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James Gaffey
Green Biorefinery opportunities for agriculture

14/02/14

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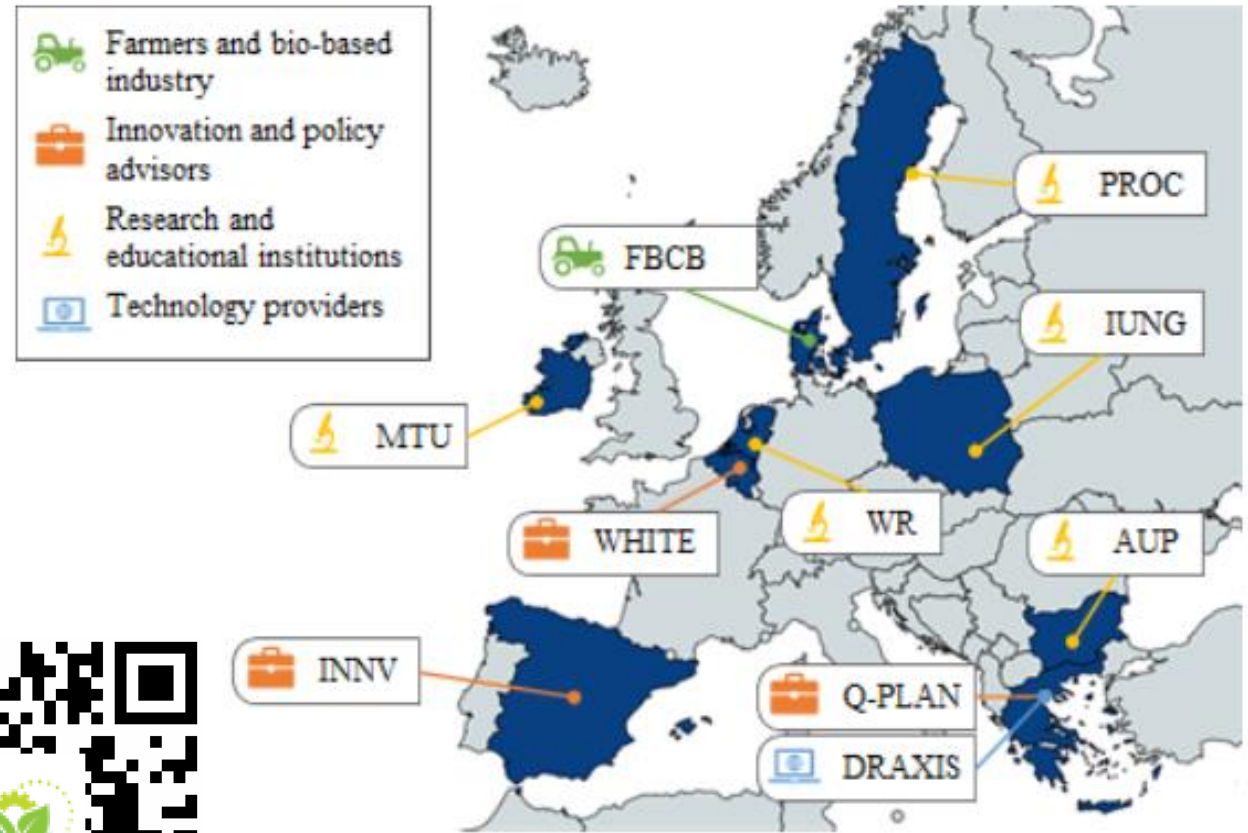

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Overall Concept

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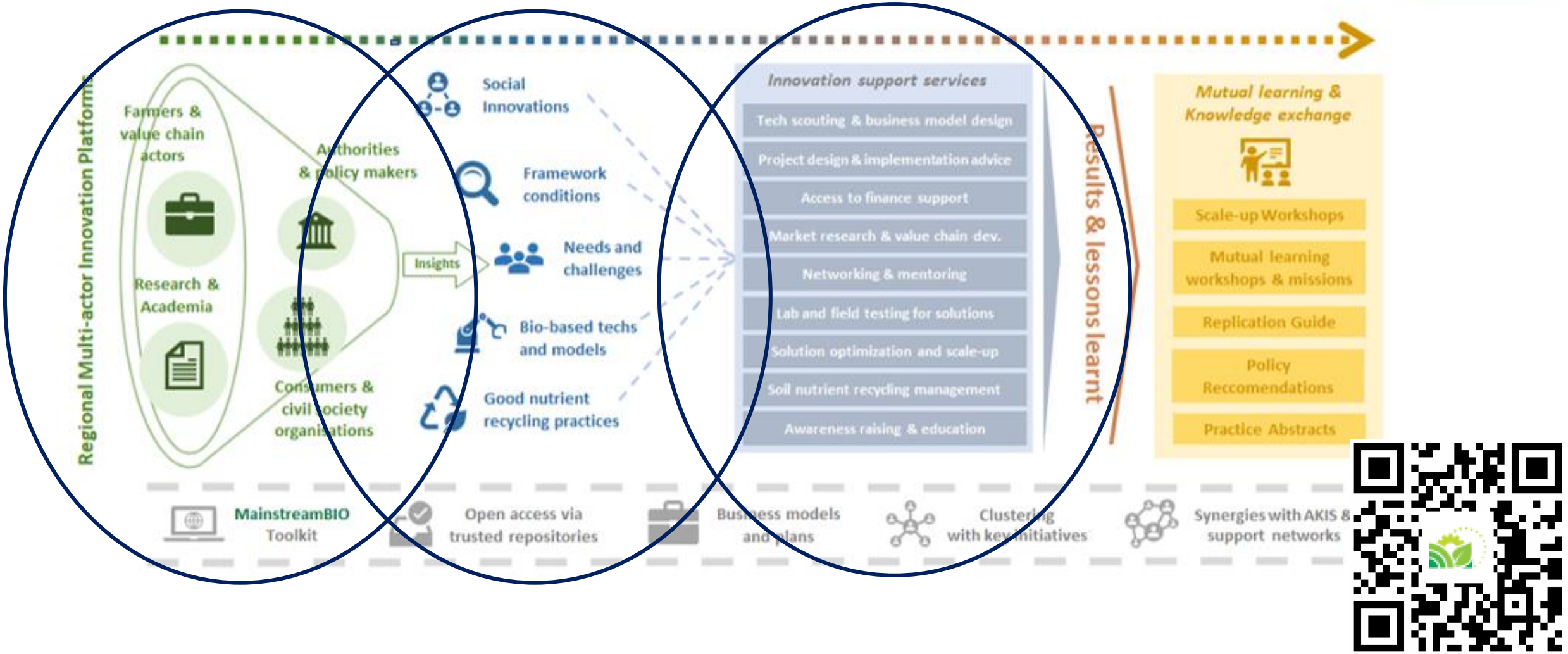


Share of total area by type and land cover (%), 2018

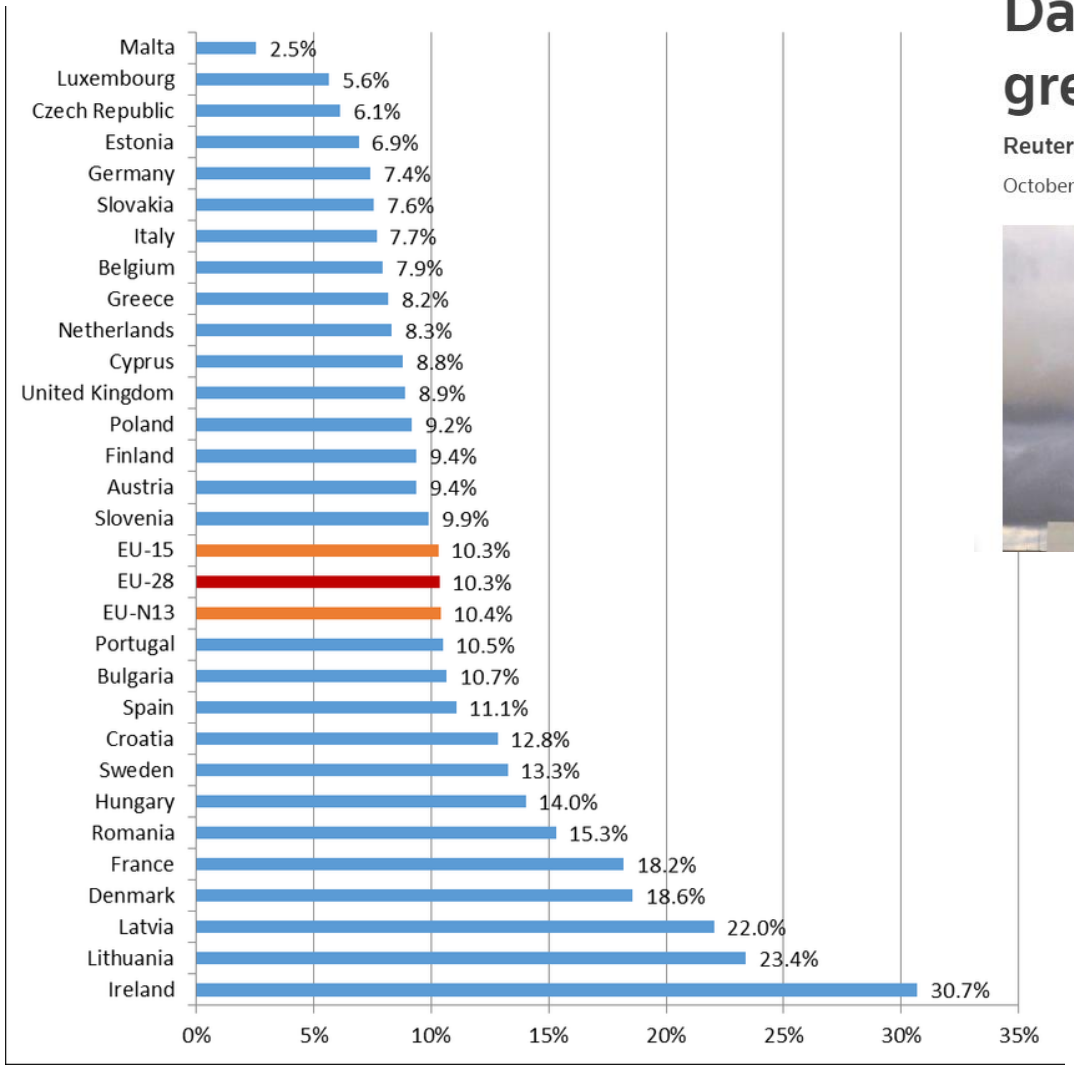
	Total area (km2)	Woodland and shrubland	Cropland	Grassland	Water areas and wetland; bareland	Artificial
EU	4 125 107	46.8	24.2	17.4	7.3	4.2
Belgium	30 666	27.8	29.1	28.2	3.3	11.7
Bulgaria	110 996	48.8	32.3	14.7	2.0	2.3
Czechia	78 871	39.3	33.7	20.1	2.4	4.4
Denmark	42 925	21.9	47.7	19.7	3.8	6.9
Germany	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

- Grasslands account for 26% of the world's total land area and 70% of its agricultural area
- PG represents approximately 34% of the UAA and 14% of the TLU in the EU-28
- Additionally, 23 of the EU-28 countries, had >20% of their arable land in the form of PG

The climate challenge for agriculture



Danish farmers required to halve greenhouse gas emissions by 2030

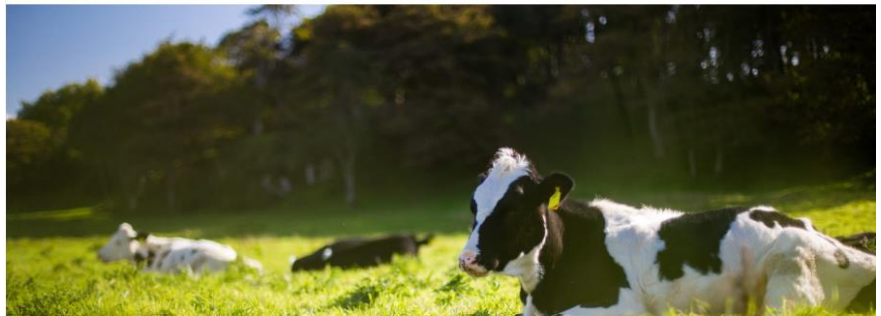
Reuters

October 5, 2021 9:27 AM GMT+1 · Updated 2 years ago

25% emissions reduction target agreed for agriculture

Stella Meehan

July 28, 2022 3:54 pm



The protein challenge

Table 1 – EU self-sufficiency in protein crops for feed

Product	Protein content (%)	Feed use 2020/2021 (million tonnes)	Feed use with EU origin (million tonnes)	EU self-sufficiency (%)
Soybean meal	45.5 %	27.1	0.9	3 %
Rapeseed meal	33 %	12	8.3	69 %
Common wheat	11 %	38.2	36.2	95 %
Barley	10 %	35.6	35.6	100 %
Maize	8 %	63.5	50.4	79 %

M&S cuts soya from production of milk to curb deforestation

UK retailer worked with dairy farms to end use of destructive cattle feed, but critics say move could 'shift problem elsewhere'

MEPs vote in favour of proposed protein strategy

More co-ops import fodder to address 'critical' shortage

A number of milk processors and mart operators have sourced fodder overseas or are planning to import to bridge the fodder supply gap.

Fresh gr

nant Feed

nogastric
Feed

ed, Food

trient-rich
whey

Fertilizer,
Bioenergy

BIOREFINERY
GLAS

Improving the protein efficiency of grass

ELSEVIER

Livestock Science
Volume 267, January 2023, 105135

Biorefined press cake silage as feed source for dairy cows: effect on milk production and composition, rumen fermentation, nitrogen and phosphorus excretion and *in vitro* methane production

E. Serra [a], M.B. Lynch [b], J. Gaffey [c], J.P.M. Sanders [d], S. Koopmans [d], M. Markiewicz-Keszycka [a], M.H. Bock [a], Z.C. McKay [a], K.M. Pierce [a]

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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

Making grass protein accessible for pigs

clean technologies

MDPI

Article

Production of Green Biorefinery Protein Concentrate Derived from Perennial Ryegrass as an Alternative Feed for Pigs

Rajeev Ravindran [1,*], Sybrandus Koopmans [2], Johan P. M. Sanders [2], Helena McMahon [1] and James Gaffey [1]

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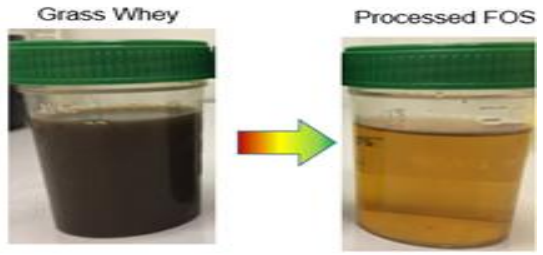
Abstract: Perennial rye grass is a widely used forage species in Ireland, on which the ruminant sector of agriculture is heavily dependent. While this species of grass is the primary source of fodder for cows, it is also abundant in plant protein, which could form a potential alternative ingredient in monogastric animal feed using a green biorefinery approach. In this study, perennial rye grass was

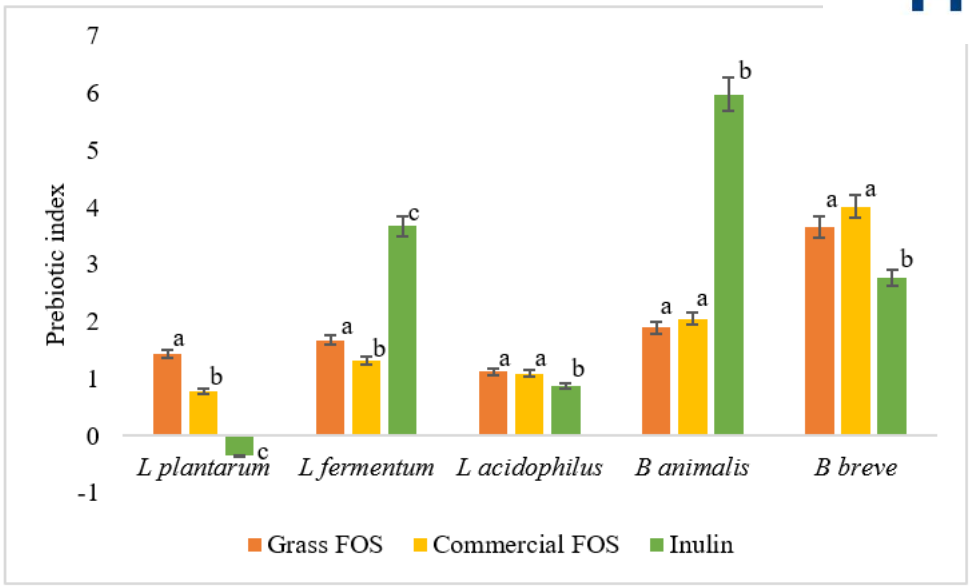
Date of Weighing	Daily Feed Intake (kg/d)		Feed Conversion Ratio		Average Daily Gain (kg/day)	
	Treatment	Control	Treatment	Control	Treatment	Control
Period 1	1.022	0.991	1.77	1.67	0.577	0.592
Period 2	1.247	1.182	1.83	1.83	0.683	0.646
Period 3	1.386	1.301	1.90	1.86	0.729	0.699
Period 4	1.512	1.400	2.04	2.05	0.742	0.682

Results of weaner trial comparing treatment (grass-protein based) v/s control diet

Feed Source	Crude Protein	Lysine	Methionine	Cysteine	Threonine	Crude Fibre
Soybean Meal	44 – 48	2.81 – 3.20	0.60 – 0.75	0.69 – 0.74	0.71 – 2.00	3.0 – 7.0
Sunflower Meal	24 – 44	1.18 – 1.49	0.74 – 0.79	0.55 – 0.59	1.21 – 1.48	12.0 – 32.0
Rapeseed Meal	34 – 36	2.00 – 2.12	0.67 – 0.75	0.54 – 0.91	1.53 – 2.21	10.0 – 15.0
Cottonseed Meal	24 – 41	1.05 – 1.71	0.41 – 0.72	0.64 – 0.70	1.32 – 1.36	25.0 – 30.0
Grass protein (Biorefinery Glas)	**33.9**	**1.81**	**0.65**	**0.18**	**1.5**	**6.1**
Grass protein	**42.8**	**2.03**	**0.72**	**0.21**	**1.71**	**3.9**

Extraction of high value materials





Compound	Conc (mg/ml)
Glucose	4.79
Nystose	2.53
Fructofuranylnystose	1.14
2-Kestose	0.98

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 *

Production of biogas from various sidestreams

		Grass press cake	Grass whey	de-FOS whey	Grass silage	Dairy whey
C:N ratio		19:1	17:1	9:1	17:1	-
Biogas and biomethane production (L/kg)	VS	510.7 (300.3)*	895.8 (544.6)*	597.4 (520.3)*	808.1 (479.0)*	(510-600)*
	DM	486.9 (286.2)*	707.7 (430.3)*	478.2 (416.5)*	737.2 (436.9)*	(280-330)*
	FM	189.9 (111.6)*	14.3 (8.7)*	41.5 (36.1)*	132.9 (78.8)*	-
Final weighted biogas composition	CH_4 (%)					
	CO_2 (%)					
	O_2 (%)					
	H_2S (ppm)					
	NH_3 (ppm)					
Biodegradability	%					

Litres of biomethane per Kg/VS of grass whey, de-FOS whey, presscake and grass silage

Open Access Article

Biogas, Biomethane and Digestate Potential of By-Products from Green Biorefinery Systems

by Rajeev Ravindran [1], Kwame Donkor [2], Lalitha Gottumukkala [2], Abhay Menon [1], Amita Jacob Guneratnam [1], Helena McMahon [1], Sybrandus Koopmans [3], Johan P. M. Sanders [3,4] and James Gaffey [1,*]

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Abstract

Global warming and climate change are imminent threats to the future of humankind. A shift from the current reliance on fossil fuels to renewable energy is key to mitigating the impacts of climate change. Biological raw materials and residues can play a key role in this transition through technologies such as anaerobic digestion. However, biological raw materials must also meet other existing food, feed and material needs. Green biorefinery is an innovative concept in which green biomass, such as grass, is processed to obtain a variety of protein products, value-added co-products and renewable energy, helping to meet many needs from a single source. In this study, an analysis has been conducted to understand the renewable energy potential of green biorefinery by-products and residues, including grass whey, de-FOS whey and press cake. Using anaerobic digestion, the biogas and biomethane potential

sustainability MDPI

Article

Synergetic Benefits for a Pig Farm and Local Bioeconomy Development from Extended Green Biorefinery Value Chains

James Gaffey [1,2,3,*], Cathal O'Donovan [4], Declan Murphy [5], Tracey O'Connor [1,2], David Walsh [6], Luis Alejandro Vergara [2], Kwame Donkor [7], Lalitha Gottumukkala [7], Sybrandus Koopmans [8], Enda Buckley [9], Kevin O'Connor [2] and Johan P. M. Sanders [8]

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Abstract: As the global population rises, agriculture and industry are under increasing pressure to become more sustainable in meeting this growing demand, while minimizing impacts on global emissions, land use change, and biodiversity. The development of efficient and symbiotic local bioeconomies can help to respond to this challenge by using land, resources, and side streams in efficient ways tailored to the needs of different regions. Green biorefineries offer a unique opportunity for regions with abundant grasslands to use this primary resource more sustainably, providing

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Citation: Gaffey, J.; O'Donovan, C.;


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Bringing farmers on board

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An Analysis of Irish Dairy Farmers' Participation in the Bioeconomy: Exploring Power and Knowledge Dynamics in a Multi-actor EIP-AGRI Operational Group

by Kieran Harrahill [1,2,3,*], Áine Macken-Walsh [2,3], Eoin O'Neill [1,3] and Mick Lennon [1]

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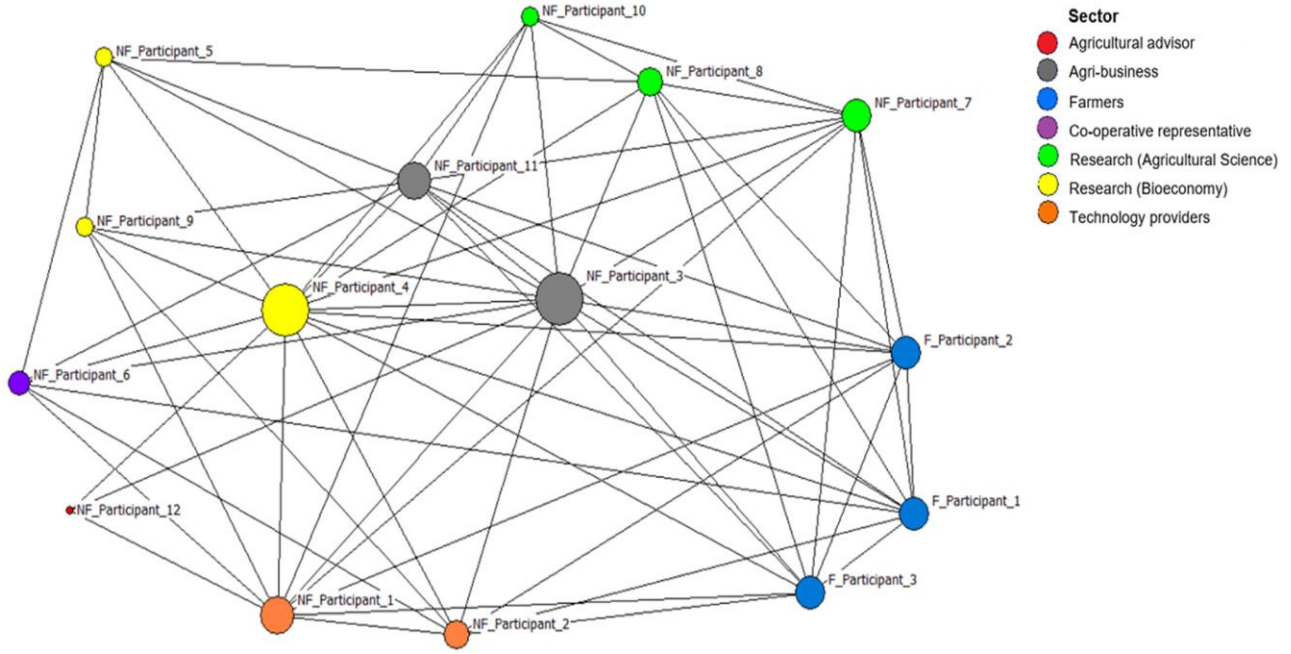
Abstract

The European Commission's European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI), part of the European Commission's Europe 2020 strategy, aims to 'achieve more and better from less' by bringing together a diversity of innovation actors to harness their combined knowledges to creatively achieve sustainability goals. The creation and novel use of biomaterials remains both a significant challenge and opportunity and bringing together all the relevant actors from primary production through to refinement and processing is anticipated to make progress in bringing into practice pilot operational approaches on the ground. For the bioeconomy, a nascent sector, it is a significant challenge for it to become established; grow; innovate and engage all the relevant actors. It has been noted internationally that primary producers, among other cohorts, remain marginalised from bioeconomy activities, which significantly compromises how inclusive and innovative the bioeconomy is likely to be henceforth. In this context, an interesting case study is the *Biorefinery Glas* Operational Group (OG), located in Ireland. The OG was a 'small-scale-farmer-led green biorefinery supporting farmer diversification into the circular bioeconomy'. The central research question of this paper concerns the dynamics of



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