

zh aw

Life Sciences und
Facility Management

LCA of food system wastes valorized in peat-reduced horticultural substrate production

peatless

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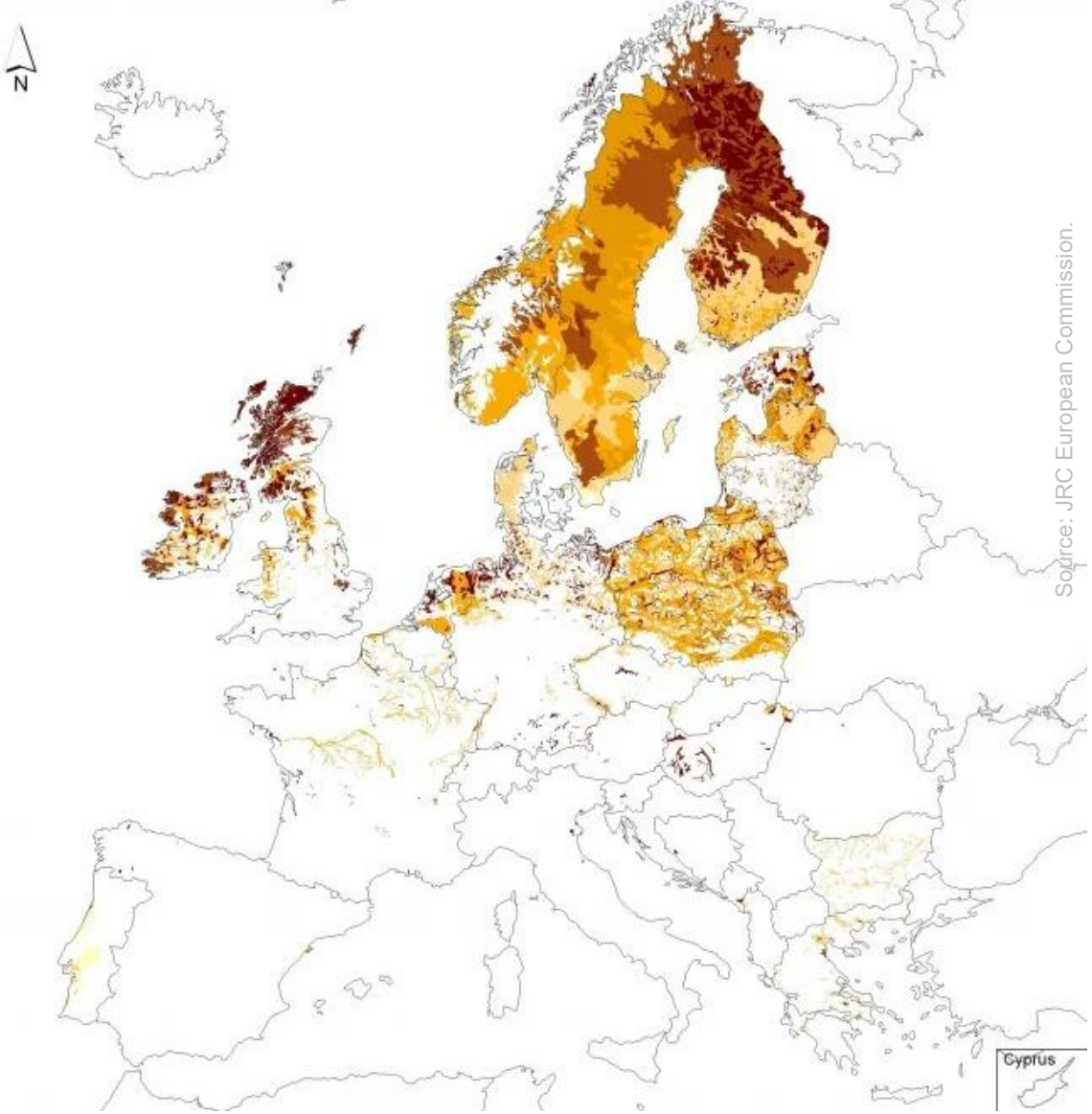
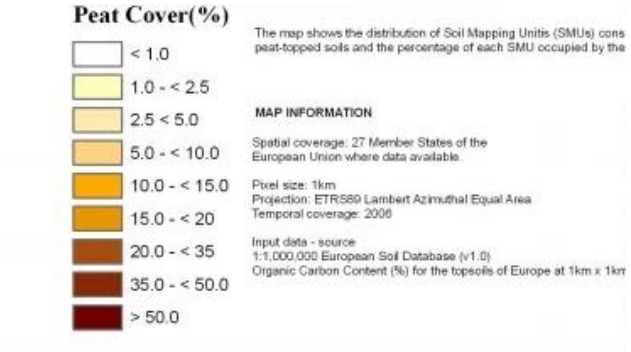
Research Group LCA

The Problem:
Why Replace Peat?

- Peat extraction as an environmental hotspot: CO_2 emissions, biodiversity loss, unsustainable extraction rates
- Horticulture depends on peat — but regulation and market pressure are forcing a transition
- No single drop-in substitute exists → need for optimized blends from alternative materials





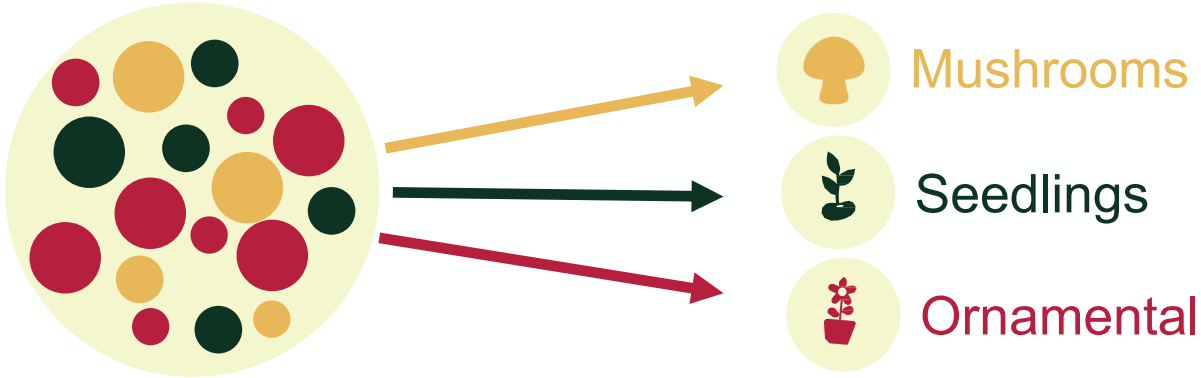
The Opportunity: **Turning Waste into Substrate**

- Food system and agricultural side streams as peat substitutes: **sheep wool powder, spent mushroom substrate** (**SMS), sunflower straw, compost, hemp shives, flax shives, sugar beet lime**
- Local availability across project regions (ES, IT, BE, CH) — closing loops in regional material flows
- From waste burden to resource: side stream valorization as a circular economy lever



PEATLESS: Project Goal and Scope

General Objective: To develop peat-reduced substrates with a maximum peat content of 30%, based on **regionally available alternative raw materials**.



18
Alternative Substrate Blends

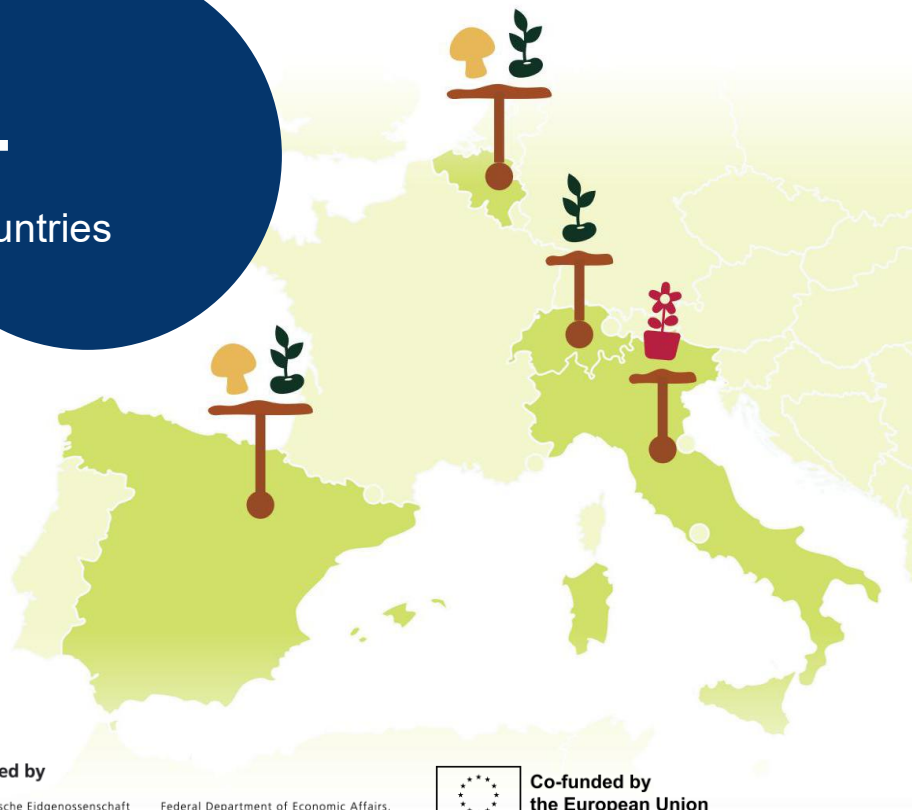
3
Sectors

Mushrooms

Seedlings

Ornamental

4
Countries



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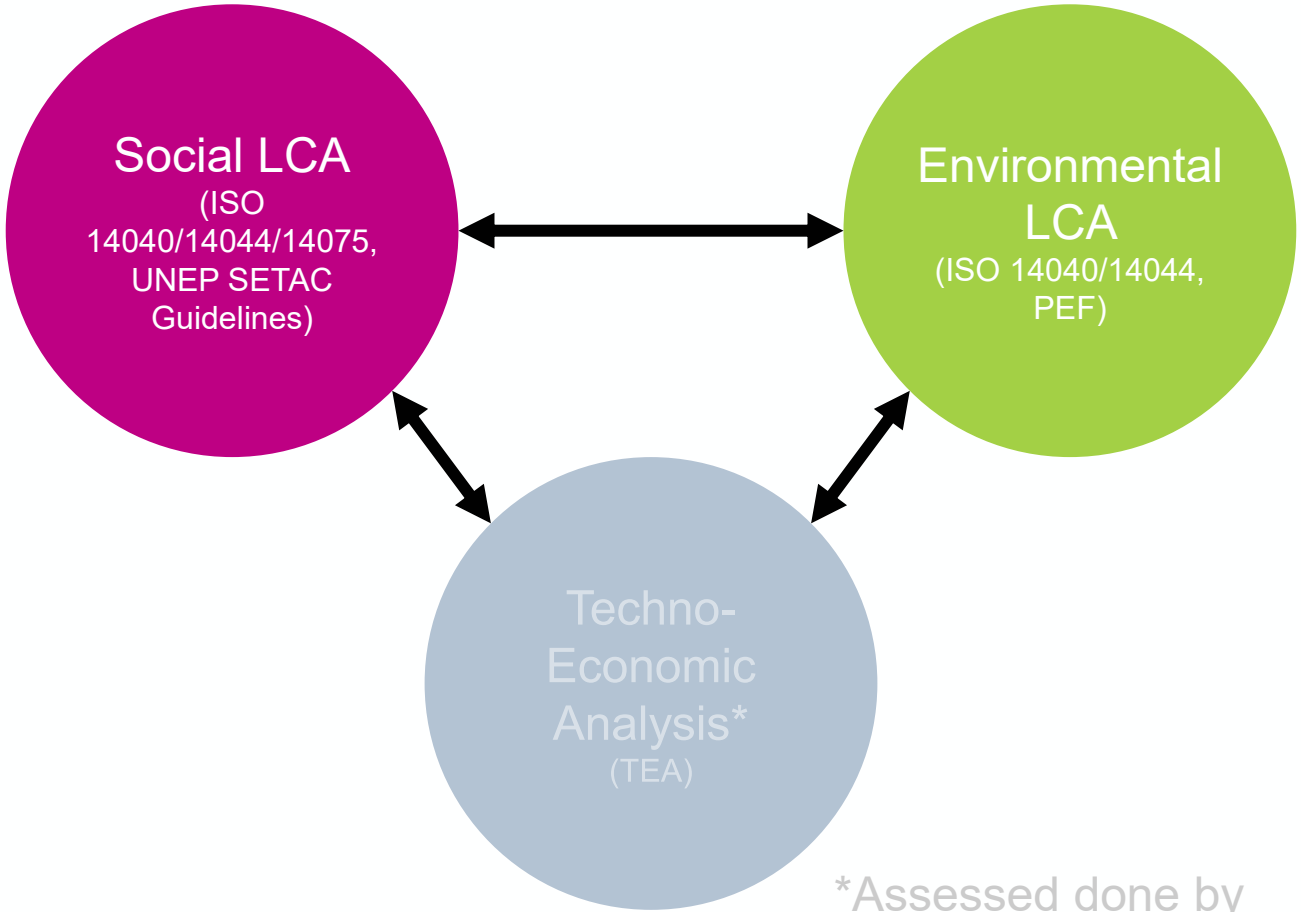
ZHAW in PEATLESS: Life Cycle Sustainability Assessment Leadership

Assessment Methods & Database:

- Social Hotspots or PSILCA
- SOCA
- ecoinvent



Assessment Method & Database:

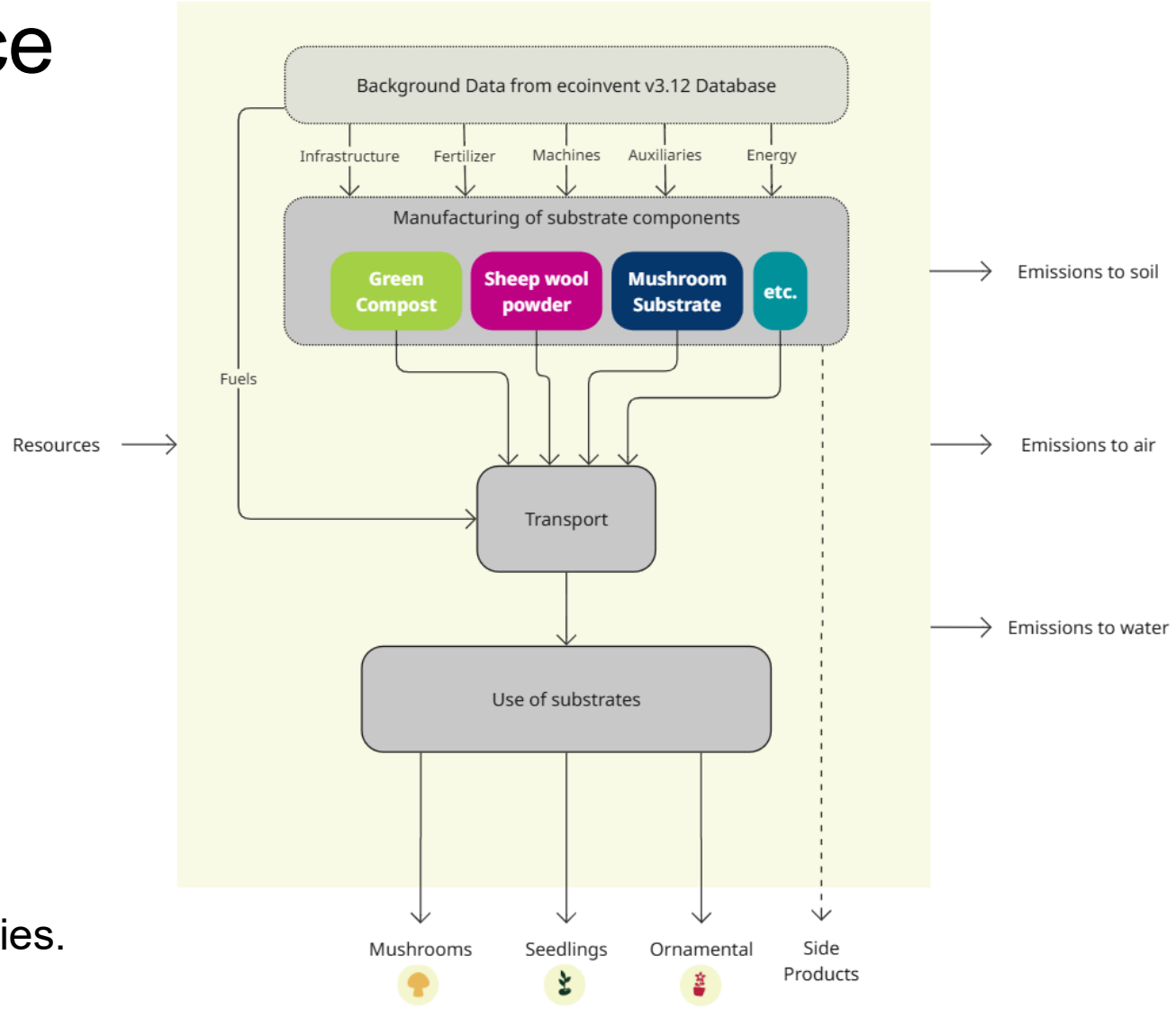
- EF 3.1
- ecoinvent

*Assessed done by Innovarum

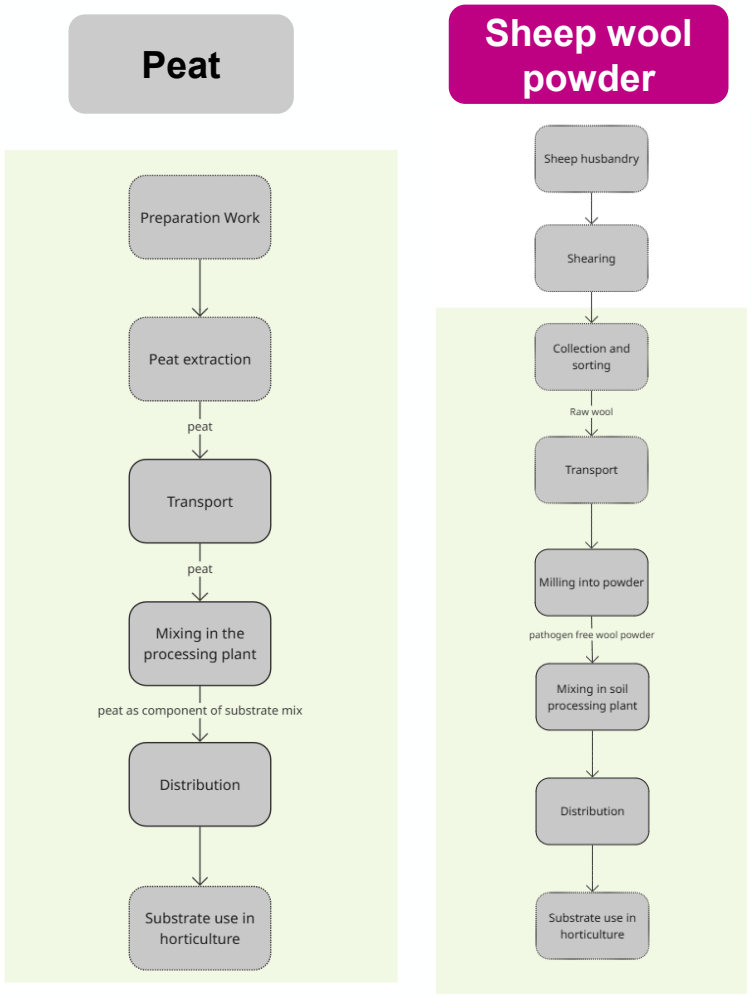
LCA Setup: How We Assess Environmental Performance

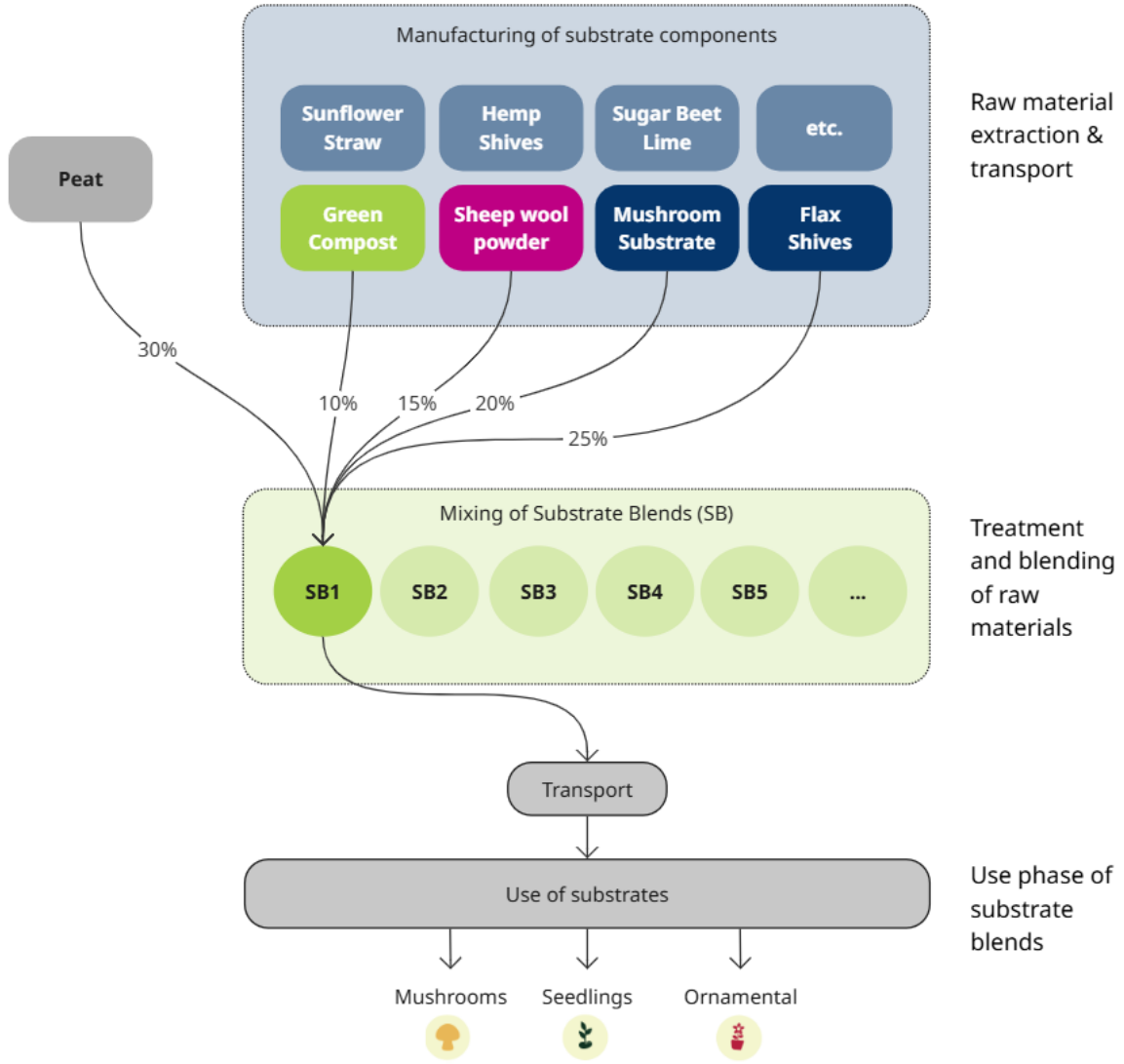
- Map complete value chains of 18 substrate blends:
  - Raw material extraction & transport
  - Treatment of raw materials
  - Blending & use phase of substrate blends
- Functional unit: **1 m³ of substrate blend as delivered; cradle-to-grave**
- Key impact categories: GWP, land use, water scarcity, eutrophication
- GME Growing Media Environmental Footprint Guideline compliant (PEF oriented)

Grounded on primary data from (pilot scale) facilities.



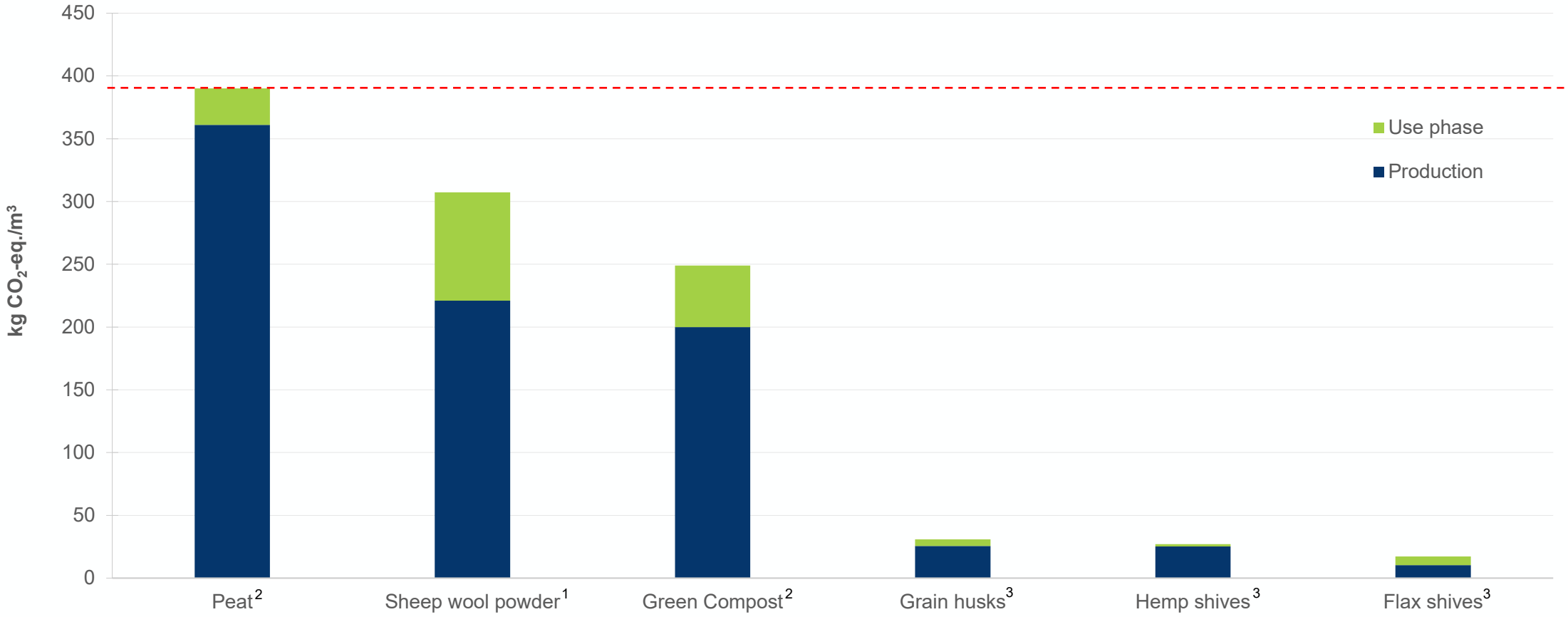
Process: From Food-Waste to Horticulture Substrate





Some Preliminary Results: Global Warming Potential

(EF 3.1 IPCC 2021, Results in kg CO_2-eq/m^3)

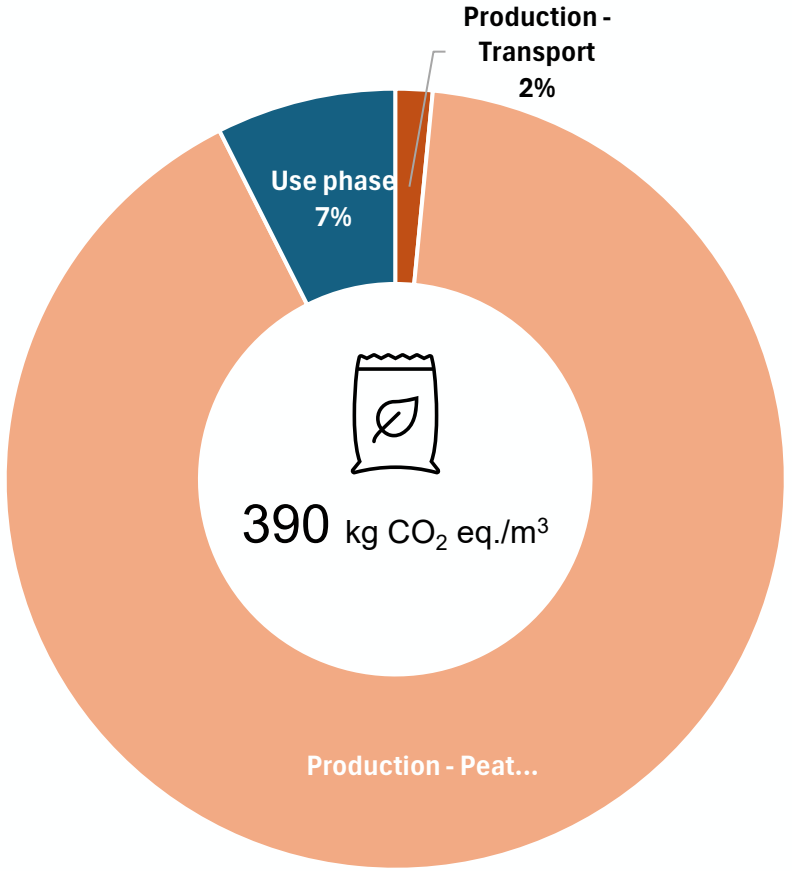


[1]Pilot scale screening LCA
[2]Results from Alejandre et al. 2026, doi:10.1016/j.jclepro.2026.149269
[3]Results from Stucki et al. 2019, Erweiterung der Studie «Torf und Torfersatzprodukte im Vergleich»: Eigenschaften, Verfügbarkeit, ökologische Nachhaltigkeit und soziale Auswirkungen

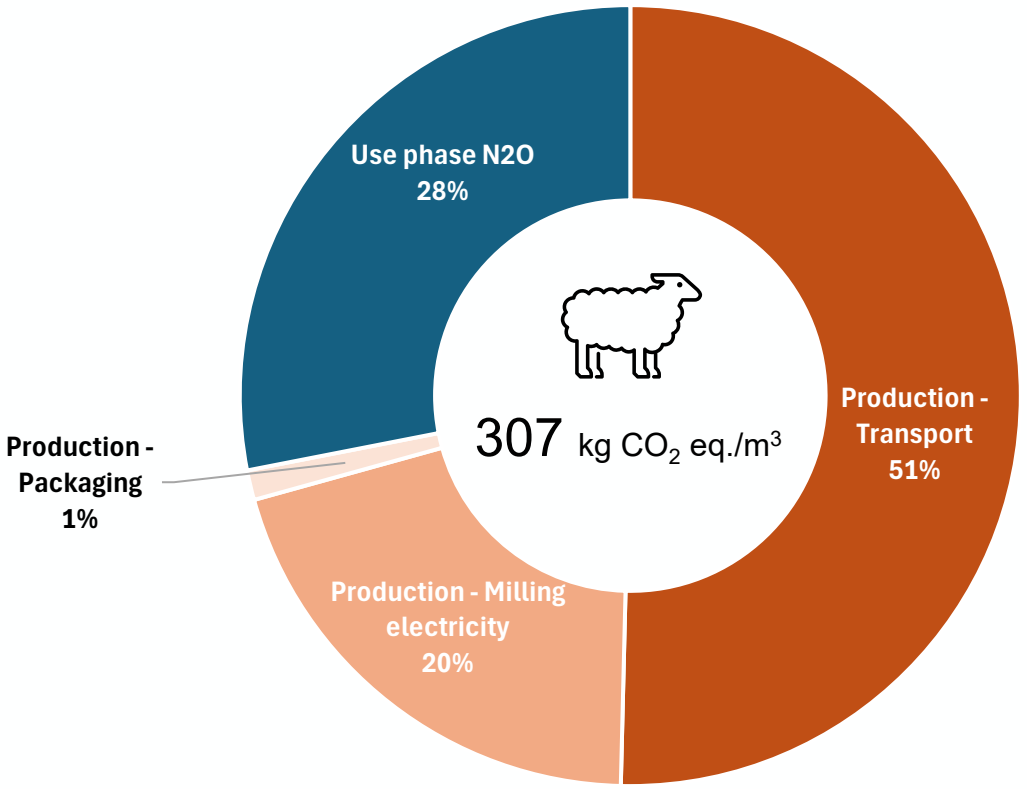
Preliminary Results Sheep Wool Powder

(EF 3.1 IPCC 2021, Results in kg CO_2-eq/m^3)

Contributions to Climate Change from 1m^3 of black peat[1]



Contributions to Climate Change from 1m^3 of sheep wool powder[2]



[1]Results from Alejandre et al. 2026, doi:10.1016/j.jclepro.2026.149269
[2]Pilot scale screening LCA, ZHAW

Key methodological challenges

- FU of raw materials (m^3 / kg / ?): how to ensure comparability between different raw materials?
- Substrate blend volume as FU ignores yield and harvest quality: how to reflect this in the functional unit?

	Plant cultivation propterties										
	Bulk density dry	pH	Buffer capacity	Nutrient content			Salt content	N-immobilization	Water retention	Air capacity	Structural stability
	kg TS/m^3	($CaCl_2$)		mg /l NO_3-N, NH_4-N	mg /l P_2O_5	mg /l K_2O	g/L	-	Vol-%	Vol-%	
Black peat	120-250	2.5-3.5	small	≤50	≤30	≤40	≤0.4	none	70	20	medium
White peat	80-120	2.5-3.5	small	≤50	≤30	≤40	≤0.4	none	60	30	medium
Bark compost	200-300	5.0-7.0	high	≤400	≤150	≤600	≤1.5	medium	50	40	medium
Green compost	600	7.6	medium	70	700	2000	2	medium	>50	30	small
Rice husks	90-100	5.0-6.0	none	0	0	800	0.6	small	9	90	medium
Wood fibres	80-130	4.7-6.0	small	≤50	80	100	0.1	medium	20	60	small
Wood chippings	130-140	3.5-4.0	small	≤50	80	100	0.2	small	30	>70	medium
Coir fibres	50-150	4.5- 6.5	small	< 50	< 50	600	0.8	high	40	60	small
Cocopeat	80	4.0-5.5	small	<5	10	500	0.6	high	70	30	small
Xylitol	160-230	4.5	small	<10	<10	<50	0.5	medium	50	40	medium
Top soil	1300	5.5-6.5	medium					none			medium
TEFA	200	6.8	medium	180	<5	150	0.4		50	40	medium
Biochar (pyrolysis)	300	5.2-8.8	high	<5	200	2000	3	medium	50	20	high
Biochar (HTC)	340	5.8-6.4	high	0.4	300	1000	2	medium	60	20	high
Miscanthus	70	5.1-6.1	none	<5	30	300	0.2	medium	10	80	high
Hemp fibres	31	7.0	none	20	60	900	0.5	small	50	40	medium
Flax shives	150-220	5.0 - 5.6	small	10	80	300	0.2	medium	20	80	high
Oat husks	150	7.6	none	80	800	900	0.6	medium	<20	80	medium
Reed	65	6.4	none	<5	<10	200	0.3	medium	10	80	high
Peat moss cultivated	30-60	3.3-5.8	small	20	10	70	0.2	small	50	40	medium
Biochar-compost	620-810	7.2-7.5	high	60	500	2000	2	medium	60	30	medium

Three Messages to Take Away

1. **Side streams** from food and agricultural systems have real potential to partly **replace peat** in horticultural substrates

2. Preliminary results show that locally sourced side streams can substantially **reduce the climate impact of substrates**

3. **Methodological challenges** lie in FU definitions



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Thanks for your attention.