Nutri2Cycle

D.7.8 Scientific outreach

Deliverable:	Scientific outreach (publications, participation to events) and organisation of an end conference
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List of abbreviations

BCE	Biorefine Cluster Europe
CBA	Cost Benefit Analysis
DBI	Dashboard Indicator
EBA	European Biogas Association
ESNI	European Sustainable Nutrient Initiative
IPS	IPS Konzalting
IRTA-CREDA	Institut De Recerca I Technologia Agroalimentaries
ISA	Instituto Superior De Agronomia Portugal
LCA	Life Cycle Assessment
NTF	National Task Forces
OG	Operational Group
RENURE	Recovered Nitrogen From Manure
RL	Research Line
SYS	Systemic
TEAGASC	Teagasc - Agriculture and Food Development Authority
THUENEN	Johann Heinrich Von Thuenen Institut
UCPH	Kobenhavns Universitet
UGent	Universiteit Gent
UMIL	Universita Degli Studi Di Milano
UE	United Experts
WP	Work Package
WR	Stichting Wageningen Research
ZLTO	Zuidelijke Land- En Tuinbouworganisatie

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Glossary

Cost benefit analysis: A cost-benefit analysis is the process of comparing the projected or estimated costs and benefits (or opportunities) associated with a project decision to determine whether it makes sense from a business perspective.

Demo day: A day when stakeholders/public may visit a lighthouse demo installation to which they do not usually have access.

Digestate: A nutrient-rich substance produced by anaerobic digestion that can be used as a fertiliser.

Life cycle assessment: A method to evaluate the environmental impacts of a product or system over its life cycle.

Lighthouse demo: Illustration and demonstration of the move from theory to practice to experiment innovative solutions.

RENURE: The Joint Research Centre (JRC) report resulted from the JRC project SAFEMANURE (SAFE processed MANURE). The concerned materials are called RENURE, from 'REcovered Nitrogen from manURE'.

Research line: Research line is defined as a research domain that characterizes a cluster of solutions being researched in frame of the project ; Nutri2Cycle has 5 distinct research lines.

Solution: A Nutri2Cycle solution is a proposed optimized farming system, aimed at closing nutrient loops and efficient mitigation measures.

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Executive Summary

Researchers are an important target group of Nutri2Cycle. The project has therefore invested greatly towards communicating at the scientific community through publications, contribution to scientific conferences, seminars, summer schools and through the extensive network of the consortium. The current deliverable summarizes the scientific outreach of the Nutri2Cycle project throughout the lifetime of the project. The deliverable focusses on the dissemination efforts towards the target group "researchers" as put forward in Deliverables D7.1, D7.2 and D7.3. For an overview of the communication and dissemination efforts towards target groups other than researchers and scientific community we refer to deliverable D7.6 and D7.7.

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Introduction

The Nutri2Cycle concept was to evaluate, showcase and implement optimized closed loop solutions at the local scale and evaluate their potential roll out. Through the WP7 work package – Communication and community management – we strived to maximally spread the results from the project to all different stakeholders by the development of a joint communication strategy for the different target groups as described in the previous deliverables D7.1, D7.2 and D7.3. Important to note is that all communication and dissemination activities have been disrupted greatly due to the COVID-19 crisis and several activities have been cancelled, replaced, or transferred online. Nevertheless, partners adapted to the evolving situation and reached the set goals.
Throughout the project different communication, dissemination (and exploitation) actions were performed. The major outcomes are depicted in Figure 1 and are in detail discussed in the individual deliverables D7.6, D7.7 and D7.8. The current deliverable D7.8 focuses on the bottom part of the figure and aims to provide a final overview of the **scientific outreach** of the Nutri2Cycle project. Scientific outreach is an umbrella term for a variety of activities by research institutes, universities, and institutions, aimed at promoting public awareness of science (open science) and making contributions to science progress in general.

Four major scientific outreach categories have been defined in frame of Nutri2Cycle, namely 1) scientific papers, 2) participation to events (e.g., conferences, webinars), 3) the set-up of a scientific community and organization of summer schools and 4) the organization of a final conference. These different categories are listed in detail below.

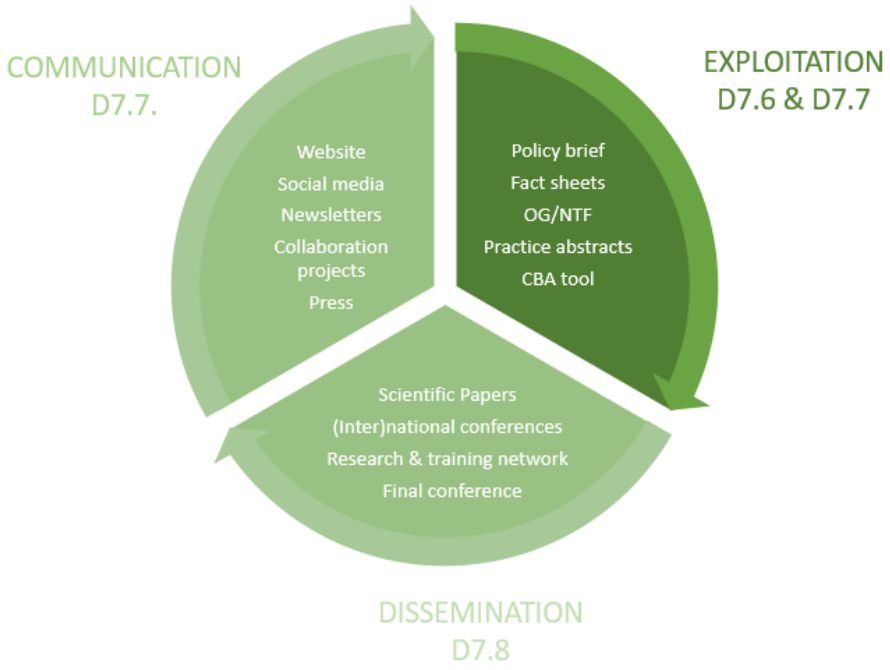

Figure 1. Nutri2Cycle communication outcomes and their categorisation into project deliverables

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1. Scientific papers

A total of 49 scientific Nutri2Cycle publications was reached which far exceeds the foreseen number of 20 in the Grant Agreement. Nutri2Cycle ensured an open access to all peer reviewed scientific publications resulting from its research and results. Importantly, besides the peer-reviewed scientific publications also the data have been disseminated. Nutri2Cycle and its beneficiaries deposited their data sets in open data repositories to allow beneficiaries to access, mine and use the data free of charge. The scientific publications were also uploaded on the Nutri2Cycle website and announced through social media to maximise attention. Many of the main messages have been translated into stakeholder orientated publications, such as factsheets or brochures – also in the local languages of those stakeholders (see D7.7).

The table below lists the 49 scientific Nutri2Cycle papers and their open access link. The publications have been categorised according to the Nutri2Cyce research line they belong (1-5) or if they reflect a more systemic approach (SYS). In addition, several publications are still in the process and will be published beyond the end of the project (of course bearing the acknowledgement to the Nutri2Cycle project).

Table 1. Overview of Nutri2Cycle scientific publications (RL= research line, SYS= systemic approach) RL 1= Innovative management systems, tools & practices for optimized nutrient and GHG management in animal husbandry, RL2= Innovative soil, fertilisation & crop management systems & practices for enhanced N,P efficiency and increased soil OC content, RL3= Tools, techniques & systems for higher-precision fertilization, RL4= Bio-based fertilisers (N,P) and soil enhancers (OC) from agro-residues, RL5= Novel animal feeds produced from agro-residues

RL/SYS	Publication
RL 1	Dróżdż, D., Wystalska, K., Malińska, K., Grosser, A., Grobelak, A., Kacprzak, M., 2020. Management of poultry manure in Poland – Current state and future perspectives. Journal of Environmental Management, 264, 110327. https://doi.org/10.1016/j.jenvman.2020.110327
RL 1	Prado, J., Chieppe, J., Raymundo, A., Fangueiro, D., 2020. Bio-acidification and enhanced crusting as an alternative to sulphuric acid addition to slurry to mitigate ammonia and greenhouse gases emissions during short term storage. Journal of Cleaner Production, 263, 121443. https://doi.org/10.1016/j.jclepro.2020.121443
RL 1	Corona, F., Hidalgo, D., Martin-Marroquin, J. M., & Meers, E., 2021. Study of pig manure digestate pre-treatment for subsequent valorisation by struvite. Environmental Science and Pollution Research, 28(19), 24731-24743. https://doi.org/10.1007/s11356-020-10918-6
RL 1	Sobik-Szołtysek, J., Wystalska, K., Malińska, K., Meers, E., 2021. Influence of pyrolysis temperature on the heavy metal sorption capacity of biochar from poultry manure. Materials, 14, 6566. https://doi.org/10.3390/ma14216566
RL 1	Silva, A.A., Fangueiro, D., Carvalho, M., 2022. Slurry acidification as a solution to minimize ammonia emissions from the combined application of animal manure and synthetic fertilizer in no-tillage. Agronomy, 12(2), 265. https://doi.org/10.3390/agronomy12020265
RL 1	Hidalgo, D., Corona, F., Martín-Marroquín, J.M., 2022. Manure biostabilization by effective microorganisms as a way to improve its agronomic value. Biomass Conversion and Biorefinery, https://doi.org/10.1007/s13399-022-02428-x
RL 1	Leip, A., Caldeira, C., Corrado, S., Hutchings, N.J., Lescchen, J.P., Schaap, M., de Vries, W., Westhoek, H., van Grinsven, H.J.M., 2022. Halving nitrogen waste in the European Union food systems requires both dietary shifts and farm level actions. Global Food Security 35, 100648. https://doi.org/10.1016/j.gfs.2022.100648
RL 1	Kacprzak, M., Malińska, K., Grosser, A., Sobik-Szołtysek, J., Dróżdż, D., Jasińska, A., Meers, E., 2023. Cycles of carbon, nitrogen and phosphorus in poultry manure management technologies – environmental aspects. Critical Reviews in Environmental Science and Technology 53(8), 914-938. https://doi.org/10.1080/10643389.2022.2096983
RL 1	Morey, L., Fernandez, B., Tey, L., Biel, C., Robles-Aguilar, A., Meers, E., Soler, J., Porta, R., Cots, M., Riau, V., 2023. Acidification and solar drying of manure-based digestate to produce improved fertilizing products. Journal of Environmental Management 336, 117664. https://doi.org/10.1016/j.jenvman.2023.117664

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RL 1	Jasińska, A., Grosser, A., Meers, E., 2023. Possibilities and limitations of anaerobic co-digestion of animal manure—a critical review. Energies, 16(9), 3885; https://doi.org/10.3390/en16093885
RL 2	Riau, V., Burgos, L., Camps, F., Domingo. F., Torrellas, M., Anton, A., Bonmati, A., 2021 Closing nutrient loops in a maize rotation. Catch crops to reduce nutrient leaching and increase biogas production by anaerobic co-digestion with dairy manure. Waste Management 126, 719–727. https://doi.org/10.1016/j.wasman.2021.04.006
RL 2	Silva, A.A., Fangueiro, D., 2021. Application of dairy manure amended with mineral fertilizer on stubble-covered soil: effects on ammonia emissions. Biology and Life Sciences Forum, 3(1), 19. https://doi.org/10.3390/IECAG2021-10017
RL 2	Silva, A.A. , Carvalho, M., Coutinho, J., Vasconcelos, E., Fangueiro, D., 2022. Can dairy slurry application to stubble, without incorporation into the soil, be sustainable? Plants, 11, 1473. https://doi.org/10.3390/plants11111473
RL2	Silva, A.A., Carvalho, M., Coutinho, J., Vasconcelos, E., Fangueiro, D., 2023. Dairy slurry application to stubble-covered soil: a study on sustainable alternatives to minimize gaseous Emissions. Agriculture, 12(7), 1021. https://doi.org/10.3390/agriculture12071021
RL 2	Prado, J., Alvarenga, P., Ribeiro, H., Fangueiro, D., 2023. Nutrient potential leachability in a sandy soil amended with manure-based fertilisers. Agronomy 13(4), 990. https://doi.org/10.3390/agronomy13040990
RL2	Reuland, G., Sleutel, S., Li, H., Dekker, H., Sigurnjak, I., Meers, E., 2023. Quantifying CO_2 emissions and carbon sequestration from digestate amended soil using natural ^{13}C abundance as a tracer. Agronomy 2023, 13(10), 2501. https://doi.org/10.3390/agronomy13102501
RL 3	Esteves, C., Ribeiro, H., Braga, R.P., Fangueiro D., 2021. Remote sensing (NDVI) and apparent soil electrical conductivity (ECap) to delineate different zones in a vineyard. Biology and Life Sciences Forum, 3(1), 42. https://doi.org/10.3390/IECAG2021-10021
RL 3	Hendriks, C.M.J., Shrivastava, V., Sigurnjak, I., Lesschen, J.P., Meers, E., van Noort, R., Yang, Z., Rietra, R.P.J.J., 2021. Replacing mineral fertilisers for bio-based fertilisers in potato growing on sandy soil: a case study. Applied Sciences, 12, 341. https://doi.org/10.3390/app12010341
RL 3	Esteves, C., Fangueiro, D., Braga, R.P., Martins, M., Botelho, M., Ribeiro, H., 2022. Assessing the contribution of EC_a and NDVI in the delineation of management zones in a vineyard. Agronomy, 12, 1331. https://doi.org/10.3390/agronomy12061331
RL 4	Melgaço, L.A.O., Meers, E., Mota, C.R., 2020. Ammonia recovery from food waste digestate using solar heat-assisted stripping-absorption. Waste Management, 113, 244-250. https://doi.org/10.1016/j.wasman.2020.05.047
RL 4	Fangueiro, D., Alvarenga, P., Fragoso, R., 2021. Horticulture and orchards as new markets for manure valorisation with less environmental impacts. Sustainability, 13, 1436. https://doi.org/10.3390/su13031436
RL 4	Ashekuzzaman, S.M., Fenton, O., Meers, E., Forrestal, P.J., 2021. Differing phosphorus crop availability of aluminium and calcium precipitated dairy processing sludge potential recycled alternatives to mineral phosphorus fertiliser. Agronomy, 11, 427. https://doi.org/10.3390/agronomy11030427
RL 4	Luo, H., Robles-Aguilar, A.A., Sigurnjak, I., Michels, E., Meers, E., 2021. Assessing nitrogen availability in biobased fertilizers: effect of vegetation on mineralization patterns. Agriculture, 11, 870. https://doi.org/10.3390/agriculture11090870
RL 4	Reuland, G., Sigurnjak, I., Dekker, H., Michels, E., Meers, E. (2021). The potential of digestate and the liquid fraction of digestate as chemical fertiliser substitutes under the RENURE Criteria. Agronomy, 11, 1374. https://doi.org/10.3390/agronomy11071374
RL 4	Melgaço, L., Robles-Aguilar, A., Meers, E., Mota, C., 2021. Phosphorus recovery from liquid digestate by chemical precipitation using low-cost ion sources. Journal of Chemical Technology and Biotechnology, 96(10), 2891-2900. https://doi.org/10.1002/jctb.6842 (Erratum to this paper: https://doi.org/10.1002/jctb.7040)
RL 4	Robles-Aguilar, A.A., Grunert, O., Meers, E., Jablonowski, N.D., 2022. Evaluating the fertilising potential of blended recovered nutrients in horticultural growing medium on *Viola x wittrockiana L*. Agronomy, 12(1), 182. https://doi.org/10.3390/agronomy12010182
RL 4	Axel, H., D'Imporzano, G., Zilio, M., Pigoli, A., Rizzi, B., Erik, M., Oscar, S., Micol, S., Federica, B., Andrea, G., Adani, F., 2022. Environmental performance in the production and use of recovered fertilizers from organic wastes treated by anaerobic digestion vs synthetic mineral fertilizers. ACS Sustainable Chemistry and Engineering, 10(2), 986-997. https://doi.org/10.1021/acssuschemeng.1c07028
RL 4	Prado, J., Ribeiro, H., Alvarenga, P., Fangueiro, D., 2022. A step towards the production of manure-based fertilizers: Disclosing the effects of animal species and slurry treatment on their nutrients content and availability. Journal of Cleaner Production, 337, 130369. https://doi.org/10.1016/j.jclepro.2022.130369
RL 4	Corona, F., Hidalgo, D., Martín-Marroquín, J.M., Castro, J., Sanz-Bedate, S., Antolín, G., 2022. Study of the crystallisation reaction behaviour to obtain struvite. Waste and Biomass Valorization, 13, 3767-3786. https://doi.org/10.1007/s12649-022-01797-8
RL 4	Luo, H., Dewitte, K., Landschoot, S., Sigurnjak, I., Robles-Aguilar, A.A., Michels, E., De Neve, S., Haesaert, G., Meers, E., 2022. Benefits of biobased fertilizers as substitutes for synthetic nitrogen fertilizers: Field

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	assessment combining minirhizotron and UAV-based spectrum sensing technologies. Frontiers in Environmental Science, 10, 988932. http://doi.org/10.3389/fenvs.2022.988932
RL 4	Prado, J., Fangueiro, D., Alvarenga, P., Ribeiro, H., 2023. Assessment of the agronomic value of manure-based fertilizers. Agronomoy, 13,140. https://doi.org/10.3390/agronomy13010140
RL 4	Herrera, A., D'Imporzano, G., Clagnan, E., Pigoli, A., Bonadei, E., Meers, E., Adani, F., 2023. Pig Slurry Management Producing N Mineral Concentrates: A Full-Scale Case Study. ACS Sustainable Chemistry & Engineering 11, 19, 7309–7322. https://doi.org/10.1021/acssuschemeng.2c07016
RL 4	Luo, H., Zilio, M., Sigurnjak, I., A.A., Robles-Aguilar, Michels, E., Adani, F., De Neve, S., Meers, E., 2023. Dynamics of soil nitrogen and N-cycling-related genes following the application of biobased fertilizers. Applied Soil Ecology, 191, 105033. https://doi.org/10.1016/j.apsoil.2023.105033
RL4	Cerrillo, M., Moreno, M., Burgos, L., Estéfano, R., Coll, D., Soraluce, J., Navarro, N., Arnau, P.A., Bonmatí, A., 2023. Low-temperature vacuum evaporation of ammonia from pig slurry at laboratory and pilot-plant scale. Processes, 11, 2910. https://doi.org/10.3390/pr11102910
RL 5	Devlamynck, R., Fernandes de Souza, M., Leenknegt, J., Eeckhout, M., Meers, E., 2020. Effect of the growth medium composition on nitrate accumulation in the novel protein crop *Lemna minor*. Ecotoxicology and Environmental Safety, 206, 111380. https://doi.org/10.1016/j.ecoenv.2020.111380
RL 5	Devlamynck, R., de Souza, M.F., Leenknegt, J., Jacxsens, L., Eeckhout, M., Meers, E., 2021. *Lemna minor* cultivation for treating swine manure and providing micronutrients for animal feed. Plants, 10, 1124. https://doi.org/10.3390/plants10061124
RL 5	Lambert, M., Devlamynck, R., Fernandes de Souza, M., Leenknegt, J., Raes, K., Eeckhout, M., Meers, E, 2022. The impact of salt accumulation on the growth of duckweed in a continuous system for pig manure treatment. Plants 2022, 11, 3189. https://doi.org/10.3390/plants11233189
RL 5	Konucu, M., Tekdal, D., Eker Develi, E., Meers, E., de Souza, M.F., 2022. Moringa oleifera Lam. as a bioflocculant for harvesting microalgae grown on agricultural wastewaters for feed production. Applied Sciences 12, 12968. https://doi.org/10.3390/app122412968
RL 5	Beyers, M., Coudron, C., Ravi, R., Meers, E., Bruun, S., 2023. Black soldier fly larvae as an alternative feed source and agro-waste disposal route – A life cycle perspective. Resources, Conservation and Recycling, 192, 106917. https://doi.org/10.1016/j.resconrec.2023.106917
SYS	Hidalgo, D., Corona, F., Martín-Marroquín, J.M., 2021. Nutrient recycling: from waste to crop. Biomass Conversion and Biorefinery, 11, 207–217. https://doi.org/10.1007/s13399-019-00590-3
SYS	Andrade, E.P., Bonmatí, A., Jimenez Esteller, L., Montemayor, E., Antón. A., 2021. Performance and environmental accounting of nutrient cycling models to estimate nitrogen emissions in agriculture and their sensitivity in life cycle assessment. The International Journal of Life Cycle Assessment, 26, 371–387, https://doi.org/10.1007/s11367-021-01867-4
SYS	Andrade, E.P., Bonmati, A., Jimenez Esteller, L., Brunn, S., Jensen, L.S., Meers E., Antón, A., 2022. Selection and application of agri-environmental indicators to assess potential technologies for nutrient recovery in agriculture. Ecological Indicators, 134, 108471. https://doi.org/10.1016/j.ecolind.2021.108471
SYS	Montemayor, E., Andrade Pereira, E., Bonmati, A., Antón, A., 2022. Critical analysis of life cycle inventory datasets for organic crop production systems. The International Journal of Life Cycle Assessment 27, 543–563. https://doi.org/10.1007/s11367-022-02044-x
SYS	Ravi, R., Beyers, M., Bruun, S., Meers, E., 2022. Life cycle assessment of struvite recovery and wastewater sludge end-use: A Flemish illustration. Resources, Conservation and Recycling, 182, 106325. https://doi.org/10.1016/j.resconrec.2022.106325
SYS	Beyers, M., Duan, Y-F., Jensen, L.S., Bruun, S., 2022. Effect of natural and regulatory conditions on the environmental impacts of pig slurry acidification across different regions in Europe: A life cycle assessment. Journal of Cleaner Production, 368, 133072. https://doi.org/10.1016/j.jclepro.2022.133072
SYS	Rieger, J., Freund, F., Offermann, F., Geibel, I., Gocht, A., 2023. From fork to farm: Impacts of more sustainable diets in the EU-27 on the agricultural sector. Journal of Agricultural Econonomy, 00:1–21. https://doi.org/10.1111/1477-9552.12530
SYS	Beyers, M., Ravi, R., Devlamynck, R., Meers, E., Jensen, L.S., Bruun, S., 2023. Constructed wetlands and duckweed ponds as a treatment step in liquid manure handling — A life cycle assessment. Science of the Total Environment 889, 163956. https://doi.org/10.1016/j.scitotenv.2023.163956
SYS	Rashid, M.A., Duan, Y.-F., Lesschen, J.P., Groenendijk, P., Bruun, S., Jensen, L.S., 2023. Evaluating the performance of biobased, recovered nitrogen fertilizers in European cropping systems using modelling. Journal of Environmental Management, 0, 0.

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2. Participation to events

Nutri2Cycle has enjoyed an elevated level of scientific exposure to agro-(industrial), policy and stakeholder groups through oral presentations and poster displays at a wide range of internationally branded conferences.

Between M37-M60, the Nutri2Cycle consortium gave 21 oral and 15 poster presentations at 15 (inter)national conferences as summarized in Table 2. For a listing of the contributions between the period M1-M18 and M18-36 we refer to D7.2 and D7.3. In total the Nutri2Cycle project had 55 oral presentations and 32 poster contributions at 49 (inter)national conferences, which exceeds the preset target of 30 individual contributions at least 10 conferences.

Table 2. Overview of oral and poster presentations at (inter)national scientific conferences between M37-M60

Name of the conference	Date and place	Partner	Presentation Type	Title / content
EBA Conference	25-26-27 October 2021	EBA, IRTA	Oral	Closing nutrient loops: Catch crops to reduce nutrient losses and increase biogas production by anaerobic co-digestion
		EBA	Poster	General Nutri2Cycle Project poster
			Oral	Key takeaways from a study on the nitrogen fertilising value
6th Biogas and Biomethane Congress	13-14.12.2021, CKS Ossa, Rawa Mazowiecka, Poland	PCz	Oral	Biogas production from poultry manure - strategies for optimizing the methane fermentation process
			Poster	The use of compost and biochar from poultry manure for soil
				Intensification of the methane fermentation process of poultry manure
				Sorption properties of biochar from poultry manure
				Production of biochar from poultry manure
				The role of the project manager in risk management
ESNI - European Sustainable Nutrient Initiative 2022	29.03.2022, online	UGent, IRTA-CREDA	Oral	Understanding consumers' behaviour, perceptions and preferences towards 'circular farming'
AgroGreen SUDOE seminar	11.05.2022, Toulouse, France	ChambAgri	Poster	Nutri2Cycle : Vers une agriculture européenne plus efficace dans la gestion du carbone et des éléments nutritifs
ManuREsource Conference	11-13.05.2022, 's Hertogenbosch, the Netherlands	Inagro, UGent	Oral	An evaluation of agricultural value and environmental impact of the use of recycling derived fertilizers - and a round table on NutriCycle Vlaanderen, the Flemish NTF
		PCz	Poster	Fertilization potential of compost and biochar from poultry manure
		IRTA	Oral	Low temperature vacuum evaporation field pilot plant for ammonia recovery from pig slurry
			Oral	Rapid socio and agri-environmental assessment of a

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				technology developed to recover ammonia from pig slurry
		ISA	Poster	Joint application of urea and acidified pig slurry on crop residues: effects on oat yield and nutrient use efficiency
			Poster	Assessment of GHG emissions from an apple orchard partially fertilized with manures and slurries
			Oral	Production of bio-based fertilizers by blending animal manures and slurries: puzzling the effects of slurry treatment and animal species on their nutrients content
			Oral	The effect of tailoring N:P ratios mixing manures with mineral fertilizers in their mineral N leaching potential
			Oral	Assessment of animal manures application as partial substitution of mineral fertilizers in an apple orchard
			Oral	Nitrogen availability in an apple orchard fertilized with manures: a laboratory experiment
		UCPH	Poster	LCA on pig slurry acidification effects of natural & regulatory conditions across different regions in Europe
			Oral	To feed or not to feed? Should we feed agro-waste to insects?
Ciência 2022	16-18.05.2022, Lisboa, Portugal	ISA	Poster	Projeto Nutri2Cycle: a fertilização orgânica e sustentabilidade
				A step towards the production of manure-based fertilizers
Profemin Conference	18-19.05.2022, Lleida, Spain	IRTA	Poster	Nutry2Cycle Project: Low temperature vacuum evaporation
		ISA	Oral	pH modification as alternative treatment for animal manure sanitization
Biorefine Conference	30-31.05.2022, Ghent, Belgium	UGent, WUR	Oral	Opportunities and limitations of using biobased fertiliser in arable farming systems
57th Croatian & 17th International Symposium on Agriculture	21.06.2022, Vodice, Croatia	IPS Konzalting	Oral	Cost benefit analysis (CBA) for the Nutri2Cycle project priority technologies
International Conference of Social Life Cycle Assessment (S-LCA 2022)	5-8.09.2022, Aache, Germany	IRTA	Oral	S-LCA of pig production in Catalonia (Spain)
13th International Conference on Life Cycle Assessment of Food 2022 (LCA Foods 2022)	12-14.09.2022, Lima, Peru	IRTA	Oral	Integration of socio and environmental LCA: Application to novel technologies for nutrient recovery

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1r Congrés BIT	29-30.09.2022, Lleida, Spain	IRTA	Oral	Projecte NUTRI2CYCLE: creació de models de negoci agrícola més
58th Croatian & 18th International Symposium on Agriculture	15.02.2023, Dubrovnik, Croatia	IPS Konzalting	Oral	Attitude of stakeholders regarding the application of Nutri2Cycle project priority technologies in Croatia
Ramiran 2023	12-14.09.2023, Cambridge, UK	ISA	Poster	Can Pig Slurry be used as a P fertiliser for Variable-Rate Manure application? (Leaching)
				Can Pig Slurry be used as a P fertiliser for Variable-Rate Manure application? (GHG - soil)
				Use of poultry manure compost and pig slurry to replace mineral fertilizers in the basal fertilization of maize production: impact on GHG emissions and maize yield
				Assessment of GHG emissions from an apple orchard fertilized with manures
		Inagro	Oral	Reduction of mineral fertiliser use without sacrificing yields while contributing to a circular economy with RENURE ammonium nitrate
		PCz	Poster	Potentials of poultry manure-derived biochar as an alternative to peat
			Poster	The influence of biochar and manure-derived composts on soil properties and plant biomass growth
ESNI - European Sustainable Nutrient Initiative 2023	20.09.2023, Brussels, Belgium	UGent, WUR	Oral	Optimizing nutrient flows and budgets in sustainable agriculture
		UGent	Poster	Digestate Improves the Separating Efficiency of Microalgae in the Flocculation Process
		ISA	Poster	Application of pig slurry as a phosphorus fertiliser at different application rates: impact on soil nutrient dynamics and GHG emissions
		IRTA	Poster	Ammonia low temperature vacuum evaporation from pig slurry at lab-scale and on-farm pilot plants

In addition project partners also actively disseminated Nutri2Cycle activities through their participation in events, other than international conferences, such as workshops, webinars, … targeting predominantly the scientific community. Table 3 provides a comprehensive overview of these events. Presentations in frame of other, specific Nutri2Cycle tasks (such as presentations for events of the National task Force, lighthouse demo's,…) are not taken up in this overview, but are part of D6.2 and D7.7.

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Table 3. Overview of Nutri2Cycle contributions and workshops from M37 to M60

Title of the workshop	Date and place	Partner	Presentation Type	Topic
EIP AGRI seminar Healthy Soil for Europe	13-14.04.2021, online	SOLTUB	Oral	EIP AGRI seminar Healthy Soil for Europe
Economia Circular en el sector agroramader: proves pilot a Catalunya	28.10.2021, online	IRTA	Oral	Anàlisis Social de Cicle de Vida de sistemes agrícoles: Perspectives i reptes a Catalunya
			Oral	Sistema de tractament Bioammoneva
XI Edição das Jornadas de Medicina Veterinária da AEICBAS-UP	19.03.2022, Porto, Portugal	ISA	Oral	Importância das Emissões de Carbono na Produção Animal
De depuradoras a biofactorías: el potencial del agua en la economía circula	7.04.2022, Orense and online, Spain	IRTA	Oral	Valorización de nutrientes en forma de fertilizantes inteligentes
Jornadas de Prunoideas	04-05.04.2022, Covilhã, Portugal	ISA	Oral	Projeto Nutri2Cycle: a fertilização orgânica e sustentabilidade
Workshop LIFE AGRICLOSE - Pro FEM,	18-19 May 2022, Lleida, Spain	ISA	Oral	pH modification as alternative treatment for animal manure sanitization
Scientific Workshop	16/11/2022, Braunschweig, Germany	Thuenen	Oral	Modelling Nutri2cycle technologies with the CAPRI model
4th conference of the European projects Nutri2Cycle & circular agronomics'	19.11.2022, Vic, Spain	IRTA	Oral	Quantificació ambiental de la recuperació de nutrients
			Oral	Recuperació de nutrients i obtenció d'aigua reutilitzable a partir dels purins (Ammoneva-Beda)
Nutrient Recycling Community - WG on technologies -	14.12.2022, online	EBA	Oral	Biogas and Biomethane EU Policy Landscape
"Best Practices of the Czestochowa University of Technology": "International" PhD programs in practice.	26.03.2023, Poland	Czestochowa University of Technology	Oral	International PhD programs in practice presented (oral presentation) by phd student Anna Jasińska and phd Danuta Dróżdż
WG on Agronomic performance of fertilising products	19.04.2023, online	Inagro	Oral	Importance of field trials
Faculty of Agrobiotechnological Sciences	18.09.2023, Osijek Croatia	IPS Konzalting	Oral	Potential of digestate application in agriculture - examples of good practice

Below some representative pictures from events are shown:

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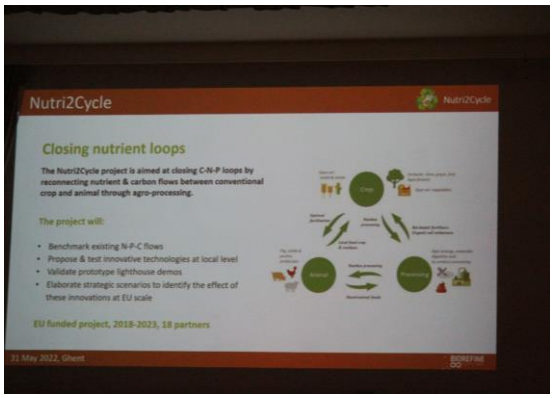
a)

b)

c)



d)

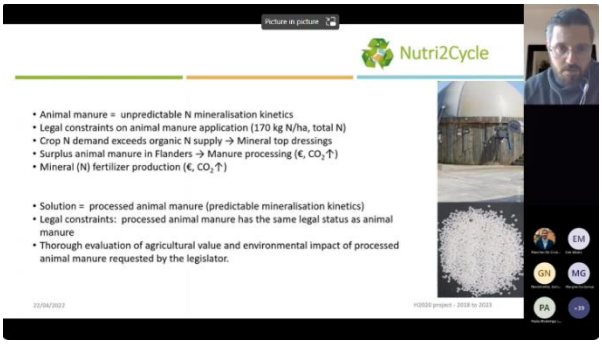


Figure 2. Pictures of events where Nutri2Cycle was presented: a) Ugent,, final Nutri2Cycle conference 19 September 2023; b) IPS Konzalting, Symposium on Agriculture -SA Conference 19-24 June 2022, Croatia c) Biorefine Conference, 29-30 May 2022, Belgium d) Webinar series on lighthouse demos 18-22 April 2022, online

Notwithstanding that all contributions generate impact, the Nutri2Cycle consortium also invested in some high-level network events, where dedicated Nutri2Cycle contributions/workshops were organised often in collaboration or exchange with other European projects to maximise outreach. This approach generated more interaction with stakeholders then originally foreseen project booths at conferences (which became impossible following the Covid crisis). A comprehensive oversight of the major events in that perspective where Nutri2Cycle had a leading role is listed below.

Nutri2Cycle co-organized, together with other EU projects, the already four editions of the **European Sustainable Nutrient Initiative (ESNI)**. ESNI was initially launched to bring together EU projects, stakeholders and EU officials in an annual physical event to nurture community building and foster collaboration and exchange.

In 2019, **ESNI** was physically organized in Brussels as a co-organisation between the EU projects Circular Agronomics, Nutri2Cycle, NUTRIMAN, Phos4You, ReNu2Farm and SYSTEMIC. The aim of the conference was to provide a comprehensive overview on the opportunities and benefits of nutrient recycling to boost research, agriculture and sustainable development. It gave a unique opportunity to focus on the current policy measures, innovative solutions and technological developments on nutrient recycling through parallel workshops. Nutri2Cycle hosted a dedicated workshop entitled “Launching national practice platforms on nutrient recycling in agriculture, under a European

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umbrella" and had a plenary pitch moment (active contribution by UGent (organization +presentation), Inagro (moderation), Thuenen (poster) & ZLTO (presentation).

In 2020 ESNI had to be organized in digital setting due to the COVID19 crisis. The foreseen single physical event was substituted by 3 separate online workshops. The first session took place on 27/10/2020 and focused on "Towards practical implementation of biobased mineral fertilizers for Europe" on which the results of the lighthouse demo 'Growing potatoes using bio-based fertilisers: A step towards the adoption of bio-based fertilisers' were presented, during the second session (26/11/2020) a strong focus was put on LCA, where the Nutri2Cycle WP3 partners presented and discussed together with a number of other EU H2020 projects involved in LCA work on "Life Cycle Assessment of Technologies for Nutrient Recycling and Production of Biobased Fertilisers – Can we Develop Common Standards?". In total 400 participants registered of which 263 specifically for session 1 and 128 specifically for the LCA session.

In 2022 a dedicated ESNI session was co-organised between Nutri2Cycle, our sister project Circular Agronomics, Lex4Bio and Fertimanure to discuss the role of farmers and consumers to reach the Farm to Fork targets set by 2030. More specifically in this digital edition the work of WP5 was highlighted. This edition gathered 130 attendees, from policy-makers to industry and researchers.

ESNI2023 was organized on September 20 2023 in Brussels, again as a multi-project collaboration. At ESNI 2023 Nutri2Cycle held a plenary speech in collaboration with the novel Interreg NWE project Renu2Cycle on policy aspects of bio-based fertilizers. Here the policy work of Nutri2Cycle was put forward while this talk also represented the formal handover of the lead of the policy working group of the Nutrient Recycling community from the finishing Nutri2Cycle project to the novel Renu2Cycle project (see point 4 and D7.7). At ESNI 2023 Nutri2Cycle also co-organised a workshop orientated towards policy (co-organisation with the Horizon project Nutribudget). The ESNI 2023 event gathered 160 attendees, again as a healthy mix between researchers, industry and policy makers.

Figure 3. ESNI 2023 - Plenary session - Policy recommendations on the legal framework on nutrient recycling

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At **Manuresource** 2019 we did not opt for the workshop option as this was too early at the stage of the project. Instead we opted to join forces with our sister project Circular Agronomics by giving a joint presentation. This close collaboration also allowed to harmonize our activities and present the call as a united front towards the stakeholders.

Manuresource 2021 took place on May 11-13 2022 (instead of the postponed date of 24-26 November 2021) in HertogenBosch (the Netherlands). As this was one of the first physical meetings following the COVID19 crisis this was a very high level event. Nutri2Cycle therefore organised a policy roundtable with more than 30 participants from different EU Member States in which we discussed the main bottlenecks for the use of recovered N,P and C as identified in task 1.4. This also formed an important base for the RENURE Policy brief (see D7.7). Furthermore Nutri2Cycle also organised two subsequent parallel sessions with the participation of more than 50 people. In the first session entitled "Measures to optimize N, P and Organic Carbon recovery in animal husbandry" the preliminary results and setup of different lighthouse demo's were shown and discussed. In the second session entitled "Field experience on application of biobased mineral fertilisers in comparison to fossil-based mineral fertilizers" the project was introduced after which LCA, economics and social LCA of different Nutri2Cycle solutions were presented.

Figure 4. Nutri2Cycle at ManuResource 2022, Hertogenbosch, The Netherlands a) Dedicated Nutri2Cycle session 1, b) Dedicated Nutri2Cycle session 2, c-d) Policy roundtable co-chaired by Nutri2Cycle

Finally, Nutri2Cycle also organised a very successful **series of webinars** (19-28 April 2022) with a specific focus on the lighthouse demo's entitled 'Nutri2Cycle Lighthouse Network: Demonstrating nutrient and carbon recycling in EU agriculture in practice'. The webinars were structured along the different Research Lines and were intended to showcase the lighthouse prototypes. During the events, partners responsible for developing lighthouse demo solutions presented and demonstrated the research outcomes at relevant pilot, field or farm scale. Each lighthouse solution was complemented by surveys developed by TEAGASC and THUENEN, aimed at assessing the technical feasibility of the proposed solutions and their real transferability across the EU regions, to be incorporated in D4.1. All relevant information related to the lighthouse demo solutions (presentations, recordings and

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factsheets) are available on the project website. The webinar series gathered approximatively 80 participants (including scientists), who joined all the different sessions.

3. Setting up a Nutri2Cycle research and training network

A large number of associated PhD, postdoc, agro-experts and other researchers are associated to the Nutri2Cycle project, all working in the same research area though all in different countries and on different research lines. It deemed therefore crucial to maximise interconnection and exchange. Nutri2Cycle therefore engaged itself to have multiple joint PhD agreements, which are interdisciplinary collaboration in doctoral training leading to a joint doctoral degree. From a total of 20 PhDs resulting from the Nutri2Cycle project in total 11 were under the form of a joint degrees. A full list of PhD thesis and their details are available in D2.5, while Table 4 gives a comprehensive overview.

Table 4. List of Nutri2Cycle (joint) PhD students

Nutri2Cycle PhD	Joint	Institution(s)
Ambrogio Pigoli	No	Università degli Studi di Milano
Amrita Saju	No	Ghent University
Anna Jasińska	Yes	Częstochowa University of Technology & Ghent University
Arejacy Antonio Sobral Silva	No	Instituto Superior de Agronomia
Axel Mauricio Herrera Moreno	No	Università degli Studi di Milano
Bruno Rizzi	No	Università degli Studi di Milano
Catarina Esteves	Yes	Instituto Superior de Agronomia & Ghent University
Danuta Dróżdż	Yes	Czestochowa University of Technology & Ghent University
Edilene Pereira Andrade	Yes	Universitat Rovira I Virgili & IRTA
Erica Yvonne Montemayor	Yes	Universitat Politècnica De Catalunya & IRTA
Gregory Reuland	Yes	European Biogas Association & Ghent University
Hongzhen Luo	No	Ghent University
Joana Prado	No	Instituto Superior de Agronomia
Jai Sankar Seelam	No	Ghent University
Lluís Morey Gual	Yes	IRTA & Ghent University
Marie Lambert	Yes	Inagro & Ghent University
Merve Konucu	No	Ghent University
Miriam Beyers	Yes	University of Copenhagen & Ghent University
Rahul Ravi	Yes	University of Copenhagen & Ghent University
Reindert Devlaminck	Yes	Inagro & Ghent University

To also foster a vigorous student exchange for all involved international partners and outside the consortium 3 Nutri2Cycle summer schools were organised. The summer schools were designed as short, intensive classes where the students were immersed in the subject and challenged to present

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their research, put their research in a bigger perspective as offered by the keynote speakers and expand their horizon for novel interactions by active discussion sessions:

- 1st Nutri2Cycle summer school: The first Nutri2Cycle summer school was organised from September 16-19 2019 in Ghent Belgium and was organised by Ghent University. Both PhDs from the Nutri2Cycle project as well as other young researchers working on more efficient use of carbon, nitrogen, and phosphorus in agriculture were specified as the target audience. The event was a great success with more than 36 participants from over ten countries, actively involved during four days. During the summer school the work within Nutri2Cycle was presented, but participants could also present their expertise and research. In an interactive session and workshop session potential links were investigated.

- 2nd Nutri2Cycle winter school: The 2nd Nutri2Cycle winter school was co-organized by UGent and the University of Copenhagen as a joint initiative with the Horizon 2020 Marie Curie FertiCycle project. In response to the COVID-19 pandemic the originally planned 3-day physical summer/autumn 2020 school was re-organized into an online winter school as a series of 9 x 3 h online webinar sessions including group work, exercises, discussion and 'elevator pitches'), with contributions from EU H2020 FertiCycle and Nutri2Cycle project partners/supervisors. The winter school brought together experts from both projects in the field of bio-based fertilisers. The event received 31 participants from 10 countries, actively involved in the 9 sessions. Among these 12 students were immediately linked to the Nutri2Cycle project.

- 3rd Nutri2Cycle summer school: the third and final Nutri2Cycle summer school took place June 7-9 2023 in Barcelona, Spain and was a co-organisation between Ghent University and IRTA. Over 50 young researches and key note speakers attended this final summer school. As this was the final summer school in the series the organisers took the opportunity to not only focus on the research progress but also broaden the participants perspective by dedicated workshops. Participants were offered a choice between a workshop on the sustainability assessment on nutrient recovery and recycling or a workshop on emission monitoring and abatement in manure processing, depending on their research interest. By hands on exercises and real life data participants were challenged and there was opportunity to ask advice on these topics for their specific research work. Furthermore, a plenary workshop was also provided an research communication, including a partim on legal frameworks and how to approach policy makers as it is crucial that Horizon research work effectively reaches the correct stakeholders. In this workshop participants were given tips and advice on how to best formulate a message, present their scientific work to different types of stakeholders. Furthermore, through an assignment real slides/tweets etc.. were evaluated and optimised so students could enhance their communication skills. Finally all participants could visit the IRTA plot site to showcase practical experience on ammonia recovery from pig slurry.

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Figure 5. Impressions from the 3rd Nutri2Cycle summer school in Barcelona, Spain

Importantly Nutri2Cycle actively engaged in the **Nutrient Recycling Community**, a consolidated network gathering projects within the nutrient recycling domain. This community aims to foster collaboration and dialogue between relevant initiatives and projects around nutrient recycling in Europe and serves as a platform to exchange knowledge and good practices. Structurally, the community is divided in 4 working groups that are led by different EU projects, among which the Nutri2Cycle project that coordinated the policy working group and organised webinars and roundtables to discuss hot topics and formulate joint position papers towards the European Commission (see bullet point 3 and D7.7). Importantly in frame of scientific outreach Nutri2Cycle also participated in the Working Group on technologies for nutrient recycling. On April 29 2022 the project was outlined and the 14 selected lighthouse demo solutions were briefly showcased and discussed. On September 23 2022, the agronomic performance of tested biobased fertilizers within Nutri2Cycle was presented. Finally on December 14 2022 the project was represented at the Webinar on Biogas Biorefineries mainly addressing the RENURE products. This kind of community work is crucial to facilitate collaboration among relevant European entities involved in nutrient recycling, identify key challenges in nutrient recycling from different perspectives and propose new research initiatives to address the identified challenges and foster collaborative research to amplify the impact of R&D at the EU level.

4. Organization of the final conference

To present the main results and recommendations of the project a final conference was organized. To reach as many interested stakeholders as possible and stimulate interaction between different projects, an interesting 3 day set up was put in place. For promotional purposes, a visual was designed by UGENT (Fig 6). This was predominantly done through the project website and in particular the Biorefine Cluster Europe which supported the event by regularly spreading the event in their own networks. A special issue of the BCE Bulletin dedicated to the nutrient recycling was delivered to give higher visibility to the final event and its interlinkage with the ESNI event.

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Fig 6. Visual for promotion of the Nutri2Cycle final conference

The Nutri2Cycle project organized its final event entitled on 19-21 September 2023, consisting of 3 events: on September 19, a dedicated workshop was organized at the "Zebrastraat Centre" in Ghent, Belgium highlighting the project specific results. On September 20, Nutri2Cycle co-organized two policy-oriented workshops at the ESNI 2023 event in Brussels, Belgium together with other EU projects dealing with nutrient recycling and within the framework of a larger event. By organizing this event in collaboration with another initiative with similar global aims, namely the European Sustainable Nutrient Initiative (ESNI, see also point 4), stakeholders could receive maximal input in a minimum amount of time while both organisations could profit from mutual promotion. Finally, on September 21, an excursion (see Fig 8) was organized to one of the lighthouse demonstration sites in Flanders (at Inagro, Roeselare, Belgium).
The aim of the final event was on the one hand to disseminate the most important findings of the project and on the other hand to present the projects' exploitable results such as the policy recommendations (see also D4.3 and the Nutri2Cycle website) and CBA tool (see also D3.6). The participants enjoyed presentations from the project partners (Gent University, University of Milan, Teagasc, University of Copenhagen, United Experts, Wageningen Research, Thuenen Institute and IRTA-CREDA) on various key results such as the Nutri2Cycle White Book, the Lighthouse Demo Network, impacts of Nutri2Cycle solutions at farm, regional and European levels as well as changes in consumer behavior towards more circular and sustainable food products.

The event attracted around 80 participants representing the different identified stakeholder groups, such as research centers, sectoral associations and universities. The participants were especially interested in the results of environmental and economic impacts of the Nutri2Cycle solutions at farm, regional and EU levels. Nutri2cycle succeeded in categorizing research towards optimized nutrient and carbon cycles in agriculture along 5 research lines that examined the interactions between animal production, plant production and agro-processing. In addition to technical research on these topics ecological (LCA, DBI), economic (both micro-economic & macro-economic) and social (both consumer behaviour and end-user preferences) aspects were also investigated and the key outcomes presented at the conference. It's utmost crucial that such project results are taken up by relevant stakeholders, that's where the importance of dissemination at different levels comes in. In that sense, farmers-oriented workshops / demo days (see D6.2) or policymakers-targeted policy recommendations (see D4.3 and the Nutri2Cycle website) played a key role. The research undertaken in Nutri2Cycle is also being followed up by other ongoing EU projects (e.g. NutriBudget, Novafert). At the moment, the methodology of Miterra-Farm modelling (see D1.7) developed in Nutri2Cycle is being expanded with new sections in NutriBudget. The methodology and results were presented both at the Nutri2Cycle final event and at the dedicated co-creation workshop co-organized by Nutri2Cycle and NutriBudget at ESNI 2023 (see Figure 7c and 7d).

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Figure 7. Pictures from the final conference of Nutri2Cycle. a) Opening speech on September 19 in Ghent b) Results of LCA work on September 19 in Ghent Final event c) Introductory presentation during the co-creation workshop at ESNI on September 20 in Brussels d) Results of modelling nutrient flows during the co-creation workshop at ESNI on September 19 in Brussels.

Figure 8. Pictures from the excursion to the lighthouse demo's on September 21. a) Introductory session at Inagro premises b) Lighthouse demo on "Floating wetland plants grown on liquid agro-residues as a new source of proteins" c) Machinery to apply the liquid BBFs during "Field trial on maize (2019), spinach (2020) and potatoes (2021) with recycling-derived fertilizers: ammonium nitrate, ammonium sulphate, (liquid fraction of) digestate, pig urine and pig slurry" d) Lighthouse demo on "Farm-scale anaerobic digestion of agro-residues/pig manure to increase local nutrient cycling & improve nutrient use efficiency".

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5. Conclusion

Scientific articles and presentations of progress, results and key messages at scientific conferences are an essential way to disseminate the results of a project towards the scientific community. Nutri2Cycle has been very successful in achieving and exceeding the preset targets, thus expanding the scientific knowledge on different aspect of nutrient (re)cycling. In total 49 scientific papers were published on behalf of Nutri2Cycle. The project results were 55 times orally presented and 32 times by poster contributions at 49 (inter)national conferences. Nutri2Cycle also engaged in organising / contributing to high-level events often in cooperation with other European projects, thus exploiting and expanding the extensive network of the consortium.

Publications and scientific conferences can be considered “classical” ways of scientific dissemination. Importantly, Nutri2Cycle went a step further by also investing in building a Nutri2Cycle research and training network, both by creating a young researchers community as by actively engaging in the Nutrient Recycling community. In total 20 PhDs will be achieved thanks to Nutri2Cycle, of which 11 joint PhD, which also illustrates the solid cooperation between partner institutes. This cooperation between leading institutes within and outside the Nutri2Cycle consortium will run further through the ESNI Nutrient Recycling Community which guarantees long life of the project results. In summary Nutri2Cycle has been successful in informing and interacting with the scientific community, showcase the project innovations and establishing beneficial connections between organisations with the common goal of creating more robust nutrient loops thus reaching its scientific outreach objective.

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