BBioNets

Boosting the adoption of Bio-Based Technologies

Cross-Fertilisation Meetings

Bio-Based Practices on Farms & Forests

"Opportunities in Green Biorefineries"

Development of rural green biorefinery research in Ireland

James Gaffey, Munster Technological University

Online, 23/04/2026

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research group



James Gaffey
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- Bioresource Mapping
- Bio-based Value Chain Development
- Biorefining
- Low Carbon Economy
- New Business Models
- Education & Outreach

>70M	30	15	300+
FUNDING	PROJECTS	PROGRAMMES	PARTNERSHIPS

Horizon 2020 European Union Funding for Research & Innovation

BBI JU

CBE JU

Bio-based Industries Consortium

Interreg Atlantic Area

Grass - key resource in challenging times..

Share of total area by type and land cover (%), 2018

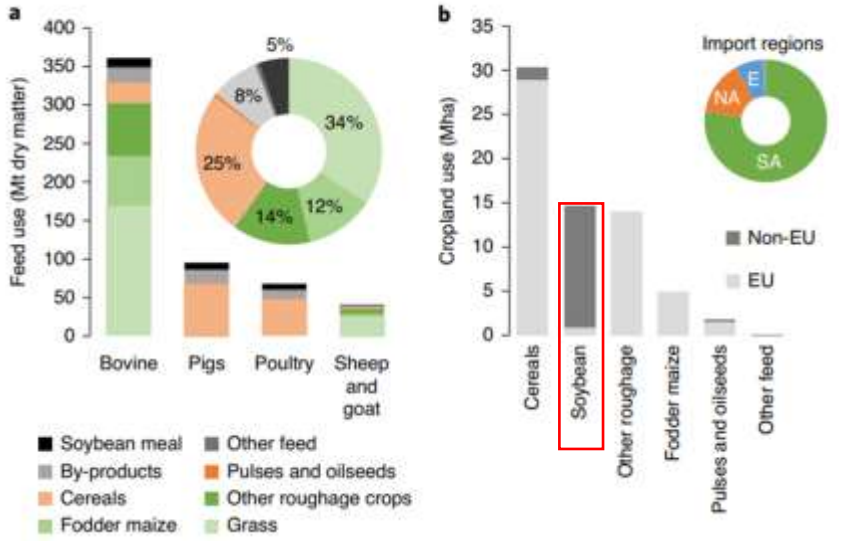
	Total area (km2)	Woodland and shrubland	Cropland	Grassland	Water areas and wetland; bareland	Artificial
EU	4 125 107	46.8	24.2	17.4	7.3	4.2
Belgium	30 666	27.8	29.1	28.2	3.3	11.7
Bulgaria	110 996	48.8	32.3	14.7	2.0	2.3
Czechia	78 871	39.3	33.7	20.1	2.4	4.4
Denmark	42 925	21.9	47.7	19.7	3.8	6.9
Germany	357 569	35.7	32.3	20.8	3.7	7.6
Estonia	45 336	58.7	12.9	16.2	10.5	1.7
Ireland	69 947	24.2	5.5	57.7	8.5	4.2
Greece	131 694	57.6	20.5	13.8	4.1	4.0
Spain	498 502	50.1	27.4	12.8	6.0	3.7
France	549 060	36.0	29.9	24.6	3.8	5.7
Croatia	56 594	59.2	16.6	17.4	3.7	3.2
Italy	302 072	41.2	31.7	16.4	4.2	6.6
Cyprus	9 253	46.5	30.4	10.9	6.0	6.2
Latvia	64 585	56.0	15.4	20.9	5.9	1.7
Lithuania	65 284	39.6	32.0	21.9	4.3	2.1
Luxembourg	2 595	36.9	21.8	32.9	1.1	7.4
Hungary	93 012	28.2	43.5	17.5	6.8	4.0
Malta	316	16.9	28.7	18.5	8.4	27.5
Netherlands	37 377	16.8	23.0	34.2	13.3	12.6
Austria	83 878	48.5	15.9	24.2	7.3	4.2
Poland	311 929	37.6	34.7	20.7	3.3	3.6
Portugal	89 103	56.2	16.3	15.8	5.3	6.4
Romania	238 398	37.0	32.6	22.9	4.7	2.8
Slovenia	20 273	65.8	11.0	17.8	1.2	4.3
Slovakia	49 035	49.5	27.5	17.6	2.0	3.4
Finland	338 411	69.6	5.3	5.7	17.6	1.7
Sweden	447 424	68.5	4.0	5.5	20.1	1.8

Source: Eurostat (online data code: lan_lcv_ovw)

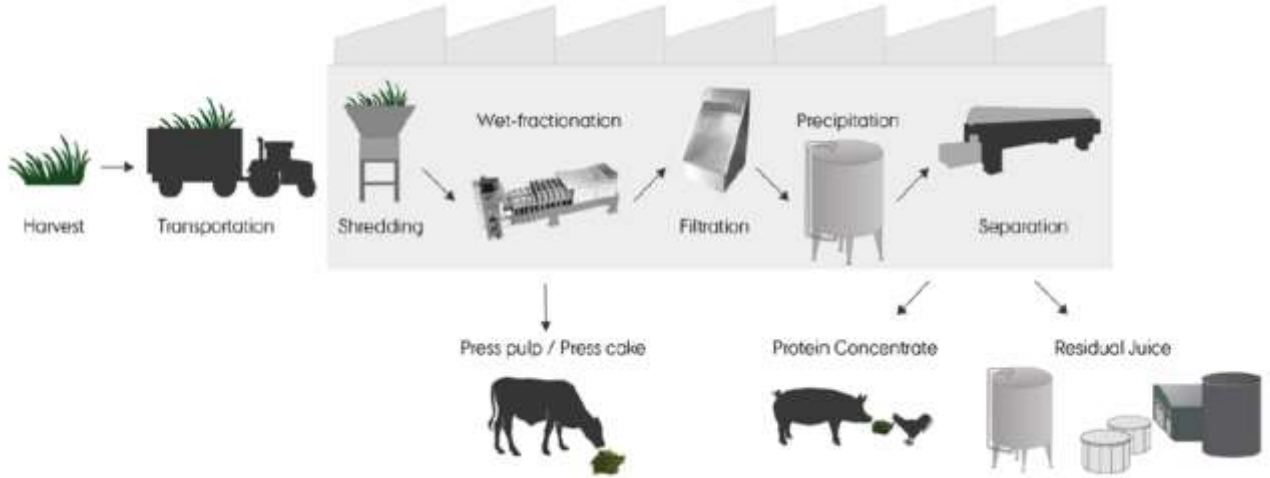
eurostat



Grass – Europe's untapped protein opportunity



Karlsson et al. 2021



	Yield, DM ton/ha	Protein %	Protein kg/ha	Lysine kg/ha	Methionine kg/ha
Soy	2	35	700	43	9
Rapeseed	5	20	1000	60	20
Wheat	9	11	1000	30	16
Faba bean	6	25	1500	92	11
Pea	6	22	1300	92	13
Clover grass	13	20	2600	200	90
Red clover	12	21	2600	200	90
Extensive grass	3	12	350	25	12

Jorgensen et al. 2013



Biorefinery Glas project

Funded by:
An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

BIOREFINERY GLAS

Fresh grass

Press Cake

Press Juice

Press Juice

Press Cake Silage

Protein concentrate

Press Cake

Fructo-oligosaccharides

Whey

trient-rich whey

Ruminant Feed

Monogastric Feed

Feed, Food

Fertilizer, Bioenergy



Use of biorefinery pulp as cattle feed

- Biorefinery pulp successfully replaced grass silage in dairy cow diets without negatively impacting yield *(Serra et al., (2023), Costigan et al., (2024)).*
- Biorefinery pulp diet achieved higher N-use efficiency and lower loses of N & P in excrement.
- Methane results mixed to date.



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Taighde Éireann Research Ireland

Treatment		
Item	GS	PC
DMI (kg DM/d)	19.33	18.00
Feed efficiency	1.31	1.27
Milk yield (kg/d)	28.02	27.33
No significant difference in milk quality		
Nitrogen Intake and Output		
Intake kg/d		
Feed N Intake (kg/d)	0.71[a]	0.61[b]
N output (kg/d)		
Milk	0.19	0.18
Faeces	0.23[a]	0.19[b]
Urine	0.27[a]	0.22[b]
NUE (%)	27.33[a]	31.90[b]
Methane Emissions Analysis Rusitec		
Gas production (l/d)	1.31	1.26
Methane (mmol/d)	6.61	5.71

Use of biorefinery protein concentrate (LPC) as pig feed

- Extracted LPC delivered high protein concentration comparable with soybean meal (SBM)
- LPC has successfully replaced 27% and 50% of SBM in pig diets *(Ravindran et al., (2021), Gaffey et al., (2023))*
- Big opportunity to isolate human food grade protein

Animal Feed Protein Sources	Crude Protein g/100g	Lysine g/100g	Methionine g/100g	Cysteine g/100g	Threonine g/100g	Crude Fibre g/100g
Soyabean Meal	44 – 48	2.81 – 3.20	0.60 – 0.75	0.69 – 0.74	0.71 – 2.00	3 – 7
Sunflower Meal	24 – 44	1.18 – 1.49	0.74 – 0.79	0.55 – 0.59	1.21 – 1.48	12 – 32
Rapeseed Meal	34 – 36	2.00 – 2.12	0.67 – 0.75	0.54 – 0.91	1.53 – 2.21	10 – 15
Cottonseed Meal	24 – 41	1.05 – 1.71	0.41 – 0.72	0.64 – 0.70	1.32 – 1.36	25 – 30
Grass Protein Concentrate	42.8	2.03	0.72	0.21	1.71	3.9

Date of weighing	Daily Feed Intake (kg/d)		Feed Conversion Efficiency (kg/d)		Average Daily Gain (kg/day)	
	Treatment	Control	Treatment	Control	Treatment	Control
Week 1	1.079	1.060	1.62	1.68	0.665	0.630
Week 2	1.155	1.167	1.89	1.78	0.611	0.656
Week 3	1.285	1.265	2.06	1.87	0.624	0.675
Week 4	1.384	1.349	2.13	2.13	0.650	0.632
Week 5	1.427	1.391	2.19	2.14	0.652	0.650

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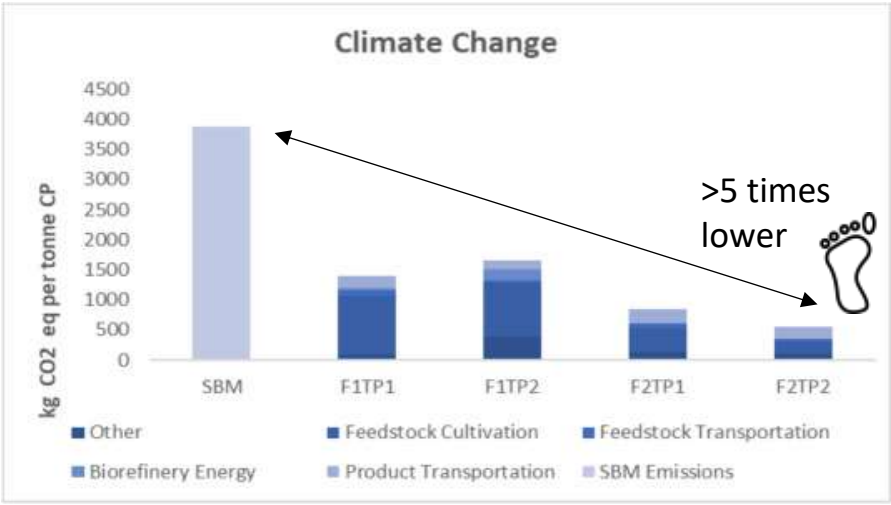


Use of biorefinery side streams to create a circular process

- Liquid (and solid) residues of biorefinery residues show high biomethane potential on DM basis (Ravindran et al., (2022))
- Can meet heat and electricity requirements of biorefinery, possibly surplus depending on scale and feedstocks



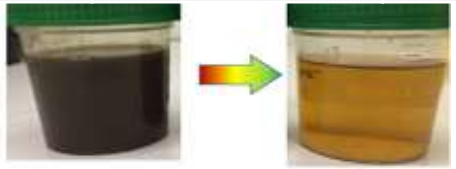
- LCA study highlighting of this model highlights large potential for Irish-based grass protein concentrate over imported soybean meal *(Gaffey et al., (2024))*



High potential for cascading extraction of high value grass-based products

- Approx 10g/l of FOS sugar concentrate extracted per litre of brown juice residue *(Menon et al., (2022))*
- Grass-based FOS demonstrated comparable prebiotic efficacy to benchmark products

Prebiotic Index			
Probiotic Strain	*Grass FOS*	Commercial FOS	Inulin
L acidophilus	*1.12±1.3*	1.09±0.8	0.88±0.6 *
L fermentum	*1.67±0.9*	1.32±0.8	3.67±0.7 *
L plantarum	*1.44±0.5*	0.78±0.7 *	-0.354±0.6 *
B animalis	*1.89±0.45*	2.05±0.11	5.98±0.41*
B breve	*3.65±0.98*	4.01±1.12	2.76±0.23 *



- Current work on "Rural BioReFarmeries" developing functional rubisco protein (white protein) from grass/legumes
- Development of processes to target additional ingredients like VFA's and bio-materials like packaging





Exploring sustainable and alternative feedstocks

Feedstock	Green Juice	Press Cake	Loss	Brown Juice	LPC
White clover, ryegrass (50%:50%) - Spring	691.09	243.68	65.23	549.31	117.58
White clover, ryegrass (5%:95%) - Spring	677.96	274.11	47.93	502.14	127.42
White clover, ryegrass (25%: 75%) - Spring	698.18	254.73	47.09	529.00	125.84
Multispecies (rye grass, clover, plantain, chicory) - Summer	696.10	224.90	79.00	566.61	94.92
Grass silage	498.16	444.53	57.31	419.30	66.12
Rye grass - Summer	608.28	363.51	28.21	473.31	103.40
White clover, ryegrass (40%/60%) - Summer	597.17	367.18	35.66	448.61	108.28
Multispeices (rye grass, clover, plantain, chicory) - Summer	654.90	313.33	31.77	525.54	95.48
Duckweed	672.52	276.32	51.16	572.29	68.14
Beet leaves	710.03	277.86	12.11	600.82	100.04
Redstart	713.02	223.44	63.53	606.79	83.84

g/kg WW











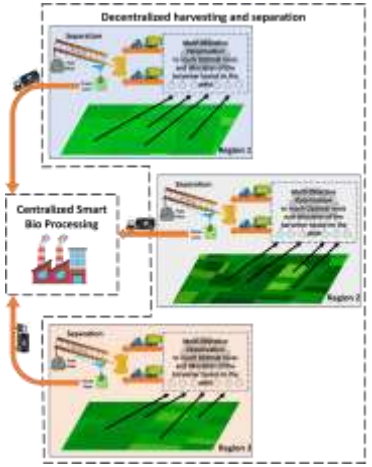
Cascading Decentralized Green Biorefinery Value Chain

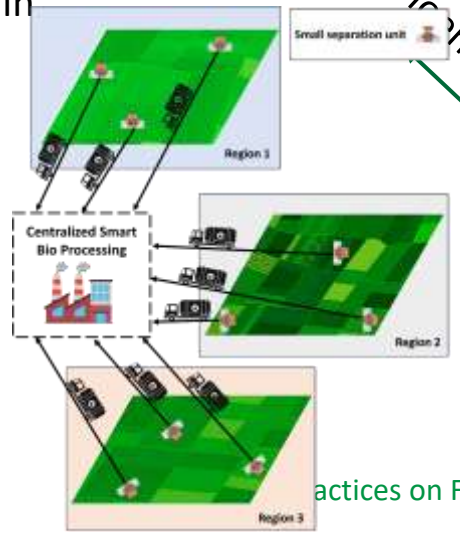


Varying green feedstocks



Decentralized/ centralized supply chain





Biorefinery & Nutrients

Pulp



Cattle Feed



WPC



Fibre Packaging



Food



LPC



Feed



Brown Juice



Flavours



Anti-microbial



Circular Bio-based Europe Joint Undertaking

National Funding for Pilot Facilities

BBioNets

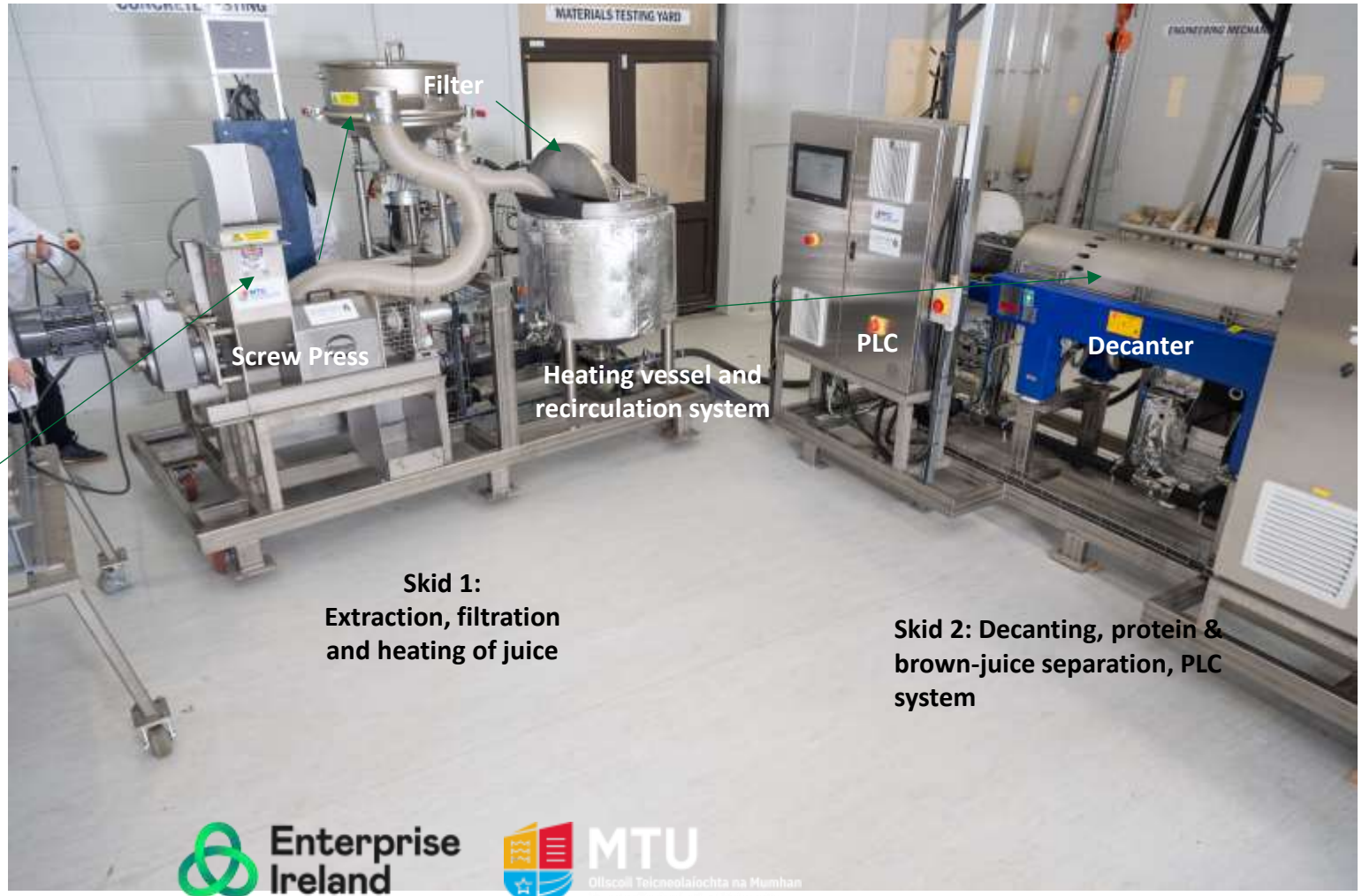


Grass/silage



Biomass Shredder

70-120kgs FW input input per hour



National Funding for Demonstration Facilities



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Department of Agriculture, Food and the Marine

MTU

UCD DUBLIN

CARBERY

AD: Department provides €3 million funding to UCD and MTU

By Charles O'Donnell
January 31, 2023 12:45 PM

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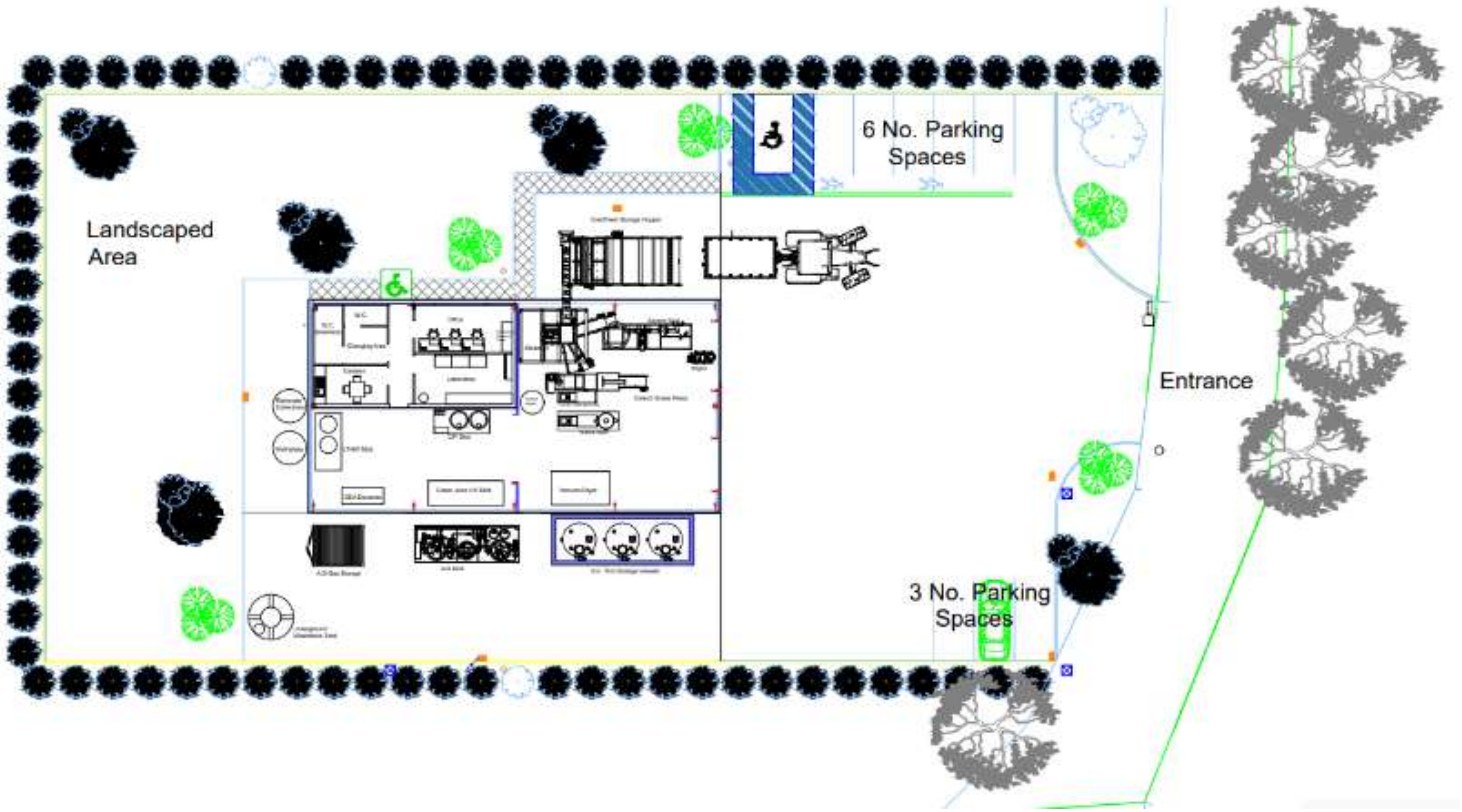




Features of Demo Facility

BBioNets

- Aiming to process approx. 10 tonnes FW per day
- PLC controlled
- Standard versus Severe Pre-treatment Options
- LPC, PC, Brown Juice Production
- >20m3 storage capacity for green and brown juice
- 2-stage AD process targeting VFA & biogas
- On site lab, office, welfare facilities
- Parking, landscaping

















Green Biorefinery Projects





Concluded

BIO4AFRICA

Ongoing

Rural BioReFarmeries

embeded

BIOREFINERY GLAS

Concluded

Grass4Value

DOT.Green

biorbic

Ongoing

FARM ZERO C

Farming for a sustainable future

Lessons Learned

- Green Biorefineries can be a great potential model for unlocking potential of rural areas
- Model aligns well with many key EU Challenges
- Brings key sustainability and resilience benefits, but coupling with high value ingredients will be important
- Important to develop a robust process with flexible feedstocks
- Partnerships with primary producers and industry is critical and has increased relevance, visibility and impact
- Further work needed to develop policy and market





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Thank you!

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