

Cascading Utilization Pathways of Food Processing Residues and Valorization Potentials of Biogas Digestates

Insights into the FFG project „CircularFood“



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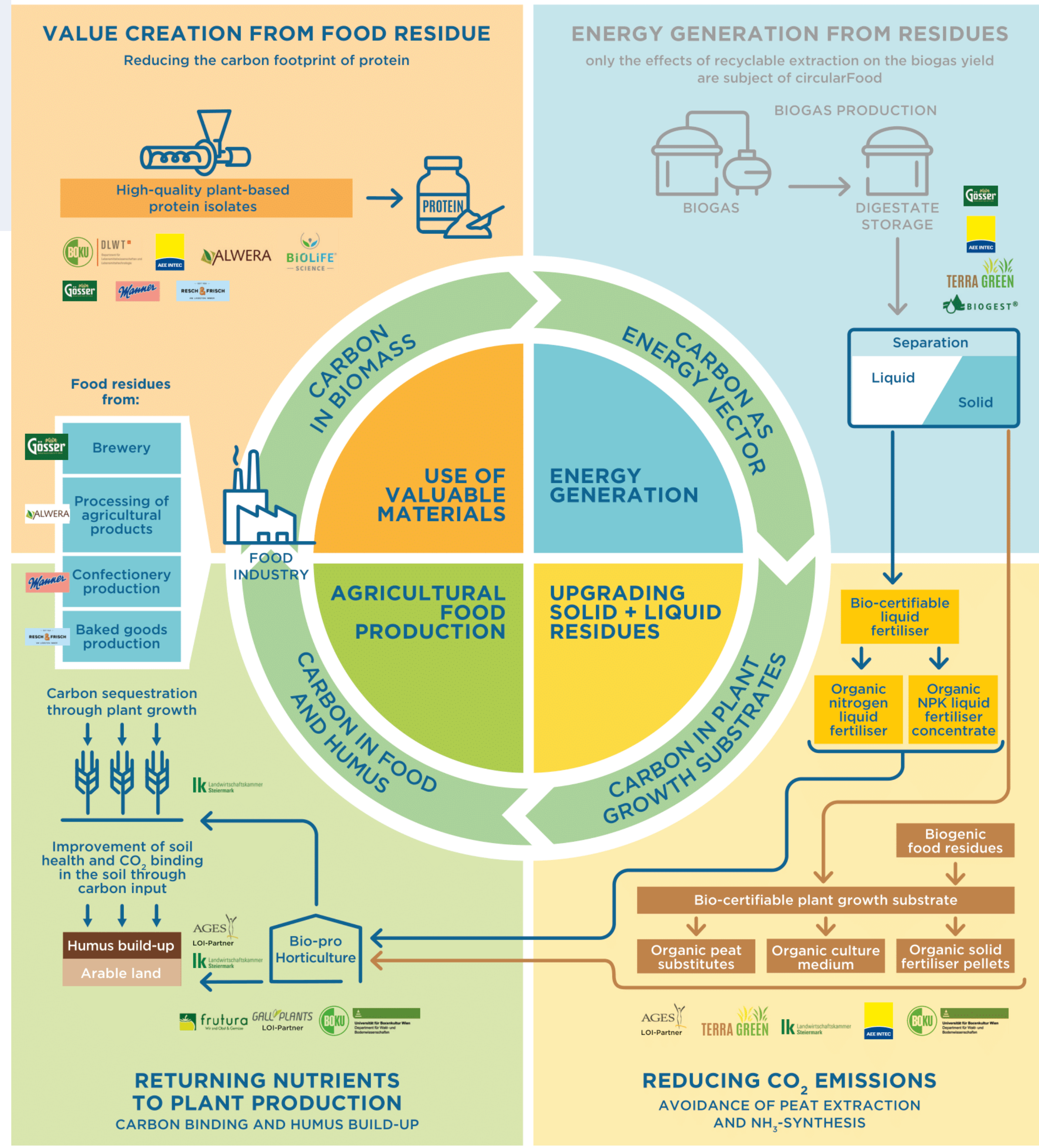
 Bundesministerium Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie

„CircularFood“ Cascading Utilization Pathways of Food Processing Residues

circularFood

Innovation along the value chain

- New flow reactors for protein hydrolysis for sustainable **protein hydrolysates**
- Optimized **solid/liquid separation** of the fermentation residue
- **Bio-certifiable liquid fertilizer** through the use of membrane distillation
- New **peat substitutes**, organic growing media and organic solid fertilizer pellets through optimal blends
- **Plant tests and practical tests** in agriculture



„CircularFood“ Cascading Utilization Path of Food Processing Residue

circularFood

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VALUE CREATION FROM FOOD RESIDUE

Protein-Hydrolyse in Continuous Oscillatory Flow Bioreactor COFB

- Processing of viscous media at high solid content
- Continuous operation (decoupling particle velocity from net-flow)
- High efficiency in continuous hydrolysis
- Hydrolysis of spent grain: proteins as amino acids in hydrolysate

Protein Recovery Spent Grain (0.2 N NaOH)

Analyses:

- % Yield (% of recovered protein from initial biomass)
- % protein content (% of protein of solid final product)

Carbon sequestration through plant growth

- agricultural products
- Confectionery production
- Baked goods production

Closing the nutrient cycle: Application liquid NPK fertilizer made from fermented brewer's grains in Bio-Horticulture and Agriculture

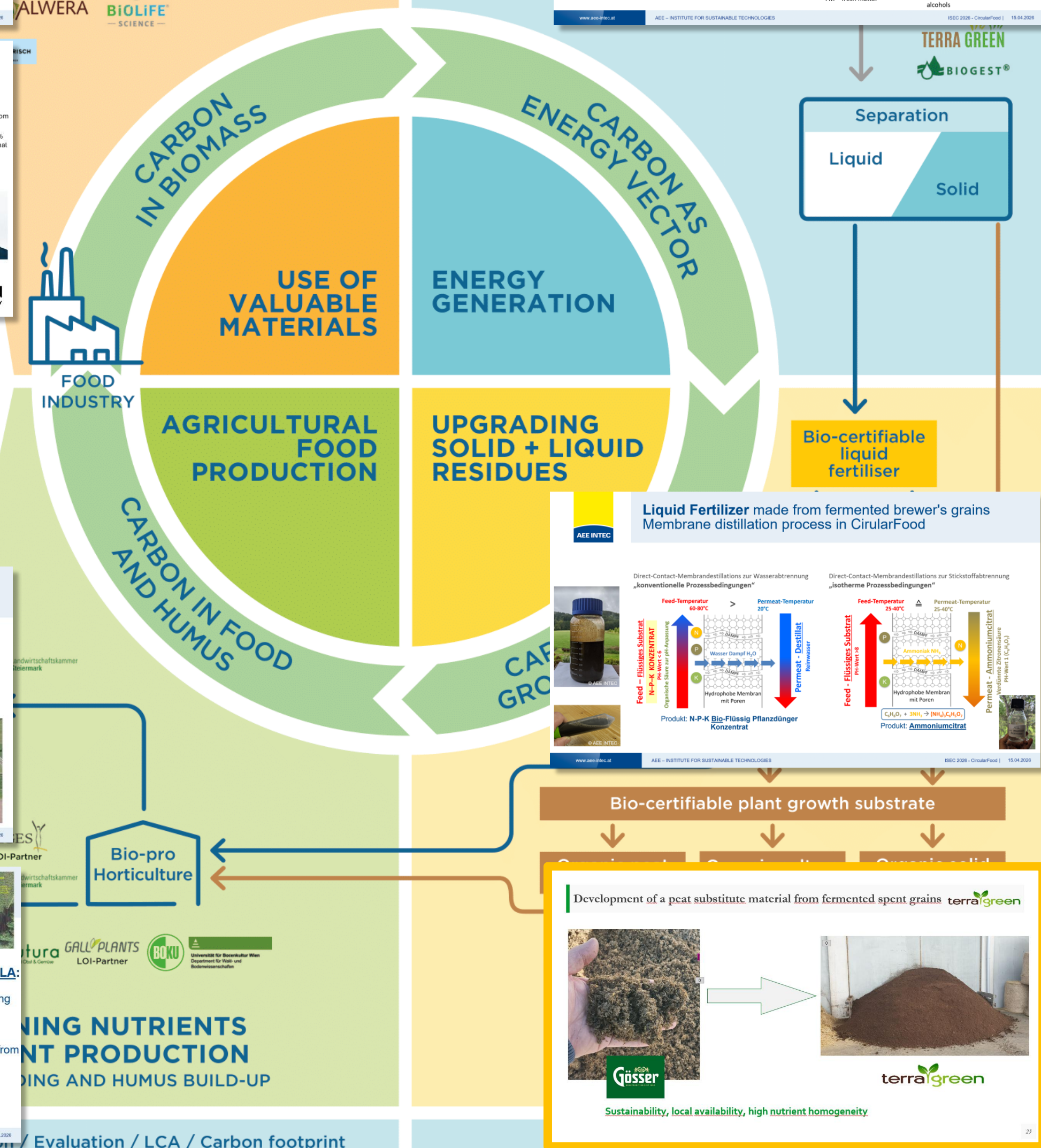
Fertilization trials on field trial agriculture using liquid NPK fertilizer made from fermented brewer's grains

Dr. Heinrich Holzner (LK-Stmk) Christian Werni, MSc (LK-Stmk)

Variable	Control	100% NPK	100% NPK + Humus	100% NPK + Humus + Bio-Pro	100% NPK + Humus + Bio-Pro + Güsser
Yield (t/ha)	236	88	87	86	22.4
Chlorophyll content	242	95	87	90	22.4
Chlorophyll content	232	93	87	90	22.4
Chlorophyll content	228	89	88	91	22.4
Chlorophyll content	224	85	89	92	22.4
Chlorophyll content	220	81	90	93	22.4
Chlorophyll content	216	77	91	94	22.4
Chlorophyll content	212	73	92	95	22.4
Chlorophyll content	208	69	93	96	22.4
Chlorophyll content	204	65	94	97	22.4
Chlorophyll content	200	61	95	98	22.4
Chlorophyll content	196	57	96	99	22.4
Chlorophyll content	192	53	97	100	22.4
Chlorophyll content	188	49	98	101	22.4
Chlorophyll content	184	45	99	102	22.4
Chlorophyll content	180	41	100	103	22.4
Chlorophyll content	176	37	101	104	22.4
Chlorophyll content	172	33	102	105	22.4
Chlorophyll content	168	29	103	106	22.4
Chlorophyll content	164	25	104	107	22.4
Chlorophyll content	160	21	105	108	22.4
Chlorophyll content	156	17	106	109	22.4
Chlorophyll content	152	13	107	110	22.4
Chlorophyll content	148	9	108	111	22.4
Chlorophyll content	144	5	109	112	22.4
Chlorophyll content	140	1	110	113	22.4
Chlorophyll content	136	-3	111	114	22.4
Chlorophyll content	132	-7	112	115	22.4
Chlorophyll content	128	-11	113	116	22.4
Chlorophyll content	124	-15	114	117	22.4
Chlorophyll content	120	-19	115	118	22.4
Chlorophyll content	116	-23	116	119	22.4
Chlorophyll content	112	-27	117	120	22.4
Chlorophyll content	108	-31	118	121	22.4
Chlorophyll content	104	-35	119	122	22.4
Chlorophyll content	100	-39	120	123	22.4
Chlorophyll content	96	-43	121	124	22.4
Chlorophyll content	92	-47	122	125	22.4
Chlorophyll content	88	-51	123	126	22.4
Chlorophyll content	84	-55	124	127	22.4
Chlorophyll content	80	-59	125	128	22.4
Chlorophyll content	76	-63	126	129	22.4
Chlorophyll content	72	-67	127	130	22.4
Chlorophyll content	68	-71	128	131	22.4
Chlorophyll content	64	-75	129	132	22.4
Chlorophyll content	60	-79	130	133	22.4
Chlorophyll content	56	-83	131	134	22.4
Chlorophyll content	52	-87	132	135	22.4
Chlorophyll content	48	-91	133	136	22.4
Chlorophyll content	44	-95	134	137	22.4
Chlorophyll content	40	-99	135	138	22.4
Chlorophyll content	36	-103	136	139	22.4
Chlorophyll content	32	-107	137	140	22.4
Chlorophyll content	28	-111	138	141	22.4
Chlorophyll content	24	-115	139	142	22.4
Chlorophyll content	20	-119	140	143	22.4
Chlorophyll content	16	-123	141	144	22.4
Chlorophyll content	12	-127	142	145	22.4
Chlorophyll content	8	-131	143	146	22.4
Chlorophyll content	4	-135	144	147	22.4
Chlorophyll content	0	-139	145	148	22.4

Results location BERGLA:

- Experimental corn planting
- Soil Type: Heavy soil
- No statistical difference from conventional mineral fertilizers



Biomethane Potential (BMP) after Proteinextraction

BMP (35d, 38°C) of the remaining solid fraction after the protein extraction (related to VS):

Reference BSG	BSG APE 3	BSG APE 2	BSG APE 1
VS [Nm³/Vha]	422.2	376.1	420.9
Yield [Nm³/Vha]	318.9	273.5	318.2
VS [Nm³/Vha]	46.2	37.7	48.4
TS [Nm³/Vha]	12.20	11.36	12.84
VS [Nm³/Vha]	10.99	10.03	11.50
TS [Nm³/Vha]	3.52	3.20	3.67
VS [Nm³/Vha]	145	138	152
VS [Nm³/Vha]	1126	1120	1039
VS [Nm³/Vha]	3000	3000	3000

Liquid Fertilizer made from fermented brewer's grains Membrane distillation process in CircularFood

Development of a peat substitute material from fermented spent grains terraGreen

Sustainability, local availability, high nutrient homogeneity



Separation Trial 18. - 19. March 2025



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Solid Fraction

© Terra Green

▪ 111 bales a ~ 1 to



© Terra Green

▪ ~ 50 IBC liquid fraction



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PEAT USE

What is peat actually used for?

- **Main component of potting soils and growing media in commercial horticulture**
- **Used in nurseries, ornamental plant and vegetable cultivation, and by local Municipality**
- **Landscaping and restoration projects**
- **...**



Where does peat come from? Peat is extracted from peat bogs / wetlands



Peat Extraction



© Weser-Kurier, Foto: dpa Picture-Alliance / R.Grossmann, picture-alliance / Helga Lade Fo

- Peatlands are among Europe's most endangered habitats and are home to a highly specialized flora and fauna
- Annual growth → 1 mm per year
- **Peat is a fossil fuel!**
(a precursor to lignite / Braunkohle)



© Imago

Problem → Destruction of peatlands and massive CO₂ emissions resulting from peat extraction for horticultural purposes

- Peatlands are massive **carbon sinks**. Although they cover only 3% of the Earth's surface, their peat layers store **one-third of terrestrial carbon**—twice as much as the world's forests.
- When peat is extracted, CO₂, methane, and nitrous oxide—a gas that is 300 times more harmful to the climate than CO₂—are released.
- According to the IPCC, emissions from peat used for horticultural purposes / gardening amount to approximately **7 million tons of CO₂ equivalents for Europe**
- Globally, the destruction of peatlands is expected to contribute to **higher CO₂ emissions than international air travel**

[Quelle: <https://science.apa.at/power-search/16090587791456171117>]

Peat Use in Austria – The Current Situation

- Import and use of approximately **160.000 tons of peat** per year in Austria ¹⁾
- The volume of imports generates annual greenhouse gas emissions of approximately **308.800 tons of CO₂-equivalents** ²⁾



1) Quelle: https://www.umweltzeichen.at/file/Richtlinie/UZ%2032/Long/UZ32_R8a_Torffreie%20Kultursubstrate_Bodenhilfsstoffe_2024.pdf
Ausgabe 1. Jänner 2024

2) Quelle: vgl. Stichnothe, H. (2022). Life cycle assessment of peat for growing media and evaluation of the suitability of using the Product Environmental Footprint methodology for peat. *The International Journal of Life Cycle Assessment*, 27, 1270–1282. DOI: 10.1007/s11367-022-02106-0

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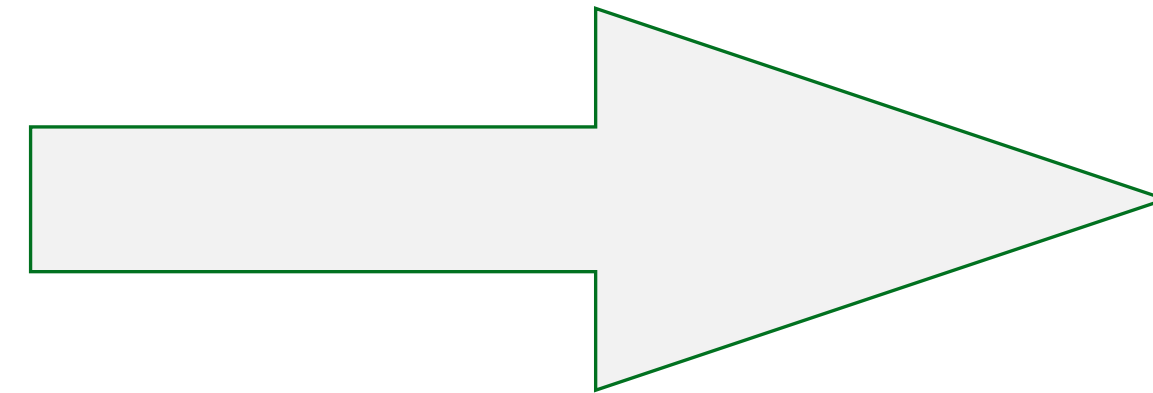
Diameter 10 m
Volume **640.000 m³**
(at bulk density)

Height **8.150 m**



Zylinder

Development of a peat substitute material from fermented spent grains



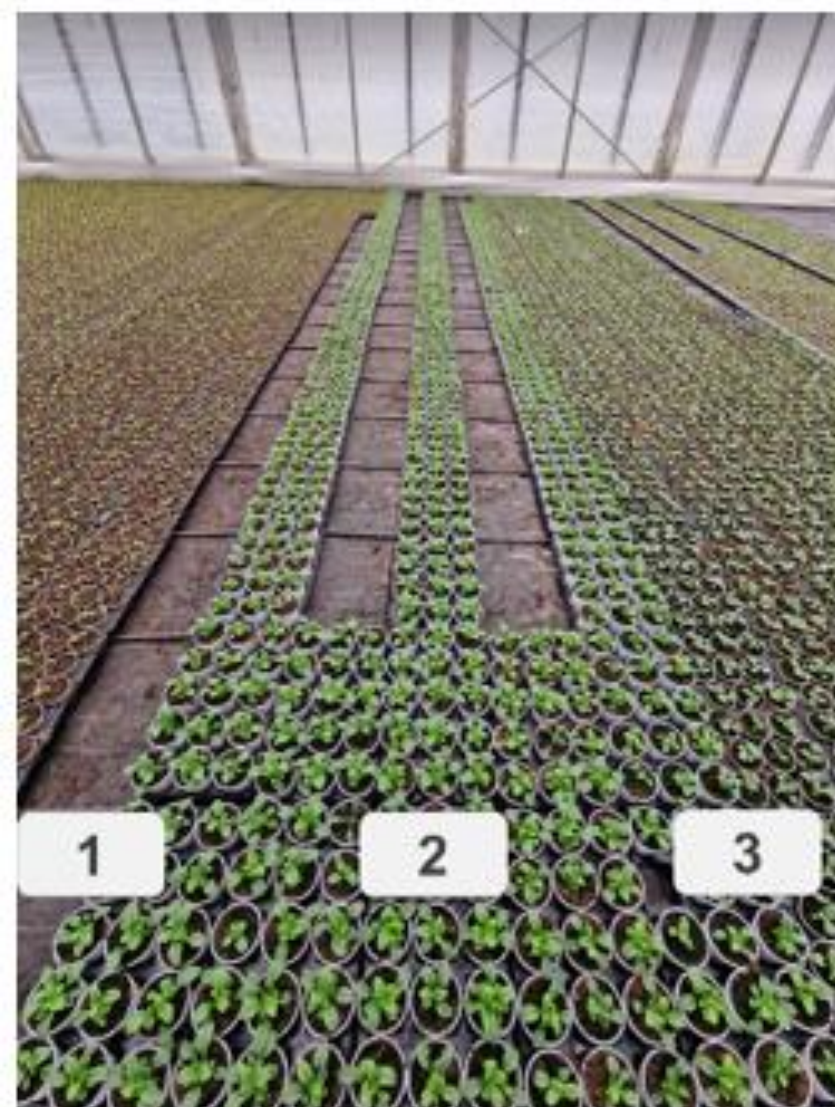
Sustainability, local availability, high nutrient homogeneity

Peat substitute from fermented spent grains

Various mixtures tested in commercial gardening



- » Testing efficient solid/liquid separation methods
- » Substrate stabilisation
- » Processing the substrate as peat substitute material (mixing with other substrates)



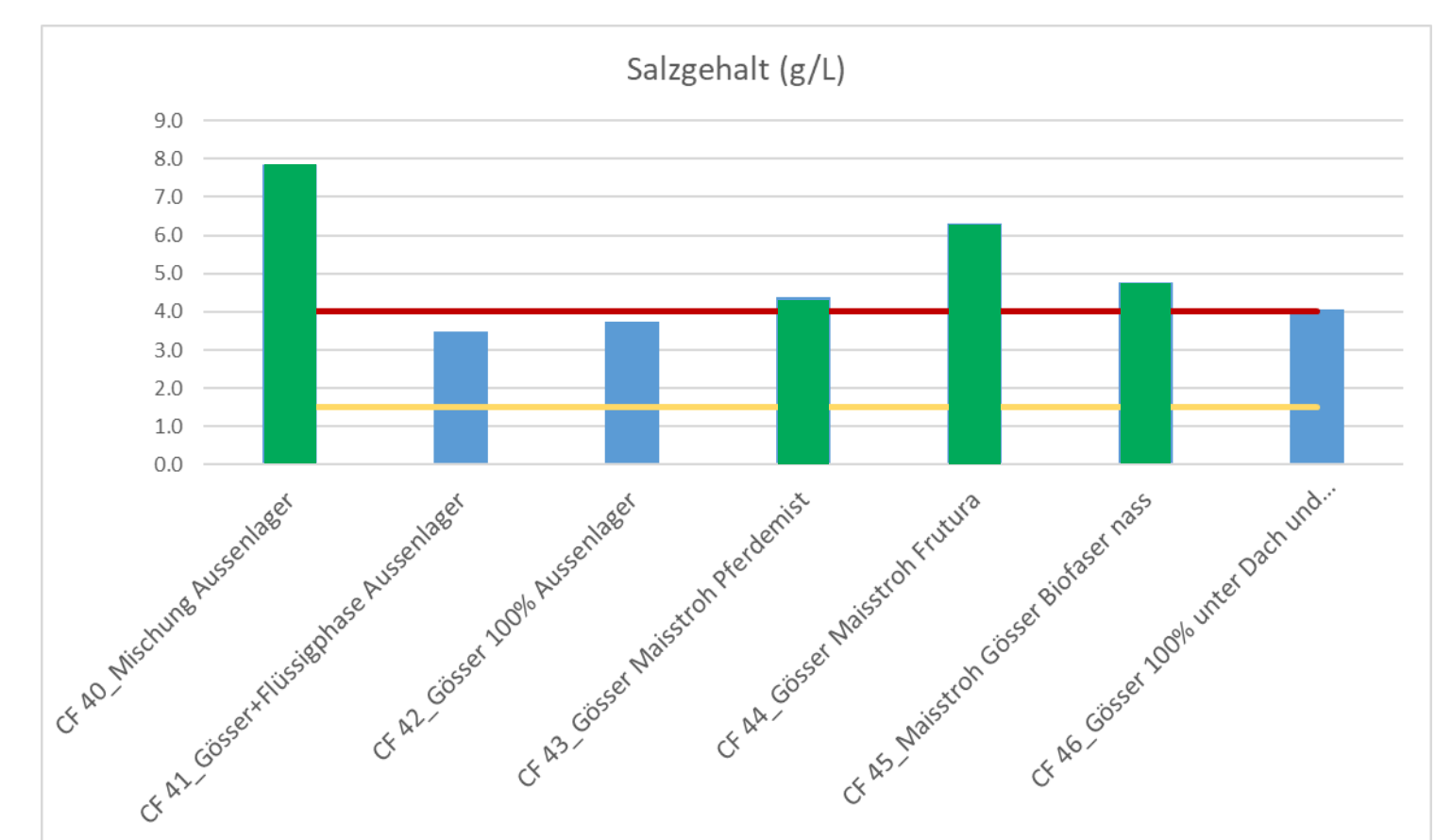
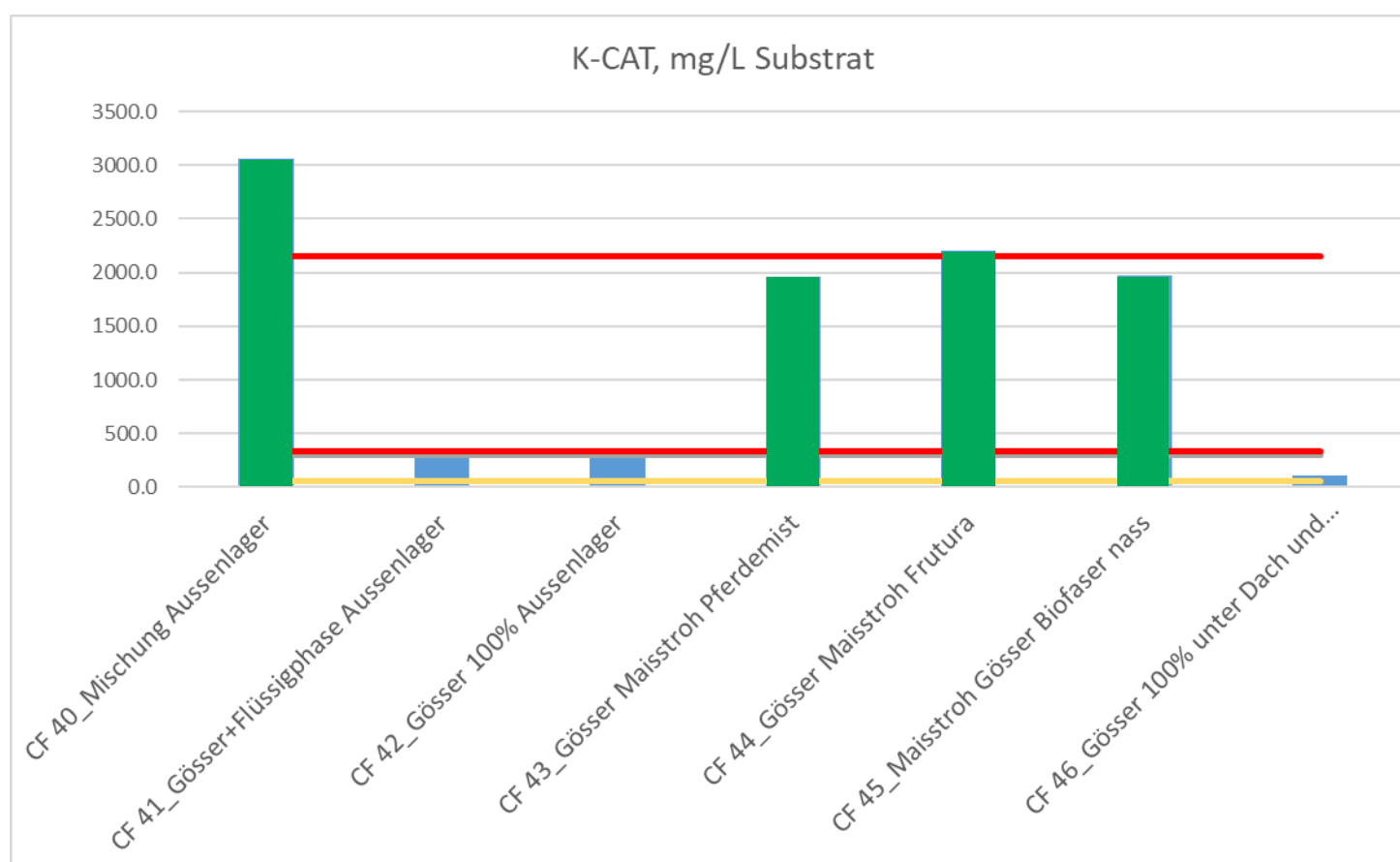
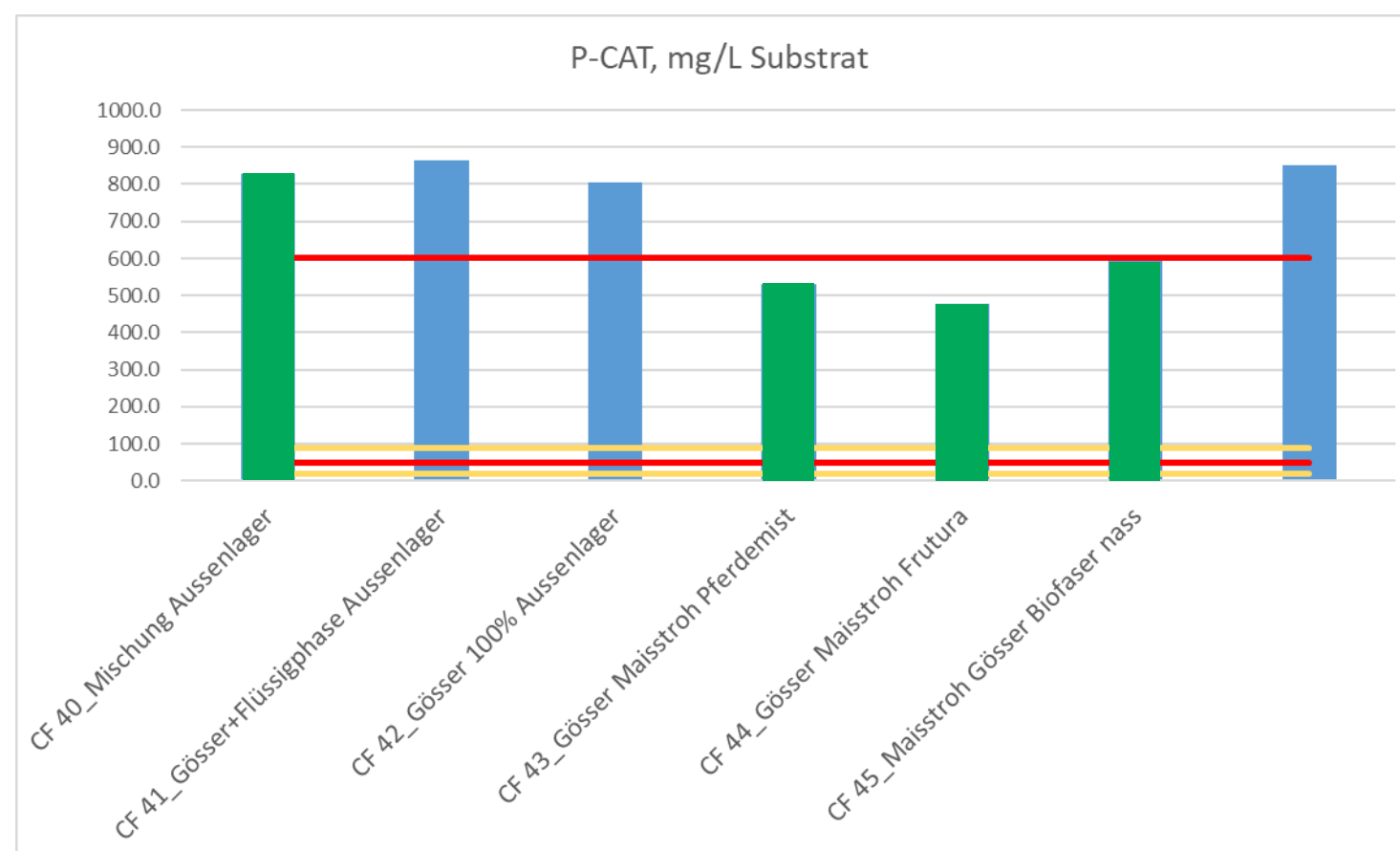
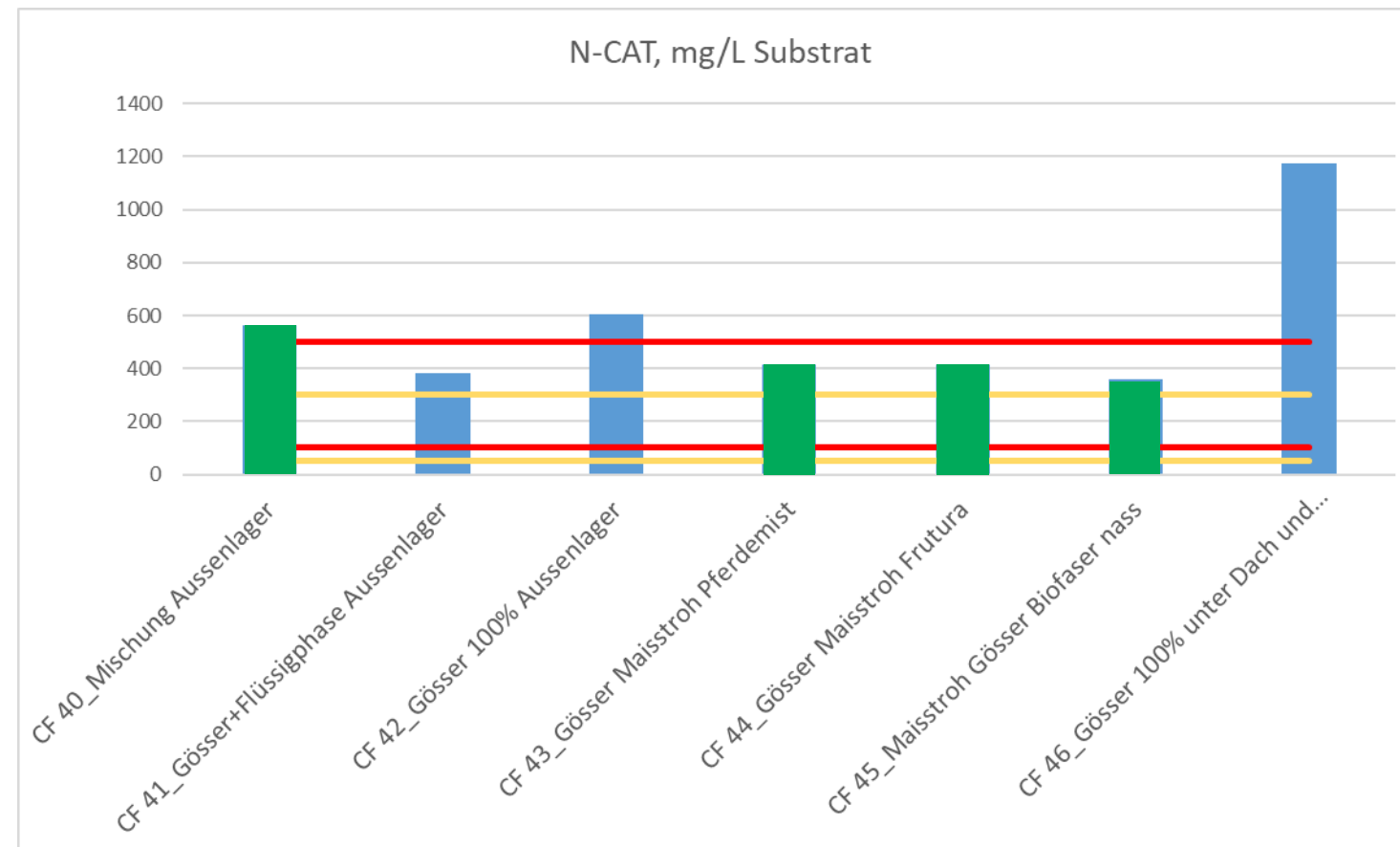
Results and Successes



- » A total of more than 22,000 plants were transplanted using the substrate mixtures, in Austria in cooperation with Gall Plants from Markt Allhau and in Germany in cooperation with the company Compaqpeat SIA
- » Results of the planting test – The root mass was significantly more developed in the mixtures containing fermented beer spent grain (samples 1, 2, 3) than in those without added fermentation residue (sample 0%)

Outlook: BOKU – Mixtures of Brewer Spent Grain and agricultural byproducts Analyses Result Testing Phase 2025

CAT-soluble N, P, K, salt content





AEE INTEC

IDEA TO ACTION

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