Nutri2Cycle
Nurturing the Circular Economy

Nutri2Cycle

D.4.3 Policy report

Deliverable:	Policy report
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Abbreviations

AD: Anaerobic Digestion

CAP: Common Agricultural Policy

CAPRI: Common Agricultural Policy Regional Impact

CMC: Component Material Categories

DG: Directorate General

ESNI: European Sustainable Nutrient Initiative

FPR: Fertilizing Products Regulation

GAEC: Good Agricultural and Environmental Conditions

GHG: Greenhouse Gas

GPS: Global Positioning System

INMAP: Integrated Nutrient Management Action Plan

JRC: Joint Research Centre

NIRS: Near-Infrared Spectroscopy

NVZ: Nitrate Vulnerable Zone

OM: Organic Matter

RENURE: Recovered Nitrogen from Manure

WG: Working Group

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Glossary

Anaerobic digestion: A series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen and produce biogas (consisting of methane and carbon dioxide).

CAPRI model: A global partial equilibrium model for the agricultural sector, with a focus on the European Union.

Common agricultural policy: Food, the environment, and the countryside are the three main pillars of the Common Agricultural Policy (CAP). As a partnership between society and agriculture, CAP safeguards farmers' income, protects the environment, and keeps rural areas vibrant.

EAT-Lancet: The EAT-Lancet report is the first full scientific review of what constitutes a healthy diet from a sustainable food system, and which actions can support and speed up food system transformation.

Floating wetland: consists of a suspended matrix planted with wetland plants which facilitates microbiological and plant processing of nutrients.

Nutrient recycling: The continued recovery, transfer and use (with possible temporary accumulations) of nutrients between different compartments (soil, plants, animals, humans, water, air) and trophic levels in the biosphere.

Precision farming: Management approach in farming that focuses on (near real-time) observation, measurement, and responses to variability in crops, fields and animals.

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Executive Summary

The Deliverable 4.3 (D4.3) aims to develop “A roadmap for more systemic evolutions for optimized nutrient use throughout Europe” and thus provides policy recommendations based on the major outcomes of Nutri2Cycle, translated into a policy context to accelerate the take-up of the results by relevant policy makers.

The report is composed of two sections: The first section presents the innovative policy measures of the selected Nutri2Cycle solutions based on the CAPRI or MITERRA modelling outputs at regional, national and EU level as follows: (i) recommendations on GHG emission reduction, (ii) precision farming sensor recommendations, (iii) manure treatment recommendations, (iv) reducing feed import recommendations, and (v) recommendations related to diet changes. The scenario analysis of these selected measures helps to understand their overall impacts, interactions and trade-offs with land use and environment and agricultural production.

The second section of D4.3 compiles the policy recommendations published by the Nutri2Cycle policy working group through the project lifetime, mainly focusing on enabling the safe use of digestate and RENURE (Recovered Nitrogen from Manure) products.

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Introduction

In the first part of this report, policy recommendations are provided regarding the technologies evaluated in Nutri2Cycle. We leverage the insights gained from previous tasks in WP4, which assessed the transferability and environmental impact of selected technologies, to identify a series of measures and corresponding policy actions. In addition, we use the results from Deliverable 5.3 in WP5, where dietary changes on the demand-side following EAT-Lancet recommendations and the mitigation technologies on the supply-side triggered by a carbon tax were analysed. The second part of this report consists of several policy recommendations published by the policy working group established in Nutri2Cycle.

1. Policy recommendations based on the effects of innovations at regional, national and EU level

GHG emission reduction recommendations

From all analysed technologies in Deliverable 4.2 in Nutri2Cycle, the widespread adoption of farm-scale anaerobic digestion of agro-residues/pig manure ("Pocket anaerobic digestion") yields the most significant benefits in terms of reducing agricultural greenhouse gas (GHG) emissions. The positive effects of pocket anaerobic digestion are amplified by its capacity to be utilized by a greater number of farms, including those with smaller sizes. Anaerobic digestion (AD) with manure offers a solution for managing livestock waste, which can otherwise contribute to environmental pollution, such as water contamination and emissions of methane. In addition, the digestate produced from farm-scale anaerobic digestion can serve as a valuable organic fertilizer due to better nutrient availability (N, P and K) and reduced nutrient runoff and leaching into water bodies compared to untreated manure, reducing the need for synthetic fertilizers in the European agricultural sector. This technology has the potential to mitigate up to 18.8 million tonnes (Mt) of CO_2 equivalents, resulting in a 4.8% reduction in agricultural GHG emissions in the EU-27, in line with to the transition to a climate neutral Europe. The highest potential for reducing GHG emissions is found in livestock-intensive countries like Germany, Spain, Italy, France, and Denmark. Anaerobic digestion technology for farm-scale operations is highly rated within Deliverable 4.1, which evaluates the transferability of technologies throughout Europe.

Benefits in terms of GHG reduction, can be attributed for a large part to avoided methane emission from manure storage by fresh delivery of manure to an (on-farm or centralized) AD resulting of capturing this methane into a useful renewable energy source. In addition of course the renewable energy production itself contributes further to the GHG-abatement benefits. The use of digestate as as fertilising product enjoying higher nutrient use efficiency than raw manure also brings additional benefits. When digestate is further refined to synthetic fertilizer substitutes, there is also the added advantage of primary resource replacement of natural gas which otherwise is consumed for the production of such synthetic fertilizers. Last, also the build-up of stable soil organic carbon as a carbon

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sink further adds to the benefits of AD – considering the higher levels of Effective Organic Carbon (i.e. oganic matter withstanding mineralization) as found in digestate.

Despite the well-documented benefits of AD, the lack of legislation promoting or (financially) incentivizing farm-scale AD have been identified as significant constraints. Nonetheless, Europe (and by extension) have the necessary tools available to integrate such incentivation – e.g. via rural investment support schemes or the revised Common Agriculture Policy (CAP) subsidies (of which 40% are already meant to focus on stimulating sustainable agriculture). Policies can promote the increased use of farm manure and the use of digestate as an organic fertiliser in particular through financial incentives by promoting them as "good agricultural and environmental condition" (GAEC) or eco-schemes in national CAP strategic plans. Another option could be the provision of investment subsidies through the 2nd pillar of the CAP in order to make necessary structural changes. Investment subsidies for livestock buildings or building permissions could be modified in such a way that the use of manure in biogas plants would be a prerequisite for larger livestock buildings. Also, the introduction of a carbon pricing mechanism in the agricultural sector including methane would serve as an incentive to investments in AD facilities. In line with the Soil Monitoring Law, the recognition of the application of digestate as a sustainable soil management/regeneration practice is also necessary.

Additionally, policies may set quality standards and guidelines for gas-tight operation to avoid methane leakage and for digestate application to ensure proper nutrient management and minimize environmental impacts.

Precision farming sensor recommendations

With regard to higher nutrient efficiency, the implementation of precision farming using NIRS technology and the N-Sensor technology shows the highest potential for reducing mineral fertiliser use at the EU level based on results from Deliverable 4.2. Via NIRS, large parts of total liquid manure in the EU could be applied more precisely. In this way, manure application can substitute mineral fertilizer to a greater extent if the N fertilization strategy is adapted accordingly (i.e., determination of N plant needs with plant analysis, split fertilizer application, and/or use of N-inhibitors). However, the application rates of N in organic and total fertilisers also depend on the requirements set at national level in application of the EU Nitrates Directive. The N-sensor utilizes near-infrared spectroscopy to monitor nitrogen requirements and uptake by assessing crop green leaf index, thereby increasing nitrogen use efficiency in agriculture. By utilizing tractor-mounted N sensors, mineral fertilizers and pesticides can be distributed based on soil nutrient availability and crop nutritional requirements. The N-sensor is used to apply mineral N fertilizer to plants in proportion to their needs, thereby reducing the risk of overapplication and groundwater pollution caused by N and P leaching.

Policies should incentivize the adoption of technologies like N-Sensor and NIRS that directly target mineral fertiliser use, manure management, and nutrient optimization. By doing so, the EU can reduce environmental impacts, decrease nitrogen surplus and leaching, and promote more sustainable agricultural practices. Based on results from Deliverable 4.1, one major barrier for the higher adoption of these sensor technologies is the technical knowledge required to operate these technologies particularly for non-specialized farmers. Policies should encourage improved industry standards - for

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communicating between the software of different brands of tractor GPS control and appliances, and consultancy services to increase the implementation of N-Sensor and NIRS technologies throughout Europe.

Manure treatment recommendations

In Deliverable 4.2 two manure treatment technologies were assessed. Upgrading manure to organo-mineral fertilizers with elevated nutrient use efficiency is of particular interest for the many regions in Europe where we observe localized excess nutrients coming from manure, yet in which we also see a concurrent high utilization of mineral nitrogen (e.g. parts of Germany, Italy, Spain, France, Poland, Belgium, Denmark and the Netherlands). It is indeed a paradox that such intensive agricultural regions encounter both nitrogen surplus coming from animal production and yet also high synthetic fertilizer consumption due to high crop nutritional demands which cannot be met with the (capped) fertilisation by animal manure (limited to 170 kg N $ha^{-1}y^{-1}$ in the Nitrate Directive). Direct substitution of mineral fertilizers from synthetic origin could thereby offer environmental benefits in terms of overall primary resource consumption, manure management as well as GHG mitigation, as well as contribute to the need to reduce dependency on nitrogen fertilisers following Russia's war on Ukraine.

In order to reconcile the objectives of food security and environmental protection, a first step should be to allow the safe use of RENURE products (REcovered Nitrogen from manURE) above the Nitrate Directive limit in the many EU countries characterized with intensive agriculture, based on the RENURE criteria developed by the Joint Research Centre (Huygens et al. 2020)[1]. However, it remains necessary to combine the use of RENURE with good management practices, including the use of living plant covers or equivalent measures, low NH3 emission application techniques and good RENURE storage conditions.

Manure treatment could in particular be stimulated in the case where nutrients from manure are otherwise lost, such as during nitrifcation-denitrifcation or manure incineration when dealing with manure surplus requiring local processing. Also N stripping in combination with anaerobic digestion is beneficial, as digestate has a high NH_4 content, which increases the risk on NH_3 emission. N stripping will reduce this and might also improve the methane production in the digester, as a high NH_3 concentration will reduce the activity of the methanogenic bacteria. Therefore stripping technology can play an added value both at the inlet of AD as at the outlet, either to mitigate NH_3 related toxicity or increased removal efficiency following anaerobic mineralization.

Apart from the direct application of manure, remaining regulatory barriers preventing the commercialisation at EU level of manure-based fertilisers, principally in the Fertilising Products Regulation or the Animal By-Products Regulation, should be tackled.

[1] Huygens, D., Orveillon, G., Lugato, E., Tavazzi, S., Comero, S., Jones, A., Gawlik, B. and Saveyn, H., 2020. Technical proposals for the safe use of processed manure above the threshold established for Nitrate Vulnerable Zones by the Nitrates Directive (91/676/EEC). JRC121636, p.170. https://doi.org/10.2760/373351

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Reducing feed import recommendations

The technology of floating wetland plants grown on liquid agro-residues as a new source of proteins could be a promising option in the future, particularly for countries with high livestock densities and high demand for protein animal feed which is primarily satisfied from imported soybean meal. As this can have negative effects on land use change and related GHG emissions, there is a need to reduce the dependency on imported protein sources as proposed in a resolution currently discussed at the European Parliament[2]. In addition, this technology could contribute towards closing nutrient loops by utilising available nutrients in agricultural wastewaters to produce a novel protein for animal feed with a comparably high protein content of duckweed between 30-35%. Although it can contribute – the extent to which it can be technically deployed as a significant alternative (waterborne) crop needs to be further investigated in order to make a more accurate assessment of the potential impact of this technology.

New legislation is needed to ensure that duckweed protein can be used as a safe source of feed for livestock. Further research studies need to be conducted to address the issues of feed value and safety, volatile nitrogen emissions, sediment accumulation, and the economic feasibility of duckweed grown on manure effluents to optimize production and make it more practicable. However, it can be noted that we expect this technology to remain a niche market, given the high demand for protein in European animal production and the relatively low-cost of imported feed by comparison.

Recommendations related to diet changes

In Deliverable 5.3 in the Nutri2Cycle project, we examined the impacts of three different scenarios on the environment, agricultural production, and trade in 2030 using the CAPRI model. The scenarios analysed were based on the dietary recommendations proposed by the EAT-Lancet report, implementing a carbon tax to stimulate the adoption of mitigation technologies and combining both approaches. The findings revealed that dietary changes resulted in decreased production of animal-based products, while there was an increase in the production of fruits, vegetables, and legumes. Additionally, these dietary changes led to reductions in GHG emissions and nitrogen surplus in the agricultural sector.

Based on these findings, policies should encourage and support the adoption of more plant-based diets in the European Union, such as the EAT-Lancet recommendations, due to their positive effects on the environment and health by reducing animal-based product consumption and production. In addition, findings of Rieger et al. (2023)[3] suggest that also the agricultural sector could benefit from dietary shifts based on recommendations from the EAT-Lancet Commission.

A combination of policy measures is recommended to facilitate this dietary shift and mitigate its economic impacts. Monetary instruments such as taxes and subsidies can be utilized to incentivize consumers towards healthier food choices and support sustainable agricultural practices. In addition, non-fiscal measures such as information campaigns and product labelling can help promote

[2] Resolution 2023/2015(INI) on European Protein Strategy

[3] 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 Economics, 74, 764–784. https://doi.org/10.1111/1477-9552.12530

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sustainable and healthy dietary choices. These measures can raise awareness among consumers and provide them with the necessary information to make informed decisions. Governments should regularly provide data on consumer behavior to assist farmers in identifying emerging dietary trends and responding appropriately. In the event of accelerated dietary shifts driven by nudging policies or other factors, policy intervention may become necessary.

This can also be achieved through measures such as reducing regulatory barriers to the transformation of production systems and value chains. In addition, it can provide infrastructure and extension services to support the adoption of new systems and production methods. Furthermore, policies can help mitigate social impacts in regions that are most affected by dietary changes. This may involve supporting retraining programs or providing temporary income support to alleviate the hardships faced by farmers during the transition.

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2. Policy recommendations published by Nutri2Cycle

The policy working group (PWG) of Nutri2Cycle actively worked on to translate the major project outcomes into policy recommendations to fasten the take up by policy advisors / makers. The PWG was led by Ghent University, in collaboration with European Biogas Association, United Experts and Thuenen Institute. Below the list of policy recommendations are given with their links to the original documents published at the Nutri2Cycle website. The policy recommendations published within Nutri2Cycle mainly focused on enabling the safe use of digestate and RENURE products, which is one of the key solutions investigated in the project (see the lighthouse demo's in Belgium on pocket anaerobic digestion and field trials on RENURE products such liquid fraction of digestate, ammonium sulphate / nitrate). Additionally, the findings of Nutri2Cycle were included in the policy recommendation on Soil Health Law published by the European Biogas Association (https://www.europeanbiogas.eu/wp-content/uploads/2023/06/EBA-Recommendations-Soil-Health-Law-June-2023.pdf).

2.1.1. Fertilising products – technical amendments to the rules on digestate

The Nutri2Cycle project (www.nutri2cycle.eu) welcomes the proposed technical amendments to the fertilising product regulation (FPR), in particular to the CMC4 and CMC5 in annex 2. The regulation will allow solid-liquid separation, dewatering and ammonia recovery for digestate upgrading.

Nutri2Cycle shares its analysis and interpretation of the proposed amendments:

To the amendment introducing the paragraph 3a[4] no remarks are raised.

The amendment introducing the new paragraph 3b[5] allows to recycle nitrogen from digestate and to use a N-reduced fraction to produce tailor-made digestate products. However, it fails to acknowledge techniques for phosphorus recycling, such as precipitation of phosphate, which produces P-reduced fractions. Nutri2Cycle suggests introducing a new paragraph 3d to acknowledge phosphate precipitation.

The new paragraph 3c[6] introduces processes to remove water. Such techniques are very useful to reduce digestate volume and constitute normal standard. Common practices include atmospheric evaporation, where no dried digestate is produced, but instead thickened liquid solutions, and vacuum evaporation, where H_2O, CO_2, NH_3 leave the liquid fraction at lower temperatures than standard boiling. The same paragraph seems to allow drying of the solid fraction of the digestate. This is typical

[4] An EU fertilising product may contain a solid or liquid fraction of digestate, provided that all of the following conditions are met:
(a) the solid or liquid fraction is obtained by mechanical separation of digestate compliant with points 1 to 3;
(b) the additives needed for the mechanical separation comply with the requirement in point 1(b)(i);
(c) the total concentration of all additives does not exceed 5 % of the digestate weight.

[5] An EU fertilising product may contain a digestate compliant with points 1 to 3, or a fraction compliant with point 3a, from which all or part of the soluble ammonium has been removed to recover nitrogen, without the intention to otherwise modify the digestate or the fraction.

[6] An EU fertilising product may contain a digestate compliant with points 1 to 3 or point 3b, as well as a fraction compliant with point 3a, which have undergone only physical processing to remove water that does not chemically modify the digestate or the fraction

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where the hot air, e.g. from the CHP of the biogas plant, is conducted through or over the digestate to be dried. Other frequent drying practices such as belt dryers, push-turn, fluid bed, and drum dryers, trailer and container dryers seem to be allowed too. However, it is not clear if membrane filtration is acknowledged by paragraph 3c. Membrane (micro, ultra, nano filtration, and reverse osmosis) requires the use of minimum additives like flocculants for proper functioning. Nutri2Cycle recommends aligning the wording of the paragraph 3c to the paragraph 3b[7]. Both paragraphs 3b, 3c and 3d should include additional subparagraphs authorising the use of additives[8], just as allowed for the solid liquid separation in paragraph 3a.

Nutri2Cycle suggest introducing a new paragraph 3e that acknowledges another upgrading technique of the dry fraction of digestate, such as pelletising. The goal of pelletising is to compact the dried digestate into digestate pellets to improve the density as well as handling and appearance. Farmers and horticulture practitioners usually prefer pellets. Digestate pellets are simply obtained through a combination of high pressure (centrifugation) and high temperatures that first melt and secondly solidify digestate.

The proposed amendments are important, but other elements are still missing, especially for animal derived products for use as fertilisers and soil improvers (i.e. by-products after anaerobic digestion). Manufacturers that want to place such digestate products on the market have to wait until an end point in the manufacturing chain is determined. Member States will start implementing the FPR in July 2022 but no information for the end point is available yet.

Other obstacles that slow down or limit the uptake of digestate fertilisation still exist. For example, in Germany N from manure and digestates including plant and waste-based N are accounted to the maximum of 170 kg N $ha^{-1}y^{-1}$ (annex III, article 2 of the Nitrates Directive) in order to protect water bodies, while in other Member States only N from livestock is included. The European Commission published a technical proposal[9] with specific safety criteria for the use of REcovered Nitrogen from manURE (RENURE) in Nitrogen Vulnerable Zone (NVZ) in 2020. RENURE materials include digestate and Nutri2Cycle recommends to translate the technical proposal in legislation to create a level playing field for safe digestate fertilization. We also highlight that member states should in parallel provide good monitoring practices to assess impact on agronomic and environmental performance of RENURE digestate while promoting this transition.

Link to the document: https://www.nutri2cycle.eu/wp-content/uploads/2022/03/N2C_briefing_FPR_Technical_Amendments_Digestate.pdf

[7] The sentence “that does not chemically modify the digestate or the fraction” should be replaced with the sentence “without the intention to otherwise modify the digestate or the fraction”.

[8] The Nutri2Cycle recommends adding the following sentence to paragraph 3b, 3c and eventually to 3d for precipitation of phosphates: “provided that all of the following conditions are met:
(a) the additives needed for the mechanical separation comply with the requirement in point 1(b)(i);
(b) the total concentration of all additives does not exceed 5 % of the fraction weight.”.

[9] https://publications.jrc.ec.europa.eu/repository/handle/JRC121636

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2.1.2. Joint position paper on RENURE

The EU has made huge progress in the implementation of circular economy solutions. With a new legal framework within the Circular Economy package (FPR, WFD, CAP-Farm to Fork) and a continued commitment to invest in research (H2020) and practical implementation (Interreg) the recovery and use of nutrients from wastes and residues is stimulated and facilitated.

The EU is the front runner in technologies for recovery of nutrients from manure which will help close the nutrient cycle of agriculture. This re-use of nutrients from manure has gained even more urgency, as outlined in recent communication of the Commission on Safeguarding food security and reinforcing the resilience of food systems[10].

The EU is also facing environmental challenges and combatting threats to water quality. The Nitrate Directive is targeting to reduce the contamination of our waters from the excess nitrates from agricultural sources. The application of manure is limited as -due to its inherent nature- the timing of nitrogen mineralisation from manure cannot be completely aligned with the nitrogen uptake by plants, resulting in run-off and leaching.

Manure treatment can be an effective way to combine the challenges of the circular economy, geographical independence of the EU while preserving our environment and waters. In the JRC-ReNure [2] research project it was investigated which manure-derived products can be safely used as equivalent to chemical derived fertilisers without posing a threat to water quality. Products adhering to these ReNure criteria can be safely exempted from the restrictions on the soil application of manure in NVZ as imposed in the Nitrate Directive and National Action Programmes.

The EU is also taking care that animal by-products, including manure, can be used and recycled in such a way that risks to public and animal health arising from those products are prevented and minimised. If manure-derived products are treated in such a way that they do not pose any risk for the safety of the food and feed chain, an 'end point in the manufacturing chain' can be declared. The end point products from manure treatment can then be used as a fertiliser under the scope of the FPR and / or national fertiliser regulations. The end-point-products will then be outside the scope of the EG1069/2009 and can be handled without the restrictions and requirements that are imposed on handling, transport and use of animal by-products.
The actual implementation of all these efforts is however still hampered by some remaining issues that need to be solved.

1. Implementation of the ReNure criteria

Manure-derived N-products that do not pose an increased risk for nitrate leaching or adverse environmental effects as compared to synthetic N fertilisers should be excluded from the 170 kg N ha^{-1} limit that is posed on manure application following the Nitrate Directive.

[10] EUROPEAN COMMISSION Brussels, 23.3.2022 COM(2022) 133 final COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Safeguarding food security and reinforcing the resilience of food systems

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The JRC-EC has evaluated a number of manure-derived products within the SAFEMANURE/ReNure research project[11]. Major outcome was that, following a set of criteria, certain manure-derived products can be safely used as replacement of chemically produced nitrogen fertilisers without increasing risk for nitrate leaching. As the technologies are developed, installations ready to produce, and farmers are in need of nitrogen fertilisers, and the EU needs to decrease the energy need for fertiliser production, the implementation of the ReNure criteria should not be delayed anymore.

2. Unambiguous definition of legal status of ammonium salts from off-gases

One of the recovered end products of manure treatment are ammonium salts (ammonium nitrate or ammonium sulphates). DG GROW and DG SANTE (Health and Food Safety) are implementing legislation with the aim to include these waste-recovered products as components for fertilisers.

However, some member states consider these products as animal by-products (ABP) in a very strict interpretation of the manure definition of the Nitrates Directive, restricting their recycling in the circular economy. Unambiguous definition of the legal status of ammonium salts recovered from air purification of the off-gases generated by manure or manure treatment processes by the DGs of the EC and the member states of the EU is urgently needed.

Ammonium salts from off-gases are high quality products which are now in the process of being qualified as a component material for the production of EU fertiliser under the regulation EU/2019/1009. This proposed CMC 15 RECOVERED HIGH PURITY MATERIALS includes:

“recovered high purity material, which is ammonium salt, sulphate salt, phosphate salt, elemental sulphur, calcium carbonate or calcium oxide, or mixtures thereof, of a purity of at least 95 % dry matter of the material. The high purity material shall be recovered from waste generated from: “…” (b) a gas purification or emission control process designed to remove nutrients from off-gases derived from one or more of the following input materials and facilities: “…” (viii) manure within the meaning of Article 3, point 20, of Regulation (EC) No 1069/2009 or derived products thereof; or (ix) livestock housing facilities.”

Following this wording, the ammonium salts from off-gases of manure or manure-derived products are considered as a waste-derived product. This was also explained by the JRC-report on the criteria for high purity materials recovered from waste (CMC 15):

“Off-gases of manure are not covered under the Regulation (EC) No 1069/2009 on animal by-products, and fall within the scope of this CMC WW/15.”

This is underlined by the Commission Expert group on Fertilising Products in their FAQ [4]:

“ 5.12 Are high purity materials out of off-gases generated by manure derived products within the scope of the Animal by-products Regulation?

[11] Huygens, D., Orveillon, G., Lugato, E., Tavazzi, S., Comero, S., Jones, A., Gawlik, B. and Saveyn, H., Technical proposals for the safe use of processed manure above the threshold established for Nitrate Vulnerable Zones by the Nitrates Directive (91/676/EEC), EUR 30363 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-21539-4 (online),978-92-76-21540-0 (print), doi:10.2760/373351 (online),10.2760/984729 (print), JRC121636.

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No. Off-gases from manure are not animal by-products or derived products within the scope of the Animal by-products Regulation, as defined in Article 2 of that Regulation. Therefore, the recovered high purity materials out of such off-gases are not within the scope of the said Regulation either and no end-point in the manufacturing chain has to be determined under the animal by-products rules for the use of such materials in EU fertilising products."

This opinion of DG GROW is in line with the statement from DG SANTE [5]: "question on nitrogen recovery from off-gases from manure treatment, manure storage, or livestock stables I confirm that off-gases from manure are not subject to Regulation (EU) No I 069/2009, since emissions are not within the scope of that Regulation."

However in practice, some member states consider the ammonium salts as waste-derived (in line with the logic of the FPR and the ABP-regulations, where the scrubbing salts are seen as waste product from purification of off-gases, and hence no End-point of manufacturing chain (EG 1069/2009 on animal by-products) should be declared).

Other member states make a distinction:

- Ammonium salts derived from scrubbing of air from stables are considered waste that are derogated to be used as a fertiliser. The ammonium off-gases in the stable air -emitted as a natural process- are considered to have lost the direct physical and chemical link with the manure.

- However, if the ammonium salts are derived from scrubbing of air that is originating from processing manure or derived products (controlled emission) they are considered to remain a manure product and hence an animal by-product. The argument that the ammonium off-gasses have lost the direct physical and chemical link to the manure treatment product that they originate from is not followed here.

The reason to consider the ammonium salts -recovered from the off-gases of manure and manure-derived products- as a manure is the definition of manure in the Nitrate Directive: 'livestock manure': means waste products excreted by livestock or a mixture of litter and waste products excreted by livestock, even in processed form. However, the off-gases are not a processed form of manure, but an emission that has lost the physical link to the manure. This interpretation of off-gases as processed manure and thus an ABP opposes the waste-derived status of the salts as outlined above and is not based on EU regulations on animal by-products or emissions and air quality.

Furthermore, the manure-ABP status does not contribute to the goals of the Nitrate Directive to protect water quality: ammonium salts recovered from off-gases are defined as ReNure products and have been evaluated as equivalent to chemical fertilisers and safe to be exempted from the 170 kg N $ha^{-1}y^{-1}$ application limit under the Nitrate directive. In effect, the ReNure status can be viewed upon as an 'end-of-manure' under the Nitrate Directive. Therefore, it would seem unnecessary to confer the status of manure or animal by-product to the ammonium salts.

The manure/ABP status limits market uptake as it poses a complex set of prerequisites on transport, handling and storage of the products (laid down in EC 1069/2009 and 142/2011) and requires registration, approval, control and and certification of all facilities, vehicles and actors along the

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market chain. This forms a logistical and administrative burden that further complicated and hinders the market entry and acceptance of the products. The different interpretation between member states also causes an unfair level playing field for producers in the different countries.

This difference in interpretation of the legal status of the product has consequences that will not be solved by the implementation of the ReNure criteria or inclusion in FPR CMC 15!

Harmonizing the views regarding the status of ammonium-salts originating from off-gas cleaning between the various branches of the European Commission (DG GROW, DG SANTE, DG ENV, DG AGRI) is a prerequisite for such circular economy processes and associated products to enter the market as sustainable, renewable alternatives to synthetic nitrogen fertilizers which are produced from conventional chemical processes using fossil resources (natural gas).

In concreto, the views expressed in the various documents and communications by DG GROW[12] and DG SANTE[13] are supportive of this transition, whereas ambiguous interpretation towards the remaining status as 'manure' for such products vis-à-vis the Nitrates Directive in other proclaimed positions by the European Commission may hinder or delay the transition towards more circularity in mineral nitrogen flows in European agriculture.

DG ENV needs to make a clear statement aligning with DG GROW and DG SANTE that the ammonium salts derived from off-gases of manure or manure treatment processes are not animal by-products and are not considered as manure under the Nitrate Directive.

This joint position is undersigned by the following European research and innovation projects: Nutri2Cycle, Renu2Farm, Circular Economics, Lex4Bio, Fertimanure, FertiCycle, Systemic, Nitroman

Link to the document: https://www.nutri2cycle.eu/wp-content/uploads/2022/10/Joint-position-on-status-of-AS-and-implementation-of-ReNure-FINAL-1.pdf

2.1.3. Joint position paper on the safe use digestate in the INMAP

Unlocking the safe use digestate in the INMAP: an opportunity for nutrients recycling and on-farm circularity

The cosignatories include COPA-COGECA, which represents over 23 million farmers and 22,000 agricultural cooperatives and the European Biogas Association, which represents nearly 8000 stakeholders from the biogas and biomethane value chain in Europe, as well as two European projects focusing on nutrients recycling and digestate – Nutri2Cycle and NOVAFERT.

[12] Note to the Commission expert group on Fertilising Products on the frequently asked questions in the implementation of the Fertilising Products Regulation. Meeting of 4-5 April 2022. Item 3.5 on the Agenda/21.03.2022

[13] European Commission DG for health and Food Safety Letter to Cssrs concerning safe recycling of nutrients in Animal By Products (ABPs) and manures Ref. Ares(2022)4033785 - 31/05/2022. Response to question raised by the ESPP on 25th of April 2022 to Stella Kyriakides, European Commissioner for Health and Food Safety and: Thierry Breton, European Commissioner for Internal Market

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The need to reduce dependency on nitrogen fertilisers by diversifying the sources of fertilisers and developing the supply of sustainable fertilisers has gained urgency following Russia's war on Ukraine. Using fossil-free, low-carbon, recycled nutrients to produce organic fertilisers will also accelerate the decarbonization pathway to a net-zero Europe. These challenges were outlined in the communication of the Commission on Safeguarding food security and reinforcing the resilience of food systems from November 2022 as well as in the resolution of the European Parliament on the availability of fertilisers in the EU from February 2023. Yet, to date, digestate faces a major barrier in the 32 years old Nitrates directive and the market of this sustainable fertiliser struggles to develop due to a lack of legal certainty. Nonetheless, digestate has the potential to significantly replace synthetic/inorganic nitrogen fertilisers as produced based on natural gas, thereby improving both the environmental impact as well as economic and geopolitical self-reliance.

In the framework of the upcoming publication of the Integrated Nutrient Management Action Plan (INMAP), we call on the Commission to allow and facilitate the safe use of digestate and employ the INMAP to provide guidelines for its usage.

Organic fertilisers partially or entirely derived from animal manure through anaerobic digestion, known as digestate, represents a key tool to substitute synthetic/inorganic fertilisers, increase on-farm circularity and make food systems resilient as they depend on locally available resources while preserving the environment and waters in Europe. In line with the objectives of the EU Green deal, digestate contributes to recycling nutrients, increasing resource efficiency and when managed adequately, avoids nutrients losses and maintains soil fertility.

In the framework of the INMAP, we urge the Commission to:

• allow for a temporary exemption from the Nitrates Directive limit, in the short term, so that the safe use of digestate is allowed above the limit of 170 kg N $ha^{-1}y^{-1}$.

• propose a revision of Annex III of the Nitrates Directives to allow for a permanent exemption of digestate from the Nitrates Directive limit in the medium term. The Expert group on the implementation of the nitrates Directive or a dedicated expert group should propose a set of guiding agronomic practices to mitigate any potential environmental risks.

It must be noted that digestate is the resulting product of a controlled biological process of anaerobic digestion whose purpose is the transformation of the easily fermentable organic fraction into biogas. The biological transformations carried out by the bacteria also determine profound modifications of the substrates subjected to the biological process, the result of which is a biologically stable matrix with excellent soil improver and fertiliser properties.

Digestate cannot be compared or assimilated with livestock manure for the following reasons:

- Anaerobic digestion is a biotechnological process that deeply transforms zootechnical effluents into another product.

- Livestock manure – unlike digestate – still contains fermentable fractions that, by degrading in the soil, can lead to the partial mineralization of organic nitrogen with a risk of nitrate leaching.

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- The fertilising effects of digestate are specific: digestate contains stabilised organic matter, whose carbon-to-nitrogen ratio (C/N) is generally very close to soil organic matter as well as ammonia which is a readily available source of nitrogen for plants. With the application of a specific amount of digestate, calibrated to the nitrogen need of the crop, comes a positive net environmental balance since the nitrogen content of digestate is about 90% efficient. This efficiency reduces the risk of nitrate leaching into groundwaters to a minimum.

Link to the document: https://www.nutri2cycle.eu/wp-content/uploads/2023/06/Open-Letter_Digestate-in-INMAP.pdf

2.1.4. Joint position paper on the safe use of RENURE products in the INMAP

Unlocking the safe use of RENURE products in the INMAP: an opportunity for nutrients recycling and on-farm circularity

The cosignatories include COPA-COGECA, which represents over 23 million farmers and 22,000 agricultural cooperatives, the European Biogas Association, which represents nearly 8000 stakeholders from the biogas and biomethane value chain in Europe, as well as four European projects focusing on nutrients recycling and alternative fertilisers – Nutri2Cycle, NOVAFERT, FERTIMANURE and NUTRI-KNOW.

The need to reduce dependency on nitrogen fertilisers by diversifying the sources of fertilisers and developing the supply of sustainable fertilisers has gained urgency following Russia's war on Ukraine. Using fossil-free, low-carbon, recycled nutrients to produce organic fertilisers will also accelerate the decarbonization pathway to a net-zero Europe. These challenges were outlined in the communication of the Commission on Safeguarding food security and reinforcing the resilience of food systems from November 2022 as well as in the resolution of the European Parliament on the availability of fertilisers in the EU from February 2023. Yet, to date, RENURE ('Recovered Nitrogen from manure'; term and criteria as initially proposed by the European Commission) products face a major barrier in the 32 years old Nitrates directive and the market of these sustainable fertilisers struggles to develop due to a lack of legal certainty. Nonetheless, RENURE products have the potential to significantly replace synthetic/inorganic nitrogen fertilisers as produced based on natural gas, thereby improving both the environmental impact as well as economic and geopolitical self-reliance.

In the framework of the upcoming publication of the Integrated Nutrient Management Action Plan (INMAP), we call on the Commission to allow and facilitate the safe use of RENURE products and employ the INMAP to provide guidelines for their usage in addition to the compositional criteria as previously proposed by the European Commission (yet never implemented upon their initial proposal).

Organic fertilisers partially or entirely derived from animal manure through processing, known as RENURE, represent a key tool to substitute synthetic/inorganic fertilisers, increase on-farm circularity and make food systems resilient as they depend on locally available resources while preserving the environment and waters in Europe. In line with the objectives of the EU Green deal, RENURE products

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contribute to recycling nutrients, increasing resource efficiency and when adequately managed, avoid nutrients losses and maintain soil fertility.

In the framework of the INMAP, we urge the Commission to:

• allow for a temporary exemption from the Nitrates Directive limit, in the short term, so that the safe use of RENURE products is allowed above the limit of 170 kg N $ha^{-1}y^{-1}$, based on the RENURE criteria developed by the JRC.

• propose a revision of Annex III of the Nitrates Directives to allow for a permanent exemption of RENURE products from the Nitrates Directive limit in the medium term. The Expert group on the implementation of the nitrates Directive or a dedicated expert group should propose a set of guiding agronomic practices to mitigate any potential environmental risks.

Today, there are still a lot of misunderstandings regarding the application of RENURE products. Emphasizing the fact that 90% of organic manure can be applied immediately, or that there can be a risk of additional ammonia emissions is true but irrelevant. Multiple streams with different contents of nitrogen, phosphorus and other minerals such as potassium are created from the processing of classic animal manure. To this end, a more targeted fertilization, tailored to crop and plant needs, is possible in a similar way to precision application of synthetic/inorganic fertilisers. Moreover, the treatment process allows a better recovery of ammonia in manure so that extra nitrogen fertiliser is ultimately available for the crops from the manure.

RENURE is made by extracting the emitted ammonia and converting it into organic precision products. This process can happen in the barn or in a digester. Therefore, a reduction in ammonia emissions is already taking place. The manure is then further processed and remains integrally available to ensure fertilisation in the organic manure proportion. Thus, the conclusion is unmistakable:

- The basic fertilisation remains virtually the same although after treatment it concerns modified products which can be targeted more efficiently.

- The RENURE product obtained reduces ammonia emissions in the process, thus generating additional nutrients and having the same characteristics as fertilisers (able to replace synthetic/inorganic fertilisers and thus usable for precision farming).

- When applying RENURE products, there is a risk of increased emissions compared to synthetic/inorganic fertilisers application (as underlined in the Safemanure report by the Joint Research Centre). Nevertheless, there are available and currently applied techniques to avoid emissions and one cannot ignore the avoidance of emissions earlier in the process when producing such fertilisers.

Facilitating the use of RENURE products is therefore not about applying extra manure, but about replacing synthetic/ inorganic fertilisers in a sustainable, circular way, while at the same time avoiding ammonia emissions and also generating energy.

Link to the document: https://www.nutri2cycle.eu/wp-content/uploads/2023/06/Open-Letter_RENURE-in-INMAP.pdf

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2.1.5. EC's public consultations

2.1.5.1. Nutrients – Action plan for better management

H2020 Project Nutri2Cycle welcomes the European Commission's commitment to draw up an integrated nutrient management action plan to help reduce nutrient losses by at least 50%, reducing the use of fertilisers by at least 20%. while ensuring that there is no deterioration in soil fertility and stimulating the market for recovered nutrients. An integrated nutrient management plan should adopt a systemic approach, tackling misalignments with the Circular economy actions Plan. Currently, the use of mineral nitrogen (N) fertilizers in the European Union (EU) agricultural sector corresponds to 10.2 million tons of N consumed in 2018, increased compared to 10 years before. Mineral fertilizers are energy intensive; with synthesis of NH3, based on the Haber-Bosch process being responsible for about 2% of the world's energy consumption and 2.5% of the global fossil-fuel-based carbon dioxide emissions.[14]

The concept of a circular economy highlights the importance of nutrient recovery, and aims at preventing environmental impacts such as soil acidification and eutrophication of water bodies, and release of greenhouse gases (GHG). The Fit for 55 includes EU-wide binding targets to cut GHG emissions by at least 55% and increase the share of renewable energy by at least 40% in the final consumption by 2030. Anaerobic digestion (AD)—which produces renewable power, heat, and fuel from organic waste—will to play a key important role in achieving the goals. However, AD will also play a crucial part in the sustainable management of organic waste streams such as manure by simultaneously providing renewable energy, closing nutrient loops, and reducing GHG emissions.

Digestate, a co-product of biogas production used as organic fertiliser, has the potential to transform Europe's agricultural sector offering an alternative to commonly used chemical fertilisers. such as nitrogen, are fully preserved in the AD process.

The adoption of the new Fertilising Products Regulation (FPR) ((EU) 2019/1009) includes organic and waste-derived fertilisers under the EU internal market. However, FPR is a product regulation and in itself does not consider limitations or constraints on product application. More specifically, under the current definitions of the Nitrates Directive, those products derived from processed manure retain the legal status of animal manure, including the restrictions that come with it such as the current limit of 170 kg N $ha^{-1}y^{-1}$ in Nitrate Vulnerable Zones applies to any fertilising product derived from livestock manure. Consequently, this threshold negatively impacts the use of bio-based fertilising materials such as digestate based on (co-)digested animal manure, although this often bears no resemblance to the manure from which their nutrients were extracted, as they can contain high amounts of mineral N (Nmin), effectively bringing them closer to chemical fertilisers in terms of plant nutrient uptake. As regulation was not updated with the latest technical advancements, farmers tend to top up with

[14] Saju et al (2022) Digestate-Derived Ammonium Fertilizers and Their Blends as Substitutes to Synthetic Nitrogen Fertilizers

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energy-demanding chemical fertilisers as a result of the 170 kg N $ha^{-1}y^{-1}$ limit not meeting most crop requirements.[15]

Nutri2Cycle urges the European Commission to address the anachronistic requirements of the Nitrate Directive and allow digestate and recovered fertilizers to actively reduce the utilisation of chemical fertilisers, effectively closing the nutrient loop and enabling carbon storage. Nutri2Cycle is concerned that the Nitrates directive makes no distinction and defines livestock manure under article 2(g) as: "waste products excreted by livestock or a mixture of litter and waste products excreted by livestock, even in processed form". This implies that all digestate from animal manure origin retains the status of animal manure in spite of its new "processed form" which increases nutrient use efficiency. The Nitrates Directive in its current form is based on the same definitions and wording (including Art. 2(g)) and does not take into account three decades of research & innovation and the technical advancement that allows manure refinery (a.o. via anaerobic digestion as key enabling technology) into fertilizing products that can act as technical alternatives to synthetic chemical fertilisers produced based on fossil resources (in casu, natural gas used to produced N synthetic fertilisers using the Haber-Bosch chemical process). The land application of organic materials needs to be carefully managed to maximize their crop available nutrient value and minimize their impact on the wider environment. Studies demonstrate that NH_3 emissions are on average lower for digested than untreated slurry due to a lower dry matter contents that increase the infiltration rate. N_2O losses are also generally lower when using digestate rather than raw slurry.[16]

Moreover, the role of digestate as a contributor to soil organic carbon (SOC) build up should be considered[17]: organic matter in digestate can build up the humus content in the soil; this is a benefit unique to organic fertilisers which is particularly crucial for arid and semi-arid lands with low carbon content.[18]

Link to the document: https://www.nutri2cycle.eu/wp-content/uploads/2022/05/Nutri2Cycle_nutrients_feedback_26April2022-1.pdf

2.1.5.2. EU Soil Health Law for protecting, sustainably managing and restoring EU soils

H2020 Nutri2Cycle welcomes the call for evidence of the European Commission for the impact assessment of the Soil Health Law (SHL).

Current production of biogas and biomethane is 4.5 % of the natural gas consumption. By 2030, biomethane must double[19] and by 2050 it could supply 30-40 % of our gas demand[20]. Compost and digestate are produced annually in Europe and are projected to grow with the expansion of

[15] Reuland et al (2021) The Potential of Digestate and the Liquid Fraction of Digestate as Chemical Fertiliser Substitutes under the RENURE Criteria
[16] Chantingy (2007) Gaseous Nitrogen Emissions and Forage Nitrogen Uptake on Soils Fertilized with Raw and Treated Swine Manure
[17] Reuland et al. (2022) Assessment of the Carbon and Nitrogen Mineralisation of Digestates Elaborated from Distinct Feedstock Profiles
[18] https://www.europeanbiogas.eu/wp-content/uploads/2019/07/Digestate-paper-final.pdf
[19] COM(2022) 108 final
[20] EBA's Statistical Reports 2021

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biomethane production and swift implementation of separate collection of biowaste (BW) from households.

The German Biogas Association[21] accounted 128 million tonnes of digestate were produced in Europe in 2018. This figure includes a large feedstock base, comprising not only materials from separate collection but also manure and crop residues. The market for recycled fertilisers can grow to 67% of the total fertiliser market by 2050[22].

Organic fertilisers and soil improvers (OF&SI) are very important mineral fertilisers substitutes that provide stable organic carbon which helps to maintain and in replenish the content of soil organic matter (OM). This recycled OM delivers a diverse range of micro-organisms that form an essential part of a healthy soil ecosystem.

Soil that are low in OM are less productive, retain less water and store less carbon. Soils with low levels of OM can be improved by regular applications of OF&SI. On the contrary, OM rich soils improve the N use efficiency, i.e. less N is needed to obtain a given potential crop yield[23]. Their correct use in agriculture will reduce the need for nutrients in the first place and the subsequent losses. Ratios of DOC:TOC are reliable predictors of the stored carbon one year after digestate incorporation and thus could be used as simple quality parameters to denote the C sequestration potential of digestates prior to their use in the field[24].

Nutri2Cycle welcomes the exploration of measures that can contribute to reducing nutrient losses by at least 50% without deterioration in soil fertility (resulting in the reduction of fertiliser use by at least 20%) in the impact assessment. It is suggested to assess the impact of a target on soil organic carbon minimum annual concentration in agricultural soil, supported by resources for farmers to carry out such monitoring.

Next to the target, an EU scheme of carbon-crediting linked to carbon farming is needed. Carbon stocking has a value not only to reduce pollution but also to climate mitigation. The SHL could contribute to climate objectives and ensure policy coherence. The value of climate actions should be converted via carbon crediting into incentives[25].

We expect that linking the target to the existing obligation of BW separate collection will generate the following impacts:

- Sequestering from 1.32 to 4.7 Mt CO_2e a year[26]
- Creating 1 job per 1380 tonnes of BW in rural areas and 1 job per 4500 tonnes in urban areas[27]
- Increasing the available water capacity by 38 cubic meters per hectare in the top 0-30 cm of soil. This is equivalent to 3.8 litres of water over one square meter of soil (in the top 0-30 cm horizon)[23]

[21] https://www.biogas.org/edcom/webfvb.nsf/id/BJHCPA-DE-Digestate-as-Fertilizer
[22] https://publications.jrc.ec.europa.eu/repository/handle/JRC123532
[23] Schjønning (2018) Chapter Two - The Role of Soil Organic Matter for Maintaining Crop Yields: Evidence for a Renewed Conceptual Basis
[24] Reuland (2022) Assessment of the Carbon and Nitrogen Mineralisation of Digestates Elaborated from Distinct Feedstock Profiles
[25] Not doing biogas first but spreading on land 'as is' (e.g. raw manure) results in mineralization of the rapidly degradable OC – turning this in CO2 emissions. So setting up schemes in which residues are passed over biogas before brining to land result in a better overall balance.
[26] https://www.iswa.org/biological-treatment-of-waste/?v=d3dcf429c679
[27] https://www.compostnetwork.info/policy/circular-economy/bio-waste-generates-jobs/

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• Preventing that a decrease by 1% in soil organic content will require an increase by 7000 tonnes of nitrogenous fertilisers[28]

Link to the document: https://www.nutri2cycle.eu/wp-content/uploads/2022/03/N2C_briefing_soil_health.pdf

3. Roadmap for further discussions with stakeholders

In order to prolong the impact on policy formation, Nutri2Cycle is one of the key founding projects that initiated the European Sustainable Nutrient Initiative (ESNI). This is an open-forum and free-of-charge community that spun out of the Biorefine Cluster Europe (www.biorefine.eu). ESNI annually organizes a summit in Brussels, with strong inclusion of European Commission officials from DG RTD, DG GROW, DG AGRI, DG ENV, REA etc.

In 2022-2023, ESNI also initiated further Community activities comprising 4 dedicated working groups, each led by one of the nutrient oriented projects : (I) Technology, (II) Sustainability assessment, (III) Agronomy, (IV) Policy. The Policy WG was moderated by the Nutri2cycle project and at the ESNI event in September 2023, the chairmanship of this WG was transferred to the INTERREG Renu2Cycle project. Therefore the nutrient recycling policy orientation is guaranteed to continue also after the Nutri2Cycle project, having successfully launched an impact-beyond-the-project strategy in terms of policy orientation.

The Nutri2Cycle partners, with UGent predominantly are also involved in supporting follow-up initiatives such as the Policy Roundtable at the Manuresource Conference in 2024 (oriented around manure).

Moreover, Nutri2Cycle has been approached both by end-users (agricultural associations, companies and EC policy makers) on further development agenda, including policy. For instance, an important development is that the EC-industrial partnership BIP (Biomethane Industrial Partnership) has asked for concerted action on nutrient and organic carbon recycling via biogas operations and digestate. The strategy being laid out for 2024 is to organize a range of top-level workshops and webinars with a dual goal: (i) develop an R&I needs agenda from the perspective of nutrient recycling related to digestate, (ii) develop a policy-driven agenda towards implementation and stimulation of nutrient recycling using biogas biorefinery as a key-enabling technology. The overall action on this will result in a co-created Report together with the EC in the first half of 2024. Also, a joint physical meeting in Brussels across different running EU projects to discuss implementation hurdles and needs based on this report is foreseen in the first half of 2024 (most likely June 2024). The ESNI (co-founded by Nutri2Cycle) has been proposed to take a key supporting role in this overall development.

Finally, Ghent University is involved in a number of follow-up projects building on the Nutri2Cycle project, including as lead partner of Novafert (CSA) and NutriBudget (RIA) projects as well as being the Policy WP leader for the INTERREG Renu2Cycle project. This as well ensure continuation of the policy

[28] Brady (2015) Valuing Supporting Soil Ecosystem Services in Agriculture: A Natural Capital Approach

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agenda building on the recommendations produced during the course of the operational stage of the Nutri2Cycle project itself.

4. Conclusions

The policy recommendations depicted in this final policy report supports one of the major expected impacts of Nutri2Cycle "Integrated scientific support for relevant EU policies" and helps to achieve the milestone "MS10 - White book of sustainable farms and policy briefs resulting from project research are published'. These recommendations were the result of three different pathways: (i) based on the CAPRI and MITERRA modeling the NUTRI2CYCLE project made a quantified prediction on the possible impact of mitigation measures, (ii) responding with substantiated expert opinions on the public consultations that the European Commission had organized and (iii) bottlenecks perceived blocking some of the high-potential mitigation measures. For the latter two pathways towards recommendations, also interlinkages were made with other European projects resulting in joint statements.

On the advice based on the modelling within the project – we clearly observe a high potential for farm-scale anaerobic digestion with benefits both at the level of GHG mitigation and nutrient household (by increased nutrient use efficiency). The use of crop, soil and fertilizer sensors in order to move towards more precision agriculture – and hence reducing losses – also offers great potential which can help reconcile intended reduction of overall fertilizer use by 2030 (as taken up in the EU Green Deal) while maintaining productivity in terms of crop yield. Manure treatment and upcycling towards synthetic N-fertilizer offers a third recommendation flowing from the collective work of the Nutri2Cycle consortium and the expected impact it could generate. A reduction in animal feed import into Europe and a return to more local circularity in terms of locally grown protein sources (including on agro-residues) has also been indicated as an point of attention. Finally, although not in the scope of Nutri2cycle itself, the CAPRI model also indicates the high potential and need for Europe to also invest in dietary shifts of European citizens (reducing the share of meat and dairy compared to that of plant-based nutrition).

On the recommendations flowing from the experimental work – these of course followed suit with the abovementioned recommendations based on modeling. Policy briefs have been drafted addressing several identified bottlenecks in regulatory frameworks, including the Nitrate Directive (or interpretation thereof) and the INMAPs. In particular, observed barriers towards implementation of RENURE in follow-up of the recommendations issued by the JRC (under mandate by the EC-DG ENV) and the fact that state of European legislation is lagging behind on the state-of-technology is causing frustration amongst stakeholders willing to invest in making agriculture more sustainable. Also the benefits of digestate as a category of more efficient and beneficial fertilizing product (as well as derivatives from digestates) has been highlighted in policy briefs, offering improvement over application of raw animal slurries or manure products.

Finally, Nutri2Cycle provided substantiated expert opinion to the European Public Consultations related to Nutrient management action plans as well as the pending Soil Health Law. These are both

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regulatory frameworks in full developments and our understanding is that projects building further on Nutri2Cycle will follow through on these developments.

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