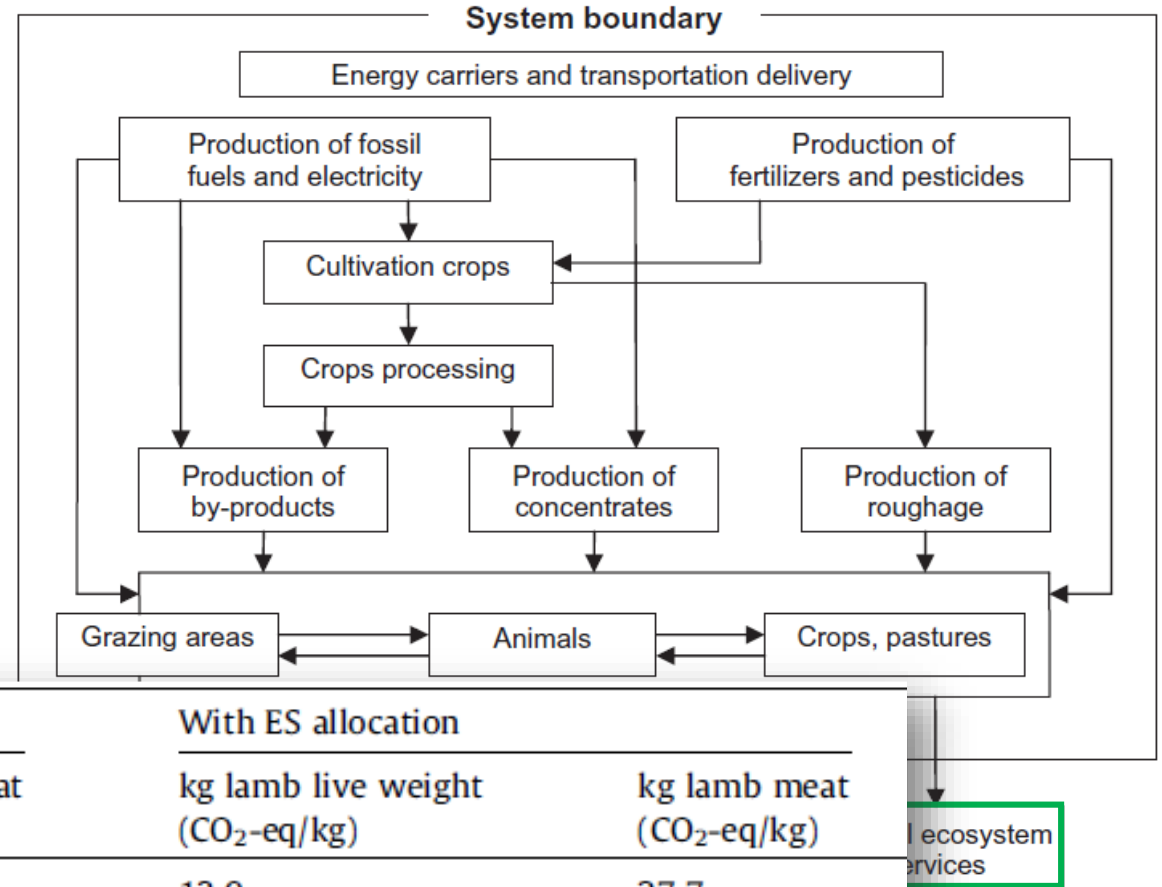


Extensive



# Allocation in LCA

- Non-physical outputs, if adequately valued, can invert the direction of product comparisons
- Intensive versus extensive grazing systems



	Without ES allocation		With ES allocation	
	kg lamb live weight (CO <sub>2</sub> -eq/kg)	kg lamb meat (CO <sub>2</sub> -eq/kg)	kg lamb live weight (CO <sub>2</sub> -eq/kg)	kg lamb meat (CO <sub>2</sub> -eq/kg)
Pasture-based	25.9	51.7	13.9	27.7
Mixed	24.0	47.9	17.7	35.4
Zero-grazing	19.5	38.9	19.5	39.0

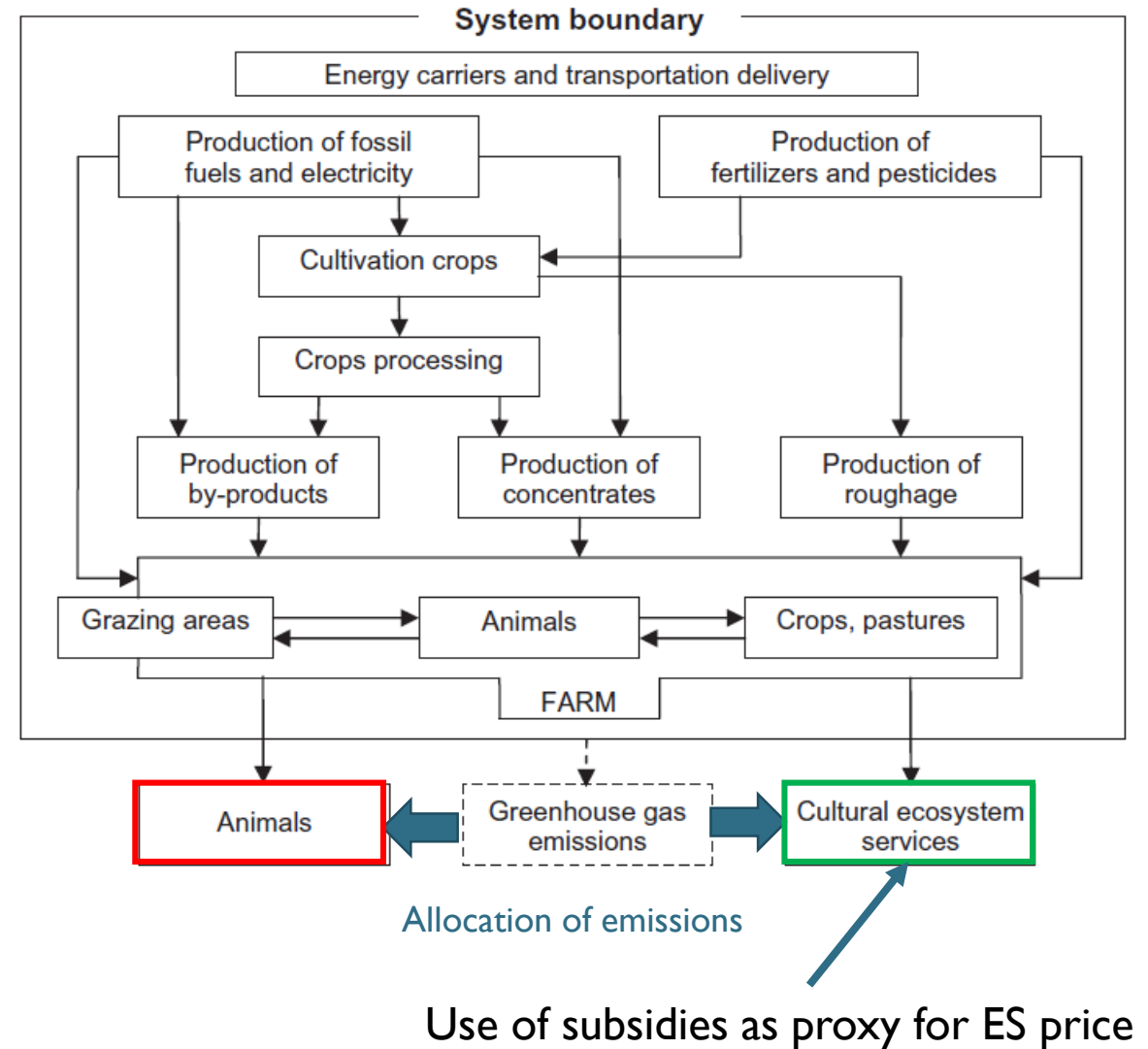
ES: ecosystem services.

Ripoll-Bosch, R., I. J. M. de Boer, A. Bernués, and T. V. Vellinga. 2013. Accounting for multi-functionality of sheep farming in the carbon footprint of lamb: A comparison of three contrasting Mediterranean systems. *Agricultural Systems* 116:60–68.



# Environmental valuation

- Valuation plays a key role in non-physical allocation
- Monetary allocation the only common value-led approach
  - Prices reflect complex properties of products that influence consumer choice
  - Captures “societal cause” of emissions
- Prices limited to markets, no use for public goods and services (e.g. many Ecosystem Services)



Ripoll-Bosch, R., I. J. M. de Boer, A. Bernués, and T. V. Vellinga. 2013. Accounting for multi-functionality of sheep farming in the carbon footprint of lamb: A comparison of three contrasting Mediterranean systems. *Agricultural Systems* 116:60–68.

# Environmental valuation

- Prices need to be supplemented with valuation approaches
- Monetary valuation alone is very problematic
- Plurality of valuation methods have emerged in recent years
- Need for interdisciplinary research to explore “value-led approaches”

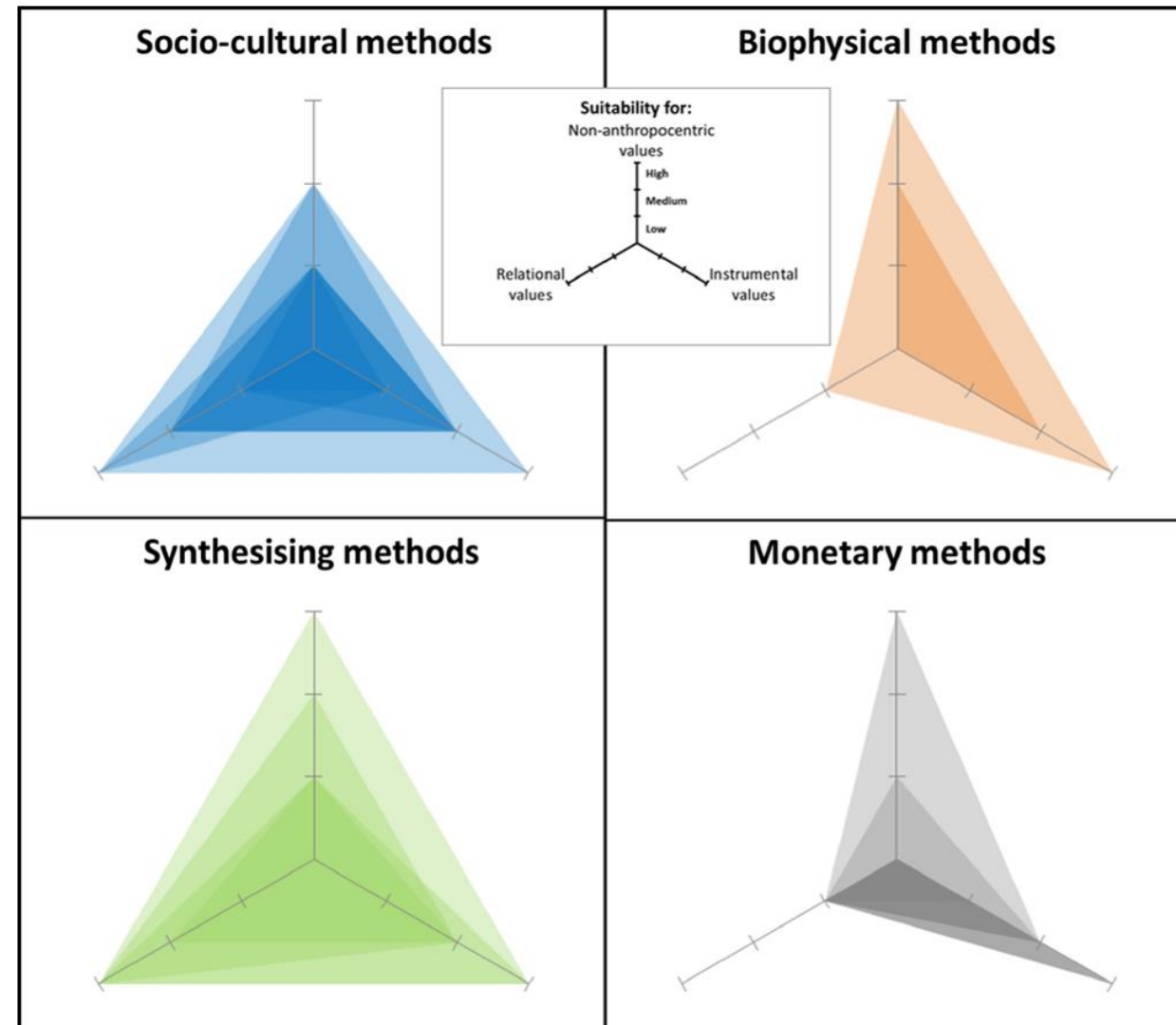
Framework	Category of value
Total Economic Value (TEV)	Direct use values (e.g. provisioning services) Indirect use values (e.g. regulation of air pollution) Option values (e.g. preservation of forests for future use and other values) Bequest values (non-use, e.g. natural heritage and cultural heritage for future generations,..) Existence values (non-use, e.g. existence of diverse species and ecosystems)
The Economics of Ecosystems and Biodiversity (TEEB)	Ecological values (e.g. resilience, biodiversity or functioning ecosystem,..) Sociocultural values (e.g. heritage, sense of place or spirituality) Monetary values (e.g. jobs, profits, costs or investments)
Intergovernmental Platform of Biodiversity and Ecosystem Services (IPBES)	Non-anthropocentric value dimension <sup>a</sup>  Instrumental value dimension  Relational value dimension

Jacobs, S., B. Martín-López, D. N. Barton, R. Dunford, P.A. Harrison, E. Kelemen, H. Saarikoski, M. Termansen, M. García-Llorente, E. Gómez-Baggethun, L. Kopperoinen, S. Luque, I. Palomo, J.A. Priess, G. M. Rusch, P.Tenerelli, F.Turkelboom, R. Demeyer, J. Hauck, H. Keune, and R. Smith. 2018. The means determine the end – Pursuing integrated valuation in practice. *Ecosystem Services* 29:515–528.



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# Conclusions

- Co-production in agriculture presents a major challenge to LCA
- Existing allocation methods cannot capture non-material, non-marketed ecosystem services
- Public goods and services fall within the remit of LCA, and thus should not be ignored
- The “production” of public goods and services also has an “environmental cost” that should be reflected in LCA
- Inclusion of plural values and other non-marketed ESs can profoundly impact the results of comparative LCAs
- Extensive (agroecological, organic) systems are the likely losers of this oversight
- New interdisciplinary research is required to explore the potential of a “value-led” approach to sustainability assessment and LCA

# Thank you for your attention

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### Curran Michael

**Activity areas**

- > Group Sustainability
- > Development and application of the SMART Sustainability Tool

**Projects**

- > [Enhancing supply chain stability, resilience and sustainability through improved sub-supplier management – chocolate and cotton apparel case studies](#)
- > [Diversification through Rotation, Intercropping, Multiple Cropping, Promoted by Actors and Value Chains towards Sustainability \(DiverIMPACTS\)](#)
- > [Sustainability Monitoring and Assessment Routine \(SMART\) \(SMART\)](#)

**Contact**

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Department of Socio-Economic Sciences

## Deliberative diets: Connecting producers and consumers to value the sustainability of Swiss food system scenarios



Principal Investigators:

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Prof. Dr. **Roland Olschewski** [roland.olschewski@wsl.ch], Group Leader, Environmental and Resource Economics, Swiss Federal Institute for Forest, Snow and Landscape Research WSL

Dr. **Sabin Bieri** [sabin.bieri@cde.unibe.ch], Head of Socio-Economic Transitions Cluster, Centre for Development and Environment (CDE), University of Bern

Dr. **Matthias Stolze** [matthias.stolze@fibl.org], Head of Department, Department of Socio-Economic Sciences, Research Institute for Organic Agriculture FiBL



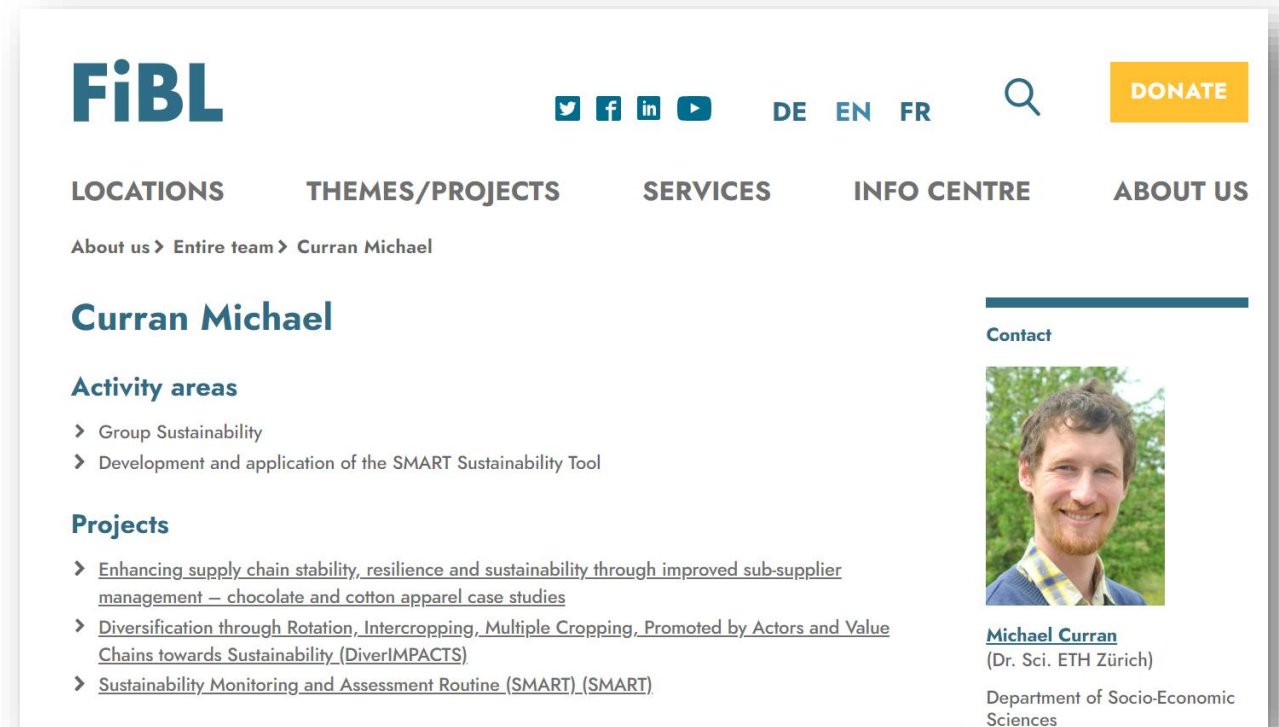
# About the speaker

## Michael Curran

- Agricultural research since 2018
- Indicator-based (multi-criteria) sustainability assessment
- <https://www.fibl.org/en/about-us/team/curran-michael-en.html>

## Background

- PhD in ecology, conservation, sustainability sciences
- Further education in agriculture (3 ha farm in Emmental, 1000 m a.s.l, mixed vegetables, breeding ewes, direct sale)



The screenshot shows the FIBL website profile for Michael Curran. At the top, the FIBL logo is on the left, and social media icons for Twitter, Facebook, LinkedIn, and YouTube are in the center. To the right are language options for DE, EN, and FR, a search icon, and a yellow 'DONATE' button. Below the navigation bar, there are links for 'LOCATIONS', 'THEMES/PROJECTS', 'SERVICES', 'INFO CENTRE', and 'ABOUT US'. The breadcrumb trail reads 'About us > Entire team > Curran Michael'. The main heading is 'Curran Michael'. Underneath, there is a 'Contact' section with a photo of Michael Curran, a man with a beard and short brown hair, wearing a blue and yellow plaid shirt. Below the photo, his name 'Michael Curran' is listed, followed by '(Dr. Sci. ETH Zürich)' and 'Department of Socio-Economic Sciences'. To the left of the photo, there are two sections: 'Activity areas' and 'Projects'. 'Activity areas' includes 'Group Sustainability' and 'Development and application of the SMART Sustainability Tool'. 'Projects' includes 'Enhancing supply chain stability, resilience and sustainability through improved sub-supplier management – chocolate and cotton apparel case studies', 'Diversification through Rotation, Intercropping, Multiple Cropping, Promoted by Actors and Value Chains towards Sustainability (DiverIMPACTS)', and 'Sustainability Monitoring and Assessment Routine (SMART)\_(SMART)'.