



Report on communication and dissemination activities and outcomes

Deliverable 8.6 – D40 - WP8

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OPTIMISING BIO-BASED FERTILISERS IN AGRICULTURE – PROVIDING A KNOWLEDGE BASIS FOR NEW POLICIES

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Deliverable 8.6 – D40

Work-package n°8

Nature of the deliverable		
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Dec	Websites, patents, filling etc.	
Dem	Demonstrator	
O	Other	

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PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	



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LEX4BIO aims to reduce the dependence upon mineral/fossil fertilisers, benefiting the environment and the EU's economy. The project will focus on collecting and processing regional nutrient stock, flow, surplus and deficiency data, and reviewing and assessing the required technological solutions. Furthermore, socioeconomic benefits and limitations to increase substitution of mineral fertiliser for BBFs will be analysed. A key result of LEX4BIO will be a universal, science-based toolkit for optimising the use of BBFs in agriculture and to assess their environmental impact in terms of non-renewable energy use, greenhouse gas emissions and other LCA impact categories. LEX4BIO provides for the first-time connection between production technologies of BBFs and regional requirements for the safe use of BBFs.

The project runs from June 2019 to May 2024 (Amendment for 12 months extension from February 2021). It involves 20 partners and is coordinated by Luke (Luonnonvarakeskus - Natural Resources Institute Finland).

More information on the project can be found at: <http://www.lex4bio.eu>



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D8.6: REPORT ON COMMUNICATION AND DISSEMINATION ACTIVITIES AND OUTCOMES

I. INTRODUCTION

This deliverable reports on the communication and dissemination (CD) activities that were conducted throughout the lifetime of LEX4BIO project, which was launched on 1st of June 2019 and ended on 31st of May 2024. It is a throwback to the numerous undertakings of all partners from the consortium to achieve the general communication and dissemination objectives of the project, defined at the outset as follows:

- To inform and raise awareness about the project and its results by communicating about events and relevant work progress to all pertinent stakeholders.
- To disseminate project outputs to relevant stakeholders and potential end-users thus engaging them with the project's activities and long-term impact.
- To increase project's visibility and knowledge exchange by clustering and creating synergies with relevant EU and national projects on nutrient recycling.
- To ensure exploitation of project results and follow-up of the potential outcomes through policies and implementation.

All CD activities that were implemented during LEX4BIO duration adhered to the Communication, dissemination and exploitation plan (D8.1), which was updated three times after its initial version, namely, in December 2020, December 2021 and May 2023.

II. DISSEMINATION, EXPLOITATION AND COMMUNICATION PLAN, COMMUNITY MANAGEMENT AND NETWORKING

Dissemination and Communication activities play a key role within LEX4BIO project to foster an impact towards stakeholders' acceptance and policy support of BBFs at the EU level as well as for the sustainability of the results post project's end. Being the reference document for all dissemination, exploitation and communication (DEC) implementation, the initial DEC plan (D8.1) was prepared and submitted by M6 to comprise planned communication and dissemination activities along with their timeline so that the objectives of WP8 were achieved. It framed the delivery of the extensive communication effort by answering the questions below:



- What do we want to say? **Messages**
- Who do we want to reach? **Audience**
- How are we reaching our audience? **Channels**
- When, where, how and to whom are we presenting results? **Dissemination Strategy**
- How do we plan to make use of the results? **Exploitation framework**

2.1. Target Audience, Messages and Channels

Table 1. Target Audiences

Target audience	Indicator	Activities implemented	Channels used
EC & national decision-making bodies, regulatory bodies	20	<p>Recommendations on actions, programmes and communication</p> <p>Policy Roadmap (D8.5)</p> <p>Specific presentations during seminars and international events, including policymakers</p> <p>Project mentions in non-scientific media outlets</p>	<p>i) Conferences, seminars</p> <p>ii) Dedicated publications</p> <p>iii) Webinars</p>
End-users (farmers, consumers)	5 000	<p>Workshops & special content easily understandable as online information materials</p> <p>Visits to demonstration sites and field days (at least once during the project)</p> <p>Popular articles at national and local level</p>	<p>i) Events, meetings</p> <p>ii) Newsletters</p> <p>iii) Popular articles, media actions</p>
Scientific community	100	<p>At least 15 publications on the methodology, approach, solutions and results in peer-reviewed, international journals</p> <p>Participation in conferences and fairs</p> <p>20 universities and 100 academics contacting regarding the project results</p> <p>Cooperation with other ongoing projects</p>	<p>i) Forum, conferences, fairs</p> <p>ii) Scientific publications</p>



Industry	150	<p>Interaction through NDF, contact with companies involved in fertilisers, biofertilisers, environmental protection and food safety</p> <p>Information and input to industries' own channels</p> <p>15 stakeholders per country reached</p>	<p>i) Fairs, market exhibition</p> <p>ii) Dedicated publications, news</p> <p>iii) NDFs & workshops</p>
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Project general messages

Bio-Based Fertilisers (BBF) have the potential to transform the agricultural industry by minimising the environmental impact of existing fertilisers and improving sustainability through recycling of nutrient-rich side-streams (NRSS)

Increased productivity of European agriculture after the Second World War was largely based on the use of mineral fertilisers, without considering its impact on the environment. Only in recent decades, protection of biosphere and food quality have gained more attention, both of which are heavily dependent on fertiliser application rate, fertiliser quality, as well as soil characteristics. Imported mineral phosphate and fossil energy-intensive nitrogen fertilisers cause major detrimental impacts on the environment, whilst nutrient-rich side-streams/organic waste remain under-used. By optimising usage of BBFs from side-streams, ensuring their safety, building evidence-based trust in their usage and developing legislative framework for their use, it will be possible to reduce dependence upon mineral/fossil fertilisers, benefiting the environment.

LEX4BIO enables the development of a profound knowledge basis and new coherent methods to take full advantage of BBFs

LEX4BIO will evaluate the fertilisation potential and other properties against national and EU fertilisation requirements of the most promising technologies for BBF production. This will provide essential tools for closing European nutrient cycles and contribute to ameliorating the impact of fertilisation on the environment.

LEX4BIO provides the basis to provide a policy framework for the EU's transition to maximising fertiliser self-sufficiency by using BBFs

LEX4BIO evaluates BBFs across different climatic and soil conditions across the EU for maximising the agronomic efficiency of BBFs in different regions while ensuring food and feed safety, human health protection and minimising environmental losses.



2.2. Key words and phrases for communication

Identifying the key words and phrases (Fig. 1) that were used in all communication was pivotal for granting higher visibility and findability of the project and its research subject area, as it was discoverable upon searches of specific hashtags or communication threads.

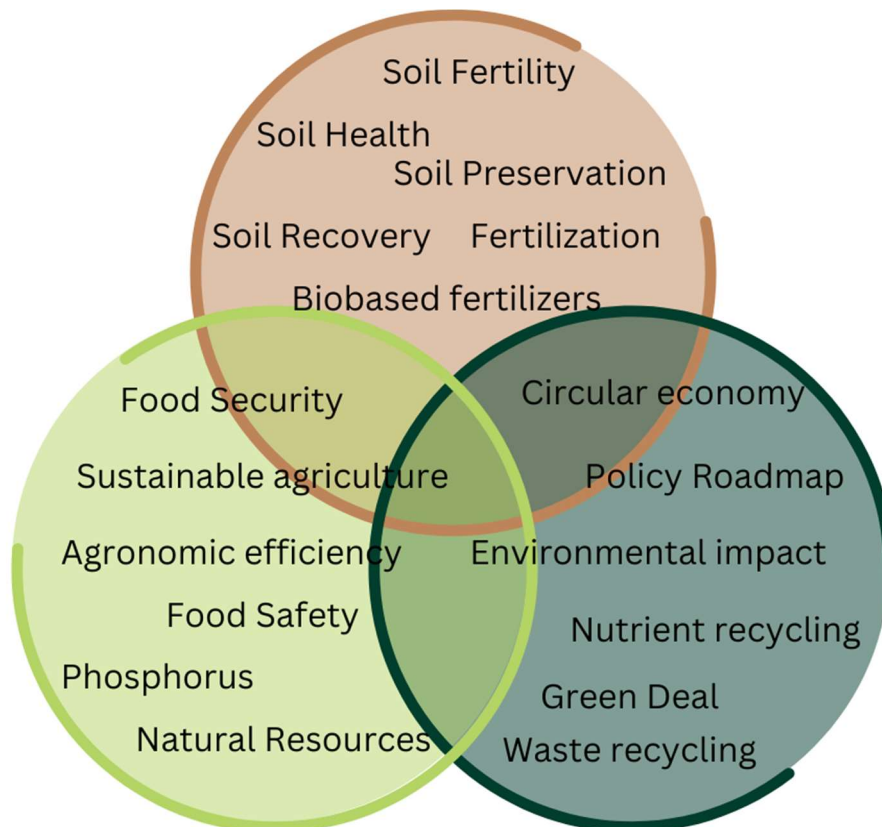


Figure 1. Key Words and Phrases

2.3. Communication and Dissemination best practices

LEX4BIO communication and dissemination strategy was based on a set of criteria that partners adhered to in order to maximize the impact of the project. The following best practices (BP) were shared with partners as guiding principles and continued to be in effect until the project's end:

BP1 – CREATE AND PROMOTE APPEALING INFORMATION BASED ON SPECIFIC CONTENT

As a research project, LEX4BIO delivers high amount of content, which should be shared to the different stakeholders. Depending on the different target groups' vested interest in the project, the communication and dissemination activities are tailored to their specific needs, channels and tools selected. Each item is based on relevant information derived from scientific data and results, especially as it regards the local and national dissemination activities, such as NDFs for example. Messages should



be clear and in line with project objectives, the interest of the audience and the overall goal of LEX4BIO to contribute to BBFs acceptance at large.

BP2 – COMMUNICATION & DISSEMINATION CHANNELS CORRESPONDING TO THE MESSAGE AND STAKEHOLDERS' EXPECTATIONS

The selection of CD channels and medium should be accommodated to the format of the delivered content as well as the audience behavior and expectations for the respective channel. Depending on the message, we should decide on the media outlet that could be used so that our goals are achieved at the desired level of performance.

BP3 – USE OFFICIAL COMMUNICATION MATERIALS FOR YOUR DEC ACTIVITIES

All tools and communication materials introduced in the Plan and in D8.2 “Portfolio of communication materials and the general project website” (M6) are shared, commented and validated by all partners. They constitute the media corner of LEX4BIO and should be used as a communication and dissemination baseline, to provide official content and complete specific technical presentations with more general information on the project itself.

BP4 – SHARE PUBLICATIONS WITH THE CONSORTIUM BEFORE PUBLISHING

LEX4BIO partners, in accordance with the Consortium and Grant Agreement (GA), have agreed on a specific notice process regarding publications, at least 30 calendar days before effective publishing. Any objection shall be made in accordance with the Grant Agreement, in writing form to the coordinator, the Parties and Europroject.

BP5 – ENRICH YOUR COMMUNICATION WITH ON-FIELD EXPERIMENT AND CONCRETE RESULTS

As a research project, LEX4BIO relies on technical and scientific terms and content. However, its main impact will be linked to the understanding of the project objectives by the whole value chain related to BBFs, from policy makers, to industries towards the final users as farmers and consumers. Hence, communication materials are adapted to a layman language through the employment of the principles of storytelling (add personal experiences and anecdotes to create perceived proximity between the narrator and their readers or listeners).

BP6 – FOLLOW THE ROADMAP AND AGENDA FOR COMMUNICATION

While defining the communication strategy, the frequency of publications, activities and events as well as the individual strategies have been aligned with the DEC plan. It is of major importance that partners commit to the plan and anticipate the needs in terms of content drafting, validation process and notice prior to publication.

2.4. Communication Tools and Activities

The visual identity of the project was established by Europroject from the very start of the action with the design of the logo, templates, branding colors, fonts and rules for the EU acknowledgment to be published in all informational and promotional materials. **The logo** was the main graphic identity element and the key to building a successful branding. It was used in all materials and documents



related to the project. The logo was designed and presented prior to the Kick-off Meeting by Europroject. Different variations were presented to the partners to select the most appropriate version. The official logos of LEX4BIO, in colour, and in black and white were made available to all partners in the shared repository Tiimeri. The branding of LEX4BIO was made openly accessible through the deliverable **“Portfolio of communication materials and the general project website” (D8.2)**, available on the website.



A total of **two brochures** were designed and developed by EP, with the contribution of all partners.

The first brochure was released in M3 and presented the overall ambition of the project (Fig. 2). It was designed in English, German and Polish to meet partners’ needs. Its architecture included: i) basic project information and key figures, ii) project objectives, iii) project expected results, iv) the partnership and v) contact information. It was made available in two versions:

- web version developed for email and on-line communication campaigns, in a flyer format, 2 pages
- print version specifically developed for distribution at project events, information days, conferences, seminars and exhibitions.



Figure 2. Web version of the brochure

The second brochure was developed and designed as an e-booklet during the second half of the project, post M30, and featured key LEX4BIO outputs to trigger engagement of interested



stakeholders, to maximize impact (Fig. 3). It featured results dedicated to the assessment of phosphorus demand in European agricultural soils based on the Olsen method and the potential ammonia volatilization from 40 different novel biobased fertilisers on the European market.

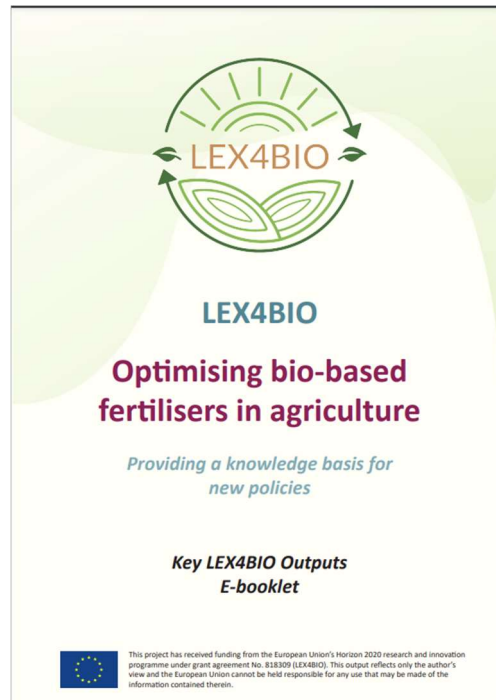


Figure 3. LEX4BIO e-booklet with results

LEXBIO website was conceived as the project's main public interface. It functioned as i) a platform to collect and provide accurate information, news and outcomes regarding LEX4BIO and its results, ii) a database for the international stakeholders to find useful information and content on BBFs and nutrient recycling and iii) a reference for our project partners to communicate about the project. The website was launched in M6 and was continuously maintained and updated throughout the project's lifetime.

In September 2022, the website was modified and optimised to become more user-friendly by providing access to sought by the visitor information with the least number of clicks. The Sections were broken down to smaller logical pieces of content and the user experience was improved by adding links where they were missing and deleting duplicating information, with News and Events, and Newsletters, in particular. The Newsletters were moved to the renamed Media and Communication Section (Fig. 4).



Figure 4. Optimised website architecture

A new subsection, Reports, was added to Results. All public and approved deliverables of LEX4BIO were also hosted under Results. In June 2023, a new Blog section was created under Media and Communication where we published 3 blog posts contributed by partners, related to the research results obtained within the project and affirming LEX4BIO as an expert voice in the field of agronomic performance and soil nutrient recycling. In addition to the blog posts, for the duration of the project a total of 46 news pieces were posted, 17 scientific publications, 7 conference posters and 2 reports.

WP8 conducted a communication campaign supporting WP7’s LEX4BIO Survey dedicated to identifying the crucial drivers and barriers regarding the replacement of conventional fertilisers by BBFs. A dedicated landing page was created on the website, social media posts linked to the Survey on the website and an email campaign to LEX4BIO subscribers.

LEX4BIO final events received broad coverage on the website with banners being added to the Home page and news posts created, which were reposted on social media.




The web address of the website is www.lex4bio.eu and it is more specifically described in deliverable D8.2 “Portfolio of communication materials and the general project website”.

EP created and had continuously maintained LEX4BIO **online communication channels and social networks** on Facebook, LinkedIn and Twitter, by sharing information about the latest developments as well as updates about project related events. This activity ensures the visibility of the project and enhances the interaction and community building with the project’s audience groups, to include sister projects and partners’ organizations. Types of news and announcements that have been communicated to the public via these channels pertain to NDFs, field days, interviews, webinars,



project presentation at conferences, other projects' meetings and conferences, and various progress activities.

LEX4BIO total number of followers on social networks, gained throughout project's lifecycle, are shown below. The statistics regarding number of posts is available for the period M30 – M60, as follows:

-  LinkedIn - 442 followers, 178 posts
-  Twitter – 532 followers, 201 posts
-  Facebook – 102 followers, 79 posts.

Earned media – invaluable additional publicity and exposure of LEX4BIO project and its work results was attained through **popular science articles** and other types of content that appeared in magazines and platforms in accordance with the partners' network of contacts, targeting public authorities, industry and end-users:

1. Natural Resources Institute Finland – Luke's senior scientist Kari Ylivainio was invited as special guest in the "Tackling the fertilizer crisis" episode of Food for Europe podcast. <https://lnkd.in/dRStjZ3Y>
2. Universidad de Sevilla featured an important research output of LEX4BIO, a result of the research done by our partner Professor Antonio Delgado and team who have proposed a simple model for identification of agricultural lands where crop yields will improve with phosphorus fertilisation – work resulting in the publication of a scientific peer-reviewed paper in the prestigious Journal of Cleaner Production. <https://lnkd.in/dUGQs2r4>
3. LEX4BIO partner and soil scientist Elke Bloem from Julius Kuhn Institut, Germany was interviewed by the German TV program WISO on biobased fertilizers and how to fertilise private garden best. LEX4BIO project analysed a set of different BBFs of different origin and processing for different contaminations. These activities caught the attention of the TV team who were interested to learn which BBFs were advisable to be used in private gardening and what were the advantages in relation to mineral fertiliser.
4. A popular science article dedicated to LEX4BIO was published by LUKE on their website – <https://www.luke.fi/en/news/luke-in-the-forefront-accelerating-efficient-and-safe-use-of-recycled-fertilisers-in-europe>
5. An article about the German field day organised by Julius Kühn Institut in the spring of 2023 was published in the German farmers newspaper "Lohnunternehmen" with a readership of 5700 people.
6. A Danish version of the blog article "New biobased fertilisers with high fertiliser efficiency" produced by Lærke Wester Larsen, Dorette Sophie Müller-Stöver and Lars Stoumann Jensen, UCPH, with the support of WP4 colleagues, for LEX4BIO website was also published in the farmer magazine 'Mark' LandbrugsAvisen (Danish Agricultural News), with a reach of around 4000 subscribers.

Additionally, news about the project were regularly published in the **Scope Newsletter of the European Sustainable Phosphorus Platform (ESPP)**, reaching over 40 000 subscribers, mostly in Europe. LEX4BIO first introduction (<https://phosphorusplatform.eu/scope-inprint/news/1875-new-espp-member-lex4bio>) was followed by sharing the results of a scientific article (Ylivainio et al. 2021,



<https://doi.org/10.1016/j.scitotenv.2021.145618>) in the Scope newsletter No. 52: <https://phosphorusplatform.eu/scope-in-print/enews/2054-essp-enews-no52-march-2021>.

LEX4BIO kept finding place in the Scope Newsletter (<https://phosphorusplatform.eu/scope-in-print/news/1875-new-essp-member-Lex4Bio>) with the conferences it participated in, abstracts of its scientific publications, and also as contributor to important policy and regulatory making in the field of nutrient recycling and circular bioeconomy, like for example in the Proposed ESPP position paper on the definition of “Bio-Based Fertiliser”. LEX4BIO Survey (<https://phosphorusplatform.eu/scope-in-print/enews/2370-essp-enews-no-74-march-2023>) was promoted in the Scope Newsletter too, as well as on ESPP LI- and X- accounts.

EIP-AGRI: LEX4BIO information was published on the EIP-AGRI database (<https://ec.europa.eu/eip/agriculture/en/find-connect/projects/optimising-bio-based-fertilisersagriculture>).

LEX4BIO is a member of the **Biorefine Cluster Europe** and the projects’ results, such as deliverables, scientific papers and reports have been disseminated through the **Biorefine Cluster bulletin and on their website**, featuring LEX4BIO work with 15 posts including press releases and some deliverables and scientific publications generated during the project’s lifetime. LEX4BIO continued to receive cross-communication support by the Biorefine Cluster Europe and the ESPP through their social channels as well, though sharing important milestones reached by the project, events attended or organized as well as abstracts of scientific publications revealing more of the projects’ results obtained from all of its research areas.

Press releases - three press releases were produced to announce important milestones of the project. The first press release announced the project’s lunch in June 2019. The second was released in in June 2023, informing on key outcomes of the project related to the evaluation of Nitrogen (N) and Phosphorus’ (P) demand in Europe across varying soil and climatic conditions. The third press release was entirely dedicated to the final conference NERM held in Brussels, Belgium and was released in May 2024. <https://lex4bio.eu/press-releases/>.

- I. **Scientific publications:** Seventeen scientific publications, two reports and four dataset were delivered. Eleven manuscripts are currently under review for publication and some are under preparation. A detailed list is available in chapter IV DISSEMINATION WITH THE EC, SCIENTIFIC COMMUNITY, PUBLICATIONS AND OUTREACH, section 4.2. Each publication and other documents related to the project and for public release had been shared with the consortium, seeking their approval. Partners had followed the agreed internal approval and reviewing procedures. More details regarding the dissemination with the scientific community, publications and manuscripts could be found in chapter IV.

LEX4BIO Newsletter: LEX4BIO newsletter offered direct communication with the project’s audience. The project delivered all the **eight newsletters** that were planned. They were compiled by EP, with the continuous support of the coordinator and all partners and were distributed to more than 450 email subscribers.



The associated Deliverable **D8.4 Project newsletters compiled** was compiled and submitted to the portal in M48 per GA, with the closing of Reporting Period 2, and comprised six of the newsletters. The remaining two, number 7 and 8, respectively, form part of this deliverable and could be found as an Annex, at the end of the report.

Shortly before the release of an issue, the project had been publishing a prompt for subscription on its social networks in an effort to further expand on the number of subscribers (Fig. 5).

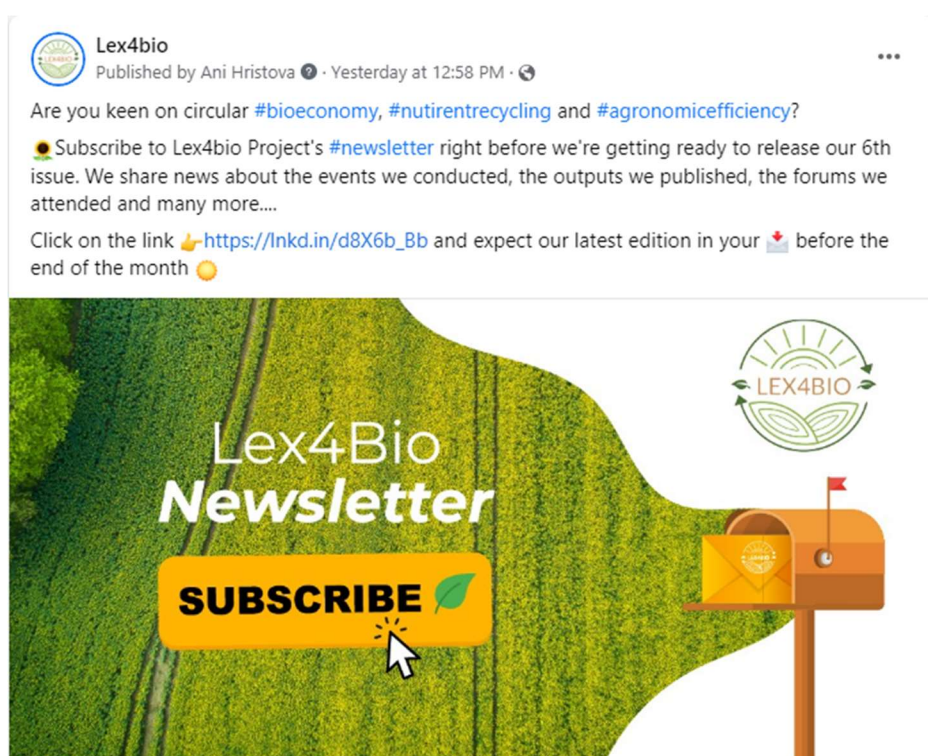


Figure 5. LinkedIn post prompting followers to subscribe

All LEX4BIO newsletters are available in downloadable format on the website: <https://lex4bio.eu/newsletters>.

In terms of LEX4BIO outputs' broad reach and dissemination, EP, with the contribution of all partners, developed a professional **animated video** featuring in a visually appealing way the need for the research conducted within LEX4BIO, the solutions it offers through its achieved results, impact in the context of circular economy and Green Deal as well as considerations for the way ahead. The video targeted policy makers, industry stakeholder groups and general public and was launched in March 2024. It was played during the final events of LEX4BIO (NERM, ManuResource) and was also uploaded to the website (<https://lex4bio.eu/video/>) and reposted on social media.



III. SYNERGIES AND CLUSTERING WITH RELEVANT PROJECTS OF NUTRIENT RECYCLING

Numerous synergy and collaborative activities were conducted during the life span of LEX4BIO with the help and support of all partners who contacted respective coordinators and agreed on a collaboration mechanism for cross-dissemination of project activities and results, joint participation as speakers in events, co-organisation of events and more. EP, with the support of LUKE, analysed initially the other projects' scopes and objectives, based on the information provided by REA, and identified areas for beneficial cooperation. A detailed *"Synergy report and action plan"* (D8.3) was prepared by LUKE, with EP's support, and approved by the consortium in M9.

1. The first synergistic activities were established with BioRefine Cluster Europe (BCE) and FERTIMANURE materials for LEX4BIO progress being shared in the newsletter of BCE. Coordinator of FERTIMANURE (Laia Llenas Argelaquet) attended the project meeting of LEX4BIO (27-29.10.2021) and presented FERTIMANURE project. Also, Kari Ylivainio (coordinator of LEX4BIO) attended the project meeting of FERTIMANURE on 3rd and 4th of November 2021 and presented LEX4BIO-project to the FERTIMANURE consortium. Prior to these meetings non-disclosure agreements (NDA) were signed by both projects.
2. Project partners/coordinator was also involved in projects RELACS and SEA2LAND ensuring synergies with them. Co-operation with SoilDiverAgro project (<http://soildiveragro.eu/>) was materialised, for evaluating phosphorus status in adjacent conventional and organic farmland in Finland, Germany, Denmark, Spain, Estonia and Belgium. Additionally, some partners had contributed to synergies with relevant national projects such as P-Net and Regionales PhosphorRecycling (RePhoR) projects in Germany. UCPH is the coordinator of a Marie S Curie Innovative Training Network - New bio-based fertilisers from organic waste upcycling (FertiCycle) making a direct synergetic link with this project.
3. From the beginning of February 2021 till the end of March 2021, a webinar and virtual winter school were organised in collaboration with the EU projects FertiCycle and Nutri2Cycle on the topic: "Waste processing and up-cycling concepts". The event was mainly organized by the University of Copenhagen (UCPH) and Ghent University (UGENT), with contributions from other partners in the EU H2020 FertiCycle (www.ferticycle.ku.dk) Marie Curie Training Network and the Nutri2Cycle (www.Nutri2Cycle.eu) project partners/supervisors. The activities were implemented as a series of 9 1½ h online webinar sessions. The webinar was part of a PhD course (closed class, max 30 students.) for several EU projects, but the beginning of each course session was an open webinar, accessible for anybody. The objectives of the webinar were to give a thorough introduction to the management, treatment, and up-cycling of bio-waste into valuable, bio-based fertiliser products, to gain understanding of fertiliser production and processes, use in the field and impacts on crops and the environment, as well as the importance of political, legislative and economic drivers as well as market mechanisms. This cooperation activity was assessed as highly relevant for LEX4BIO due to providing the participants with important initial insight in the R&D



needed in the BBF technology industry, farming sector implementation barriers and public administration and international organisations challenges.

4. There was also a SYSTEMIC (H2020 project) CE Workshop on 13 April 2021
 - representatives from national competent authorities, comprising officers from the ministry of agriculture, the agency for food safety (authorised body for licensing fertilisers), universities, specialised schools, organic and conventional farming research institutes and chambers of agriculture. SYSTEMIC organised a small expert workshop to better support the development of a market for nutrients recovered from biowaste, to enhance the circularity of agriculture.
5. Synergies with BioRefine Cluster Europe (BCE) and FERTIMANURE continued during the following months, as follows:
 - LEX4BIO was invited to participate in the third edition of the European Sustainable Nutrient Initiative (ESNI) organized by BCE, held in March 2022. Kari Ylivainio, LUKE spoke about the potential of BBFs for achieving the goals set by the Farm to Fork Strategy and effects for farmers and consumers, which was part of the session dedicated to policy recommendations for achieving F2F nutrient objectives;
 - As a member of the Nutrient Recycling Community established by BCE and FERTIMANURE, LEX4BIO led the Agronomic performance of fertilising products sub-group. The community organized webinars for professionals in soil science, nutrient recycling and agronomic efficiency. During the first webinar, organized in September 2022, ten projects were introduced, describing their primary goal, the feedstock the project is valorizing, the products produced, the agronomic value of the recovered products, and any successes and bottlenecks. Second webinar was organised on the lexicon of BBFs in February 2022 and third one on the quality assessment of BBFs in May 2024.
6. Dr. Toth Zoltan, MATE was invited to participate in an online webinar organised by Nutri2Cycle for the Hungarian audience and presented goals, results and experiences MATE partners obtained in LEX4BIO Project (Nov 2022).
7. Kari Ylivainio, LUKE was a guest speaker in a conversation about the “Nextgen bio-based fertilisers – from components to products” – a webinar organised by SUSFERT on May 23, 2023. The topic Kari presented on was “Components for bio-based fertilisers in Europe” (Fig. 6).



Figure 6. Online poster announcing LEX4BIO coordinator's participation in a webinar

8. Kari Ylivainio, LUKE attended the Circular Agronomics Final Conference in Feb 2023 and presented LEX4BIO.
9. Andrea Bauerle, UHOH attended the kick-off meeting of trans4num project (Grant Agreement No. 101081847) in Feb 2023 and presented LEX4BIO. In a subsequent webinar organised by trans4num in April 2023, she talked about BBF selection process and experiences with multi-location field trials in LEX4BIO.
10. LUKE is a partner in NOVAFERT project (Novel procedures and sustainable guidelines to enhance the use of alternative fertilisers, Grant Agreement No.101060835), targeting to improve the utilization of BBFs. An NDA was drafted between LUKE and NOVAFERT consortium for allowing NOVAFERT to utilize information collected by LEX4BIO (D2.1, confidential) for evaluating available BBFs on the European market.
11. LEX4BIO Coordinator was contacted by FER-PLAY project ("Multi-assessment of alternative fertilisers for promoting local sustainable value chains and clean ecosystems", funded by the EU under Grant Agreement No. 101060426) with the invitation to collaborate and identify possible synergy actions with LEX4BIO. FER-PLAY and NOVAFERT are sister projects. One of their tasks is to study the social acceptance of alternative fertilisers by farmers, producers, general public and local administrations. They are planning to conduct surveys to assess this and believe that both projects can help each other in this task.
12. Lærke Wester-Larsen (UCPH) presented project's results at the DeliSoil - EU Mission Soil Project first Living Lab workshop in Denmark in Jan 2024 (Fig. 7). Lærke presented results on N fertiliser value and soil quality impacts of the range of BBFs she had tested in LEX4BIO, discussing results

and Danish stakeholders from the organic waste recycling industry, farmers, advisors and authorities, inspiring colleagues for the DeliSoil Living Lab.



Figure 7. Lærke Wester-Larsen (UCPH) presented project's results at the DeliSoil - EU Mission Soil Project workshop.

13. The synergies with BioRefine Cluster Europe (BCE) and FERTIMANURE continued during the final stage of the project, as follows:

- LEX4BIO, through its coordinator, joined the fourth edition of the European Sustainable Nutrient Initiative (ESNI) Conference, organised by BCE in Brussels in September 2023. Other fellow projects that attended and presented at the event were WaINUT, Rustica, FERTIMANURE, Nutri2Cycle and SEA2LAND. The conference offered a platform for fruitful discussion and exchange of knowledge where policy-makers, researchers, industry representatives and many other stakeholders discussed approaches to raising awareness about the benefits of nutrient recycling and reuse.
- As part of ManuREsource Conference, the ESNI Community was represented through four dynamic round table discussions. These sessions focused on the pivotal role of manure in driving the transition towards a circular economy and sustainable resource management. The discussions facilitated by the Agronomic performance working group and led by Kari Ylivainio, LEX4BIO coordinator (Fig. 8). Each session provided invaluable insights and strategies to accelerate the adoption of sustainable practices in nutrient management, contributing to the broader goal of fostering a circular economy.



Figure 8. Photo from the round table discussions of ESNI

- NERM - LEX4BIO & FERTIMANURE final conference, co-organized with ESPP, BCE, Rustica EU Project, SEA2LAND H2020-EU and WalNUT in Brussels, April 16 – 17, 2024. As mementos from the event, FERTIMANURE and LEX4BIO prepared promotional materials (notebook, bag and pen) for participants featuring the logos of the conference and the two sister projects. All projects took part in a policy session with DGs discussing **2 position papers** jointly developed by the projects: "Bio-based Fertilising Products: Quality, safety and alignment with EU Regulation" and "Market Barriers of BBFs".
- Active cross-communication and dissemination support with FERTIMANURE, SUSFERT, Nutri2Cycle, BCE, ESPP, FER-PLAY on social media.

Luke, supported by EP, led the coordination of the synergy activities and involved all partners in the evaluation of their potential and actual implementation as well as adequate communication. The synergy report was updated accordingly to correspond to the latest state of play regarding the cooperation and collaboration with the most active similar projects and initiatives.

IV. DISSEMINATION WITH THE EC, SCIENTIFIC COMMUNITY, PUBLICATIONS AND OUTREACH

European and national policy makers and regulatory bodies, researchers and specialists in the field of circular economy were reached predominantly through deliverables and peer-reviewed publications in scientific journals but also at large scale international scientific conferences and some specifically targeted activities. At these venues, LEX4BIO presented outputs with the intent to establish future collaborations by stepping on the novel methods developed within the project and to highlight utilization opportunities of the results and data collected from the field trials and the findings analysis. The other two major audience segments of LEX4BIO, industry and end-users (farmers, consumers) had



been involved through integrating them in the National Dissemination Forums and field days organised by partners (cf. Section 4.5).

For policy makers, deliverables were the main channel for providing information from the results obtained in LEX4BIO. The amount of the deliverables, titles and the submission dates were included in the Grant Agreement. A total of 36 deliverables were produced from the WPs 1-8. All, except two (D2.1 and D4.3), are public. In WP9 (Management) and WP10 (Ethics), a total of 9 and 4 deliverables were produced, respectively. All deliverables in WP10 were confidential and from WP9, these concerning progress reports and cumulative expenditure incurred were confidential (5 deliverables), available only for EC. All public deliverables have been uploaded to LEX4BIO's website, <https://lex4bio.eu/delivrables/> upon their approval by the EC.

A list of all deliverables is listed below.

4.1. Deliverables

WP1: Assessment of NRSS in the EU and their use as BBFs

- 1) D1.1 Dataset of regional NRSS available for producing BBFs in the EU
- 2) D1.2 Report on the legal restrictions for using BBFs in the EU
- 3) D1.3 Report on NRSS potential to replace mineral N and P fertilisers in the EU
- 4) D1.4 Case study report on existing inter-regional and trans-boundary exchange of NRSS/BBFs

WP2: General effects of BBFs on soil quality/functioning and plant growth

- 5) D2.1 Protocol for selecting the most promising BBFs to be studied in LEX4BIO
- 6) D2.2 Report on the effect of BBFs on soil quality and C sequestration
- 7) D2.3 Report on BBFs' effect on crop growth and physiology
- 8) D2.4 Recommendation for optimising BBF formulation under various climatic conditions

WP3: Agronomic efficiency of BBFs as P source for crops

- 9) D3.1 Recommendations on agronomic P efficiency of different BBFs across European climate, crop
- 10) D3.2 Compliance methods for different types of BBFs
- 11) D3.3 Guidelines for uniform soil test-based P fertilisation recommendations across the EU
- 12) D3.4 Description of soil and BBFs characteristics affecting P leaching

WP4: Agronomic efficiency of BBFs as a N source for crops

- 13) D4.1 Report on bioavailability and agronomic N use efficiency of BBFs across different European climates, crops and soils
- 14) D4.2 Standardised test protocols to characterise N bioavailability in BBF and fertiliser replacement value
- 15) D4.3 Prototype of new concept for satellite-based remote sensing and spectral imaging of crops and soils to guide variable rate application of BBFs for more optimal N use efficiency
- 16) D4.4 Case study report on potential N losses from BBFs to the aquatic and atmospheric environment in European cropping system



WP5: Risk assessment of the application of BBFs

- 17) D5.1. Report on organic contaminants in BBFs and their persistency and crop uptake from soil
- 18) D5.2 Risk assessment of heavy metal after application of BBFs across EU: human health and environmental losses
- 19) D5.3 Report on the effects of BBF manufacturing and use on the abundance of antibiotic resistance genes and mobile genetic elements in soils
- 20) D5.4 Toolkit for ecotoxicological methods to assess the environmental risks associated with using BBFs in agriculture

WP6: Life Cycle Assessment (LCA)

- 21) D6.1 Review and assessment of published LCA studies
- 22) D6.2 Draft convention for comparable LCA studies of fertilising products manufactured from primary and secondary raw materials
- 23) D6.3 LCA study of processes and products subject to the current project, parameters based on the new convention
- 24) D6.4 Final convention for comparable LCA studies of fertilising materials from primary and secondary resources

WP7: Coherent policy framework and socio-economic impacts for the use of BBFs

- 25) D7.1 Report on socio-economic impacts of current products and practices, incl. non-accounted externalities
- 26) D7.2 Report on drivers and barriers regarding the replacement of conventional fertilisers by BBFs for all stakeholders in the value chain
- 27) D7.3 Models of region and framework specific solutions for processing, transport and use of BBFs
- 28) D7.4 White paper on regulation potential for encouraging more efficient utilisation of BBFs
- 29) D7.5 White paper on socio-economic and policy recommendations encouraging stakeholders' interest and social acceptance to use BBFs
- 30) D7.6 Policy brief with a clear concise summary of policy recommendations

WP8: Dissemination and Communication

- 31) D8.1 Dissemination, communication and exploitation plan
- 32) D8.2 Portfolio of communication materials and the general project website
- 33) D8.3 Synergy report and action plan
- 34) D8.4 Project newsletters compiled
- 35) D8.5 Policy roadmap
- 36) D8.6 Report on communication and dissemination activities and outcomes

WP9: Project management and coordination

- 37) D9.1 Guideline document on project management, rules and time schedules to be distributed to all partners
- 38) D9.2 Minutes of the General Assembly meetings compiled
- 39) D9.3 Data management plan (DMP)
- 40) D9.4 Continuously updated risk management plan



4.2. Publication of papers in peer-reviewed journals

From its start, LEX4BIO project was perceived to have potential to greatly impact the research background in the field of BBFs in Europe. To enhance the results of the project and to strengthen the exploitation plan, publications were seen as a core activity of the communication strategy. All publications related to LEX4BIO project are available in LEX4BIO community on ZENODO and on the website. They were published in concurrence with the established within the consortium pre-publication approval process. Per Grant Agreement, the project committed to producing at least 15 peer-reviewed publications in Open Access scientific journals.

List of published scientific papers:

- 1) Kurniawati, A., Windriyati, R.D.H., Wulansari, N.K., Toth, G. & Toth, Z. 2021. *Alternatives for circular bioeconomy in organic farming under excessive nutrients (goat manure and arbuscular mycorrhizal fungi): A case study in Indonesia*. Sustainability 13(22), 12333. <https://doi.org/10.3390/su132212333>.
- 2) Ylivainio, K., Lehti, A., Jermakka, J., Wikberg, H. & Turtola, E. 2021. *Predicting relative agronomic efficiency of phosphorus-rich organic residues*. Science of The Total Environment 773, 145618. <https://doi.org/10.1016/j.scitotenv.2021.145618>.
- 3) Tanzer, J., Hermann, R. & Hermann, L. 2021. *Remediating agricultural legacy nutrient loads in the Baltic Sea region*. Sustainability 13(7), 3872. <https://doi.org/10.3390/su13073872>.
- 4) Duboc, O., Hernandez-Mora, A., Wenzel, W.W. & Santner, J. 2022. *Improving the prediction of fertilizer phosphorus availability to plants with simple, but nonstandardized extraction techniques*. Science of The Total Environment 806, 150486. <https://doi.org/10.1016/j.scitotenv.2021.150486>.
- 5) Smol, M. 2021. *Transition to circular economy in the fertilizer sector – Analysis of recommended directions and end-users' perceptions of waste-based products in Poland*. Energies 14(4), 4312. <https://doi.org/10.3390/en14144312>.
- 6) Jupp, A.R., Beijer, S., Narain, G.C., Schipper, W. & Sloopweg, J. C. 2021. *Phosphorus Recovery and Recycling – Closing the Loop*. Chemical Society Review 50, 87–101. <https://doi.org/10.1039/d0cs01150a>.
- 7) Kraj, K. & Smol, M. 2022. *Identyfikacja barier i sił napędowych produkcji oraz wykorzystania nawozów pochodzenia organicznego*. Przemysł Chemiczny 101(2), 126-134. <https://doi.org/10.15199/62.2022.2.8>.
- 8) Wester-Larsen, L., Müller-Stöver, D. S., Salo, T. & Jensen, L.S. 2022. *Potential ammonia volatilization from 39 different novel biobased fertilizers on the European market – A laboratory study using 5 European soils*. Journal of Environmental Management 323, 116249. <https://doi.org/10.1016/j.jenvman.2022.116249>.
- 9) Recena, R., García-López, A.M., Quintero, J.M., Skyttä, A., Ylivainio, K., Santner, J., Buenemann, E. & Delgado, A. 2022. *Assessing the phosphorus demand in European agricultural soils based on the*



Olsen method. Journal of Cleaner Production, Volume 379, 134749.

<https://doi.org/10.1016/j.jclepro.2022.134749>.

10) Albert, S. & Bloem, E. 2023. *Ecotoxicological methods to evaluate the toxicity of bio-based fertilizer application to agricultural soils – A review*. Science of the Total Environment 879, 163076. <https://doi.org/10.1016/j.scitotenv.2023.163076>.

11) Kurniawati, A., Stankovics, P., Hilmi, Y.S., Toth, G, Smol, M. & Toth, Z. 2023. *Understanding the future of bio-based fertilisers: The EU's policy and implementation*. Sustainable Chemistry for Climate Action 3, 100033. <https://doi.org/10.1016/j.scca.2023.100033>

12) Kurniawati, A., Toth, G., Ylivainio, K. & Toth, Z. 2023. *Opportunities and challenges of bio-based fertilizers utilization for improving soil health*. Organic Agriculture. <https://doi.org/10.1007/s13165-023-00432-7>.

13) Das, S., Helmus, R., Dong, Y., Beijer, S., Praetorius, A., Parsons, J.R. & Jansen, B. 2023. *Organic contaminants in bio-based fertilizer treated soil: Target and suspect screening approaches*. Chemosphere, Volume 337, October 2023, 139261. <https://doi.org/10.1016/j.chemosphere.2023.139261>.

14) Dong, Y., Das, S., Parsons, J.R., Praetorius, A., de Rijke, E., Helmus, R., Slootweg, J.C. & Jansen, B. 2023. *Simultaneous detection of pesticides and pharmaceuticals in three types of bio-based fertilizers by an improved QuEChERS method coupled with UHPLC-q-ToF-MS/MS*. Journal of Hazardous Materials, Volume 458, September 2023, 131992. <https://doi.org/10.1016/j.jhazmat.2023.131992>.

15) van Dijk, J., Flerlage, H., Beijer, S. & Slootweg, J.C. 2023. *Safe and sustainable by design: A computer-based approach to redesign chemicals for reduced environmental hazards*. Chemosphere 296, 134050. <https://doi.org/10.1016/j.chemosphere.2022.134050>.

16) Estoppey, N., Castro, G., Slinde, G.A., Hansen, C.B., Løseth, M.E., Krahn, K.M., Demmer, V., Svenni, J., Tran, T-V-A.T. Asimakopoulos, A.G., Arp, H.P.H. & Cornelissen, G. 2024. *Exposure assessment of plastics, phthalate plasticizers and their transformation products in diverse bio-based fertilizers*. Science of The Total Environment, Volume 918, March 2024, 170501. <https://doi.org/10.1016/j.scitotenv.2024.170501>.

17) Wester-Larsen, L., Jensen, L.S., Jensen, J.L. & Müller-Stöver, D.S. 2024. *Effects of biobased fertilisers on soil physical, chemical and biological indicators – a one-year incubation study*. Soil Research 62, SR23213. <https://doi.org/10.1071/SR23213>.

Datasets:

1) Improving the prediction of fertilizer phosphorus availability to plants with simple, but non-standardized extraction techniques, 2021, ZENODO, <https://zenodo.org/records/5749221>

2) Database for Research Results. Biomass. https://px.luke.fi/PxWeb/pxweb/en/maatalous/maatalous_biomassa/

3) Dataset of regional NRSS available for producing BBFs in the EU, 2024, ZENODO, <https://zenodo.org/records/11192560>



4) Dataset: Predicting agronomic efficiency of phosphorus-rich organic residues, 2024, ZENODO, <https://zenodo.org/records/11369152>

Manuscript submitted/under review for publication

- 1) Dong, Y., Parsons, J.R., Praetorius, A., de Rijke, E., Slootweg, J.C. & Jansen, B. 2024. *Influence of bio-based fertilizers (BBFs) on the sorption of pharmaceuticals in soil*. Chemosphere (submitted).
- 2) Dong, Y., Parsons, J.R., Praetorius, A., de Rijke, E., Slootweg, J.C. & Jansen, B. 2024. *Degradation of pharmaceuticals in soil amended with bio-based fertilizers (BBFs)*. Journal of Hazardous Materials (submitted).
- 3) Beijer, S., Das, S., Helmus, R., Scheer, P., Jansen, B. & Slootweg, J.C. 2024. *Urine as Biobased Fertilizer: The Netherlands as Case Study*. Sustainability & Circularity NOW (submitted).
- 4) Domínguez Carrasco, M.D.R., Salo, T., Keskinen, R. & Suomi, J. 2024. *Comparison of bio-based and mineral fertiliser use on heavy metals dietary exposure in six European countries*. Agricultural and Food Science (submitted).
- 5) Steffens, M., & Bünemann, E. 2023. *Quality of bio-based fertilisers is decisive for improving soil quality – a meta-analysis*. Soil Use and Management (submitted).
- 6) Hernandez-Mora, A., Duboc, O., Bünemann, E.K., Ylivainio, K., Lombi, E., Symanczik, S., Horn, D., Delgado, A., Abu Zahra, N., Zuin, L., Doolette, C.L., Eigner, H. & Santner, J. 2024. *Comparative evaluation of six phosphorus extraction methods for fertilizer compliance testing* (will be submitted in May).
- 7) Müller, B., Wester-Larsen, L., Jensen, L.S., Salo, T., Recena, R., Arkoun, M., D'Oria, A., Lewandowski, I., Müller, T. & Bauerle, A. 2024. *Agronomic performance of novel, nitrogen-rich biobased fertilizers across European field trial sites*. Field Crops Research (Submitted to and accepted subject to revisions, April 2024).
- 8) Agostini, L., Bünemann, E. K., Jakobsen, C., Salo, T., Wester-Larsen, L. & Symanczik, S., 2024. *Prediction of nitrogen mineralization from novel bio-based fertilizers using chemical extractions*. Submitted to Environmental Technology & Innovation (under review).
- 9) Bloem, E., Albert, S., Thiel, M., Keßeler, P., Clemens, J., Kolb, A. & Dockhorn, T. 2024. *Antibiotic residues in struvite precipitated by different processes in municipal wastewater treatment plants (WWTPs)*. Environmental Toxicology (submitted).
- 10) Rashid M.A, Duan Y.F., Lesschen J.P., Groenendijk P., Bruun S., Jensen L.S. 2024. *Evaluating the performance of biobased, recovered nitrogen fertilizers in European cropping systems using modelling*. Agricultural Systems (submitted).
- 11) Hernandez-Mora, A., Duboc, O., Lombi, E., Bünemann, E.K., Ylivainio, K., Symanczik, S., Delgado, A., Abu Zahra, N., Nikama, J., Zuin, L., Doolette, C.L., Eigner, H. & Santner, J. 2024. *Fertilization efficiency of thirty marketed and experimental recycled phosphorus fertilizers*. Journal of Cleaner Production (Submitted and revised, March 2024)

Manuscripts in preparation for publication

- 1) Estoppey, N., Knight, E., Allan, I., Ndungu, K., Slinde, G.A., Ylivainio, K., Hernandez Mora, A., Erlend Sørmo, E., Arp, H.P. & Cornelissen, G. 2024. *Persistent organic contaminants in bio-based fertilizers*,



amended soils and plants: exposure assessment of PFAS, PCBs, PCDD/Fs, PAHs, and extractable organic fluorine. Science of the Total Environment (under review by co-authors).

2) Müller, B., Herrmann, M., Lewandowski, I., Müller, T., Hartmann, J. & Bauerle, A. 2024. *The effect of P- and N-BBF fertilization and their residual value on biomass yield and components of Lolium perenne L.* (under review by co-authors).

3) Salo, T., Keskinen, K., del Rosario Dominguez Carrasco, M., Suomi, J. & Ylivainio, K. *Substituting conventional fossil-based mineral fertilizers with bio-based products – impacts on harmful metals in soil and crops.*

4) Ylivainio, K., Uusitalo, R. Nikama, J., Bauerle, A. & Delgado, A. *A rainfall simulation study on phosphorus, nitrogen and carbon mobilization from soils as affected by bio-based fertilisers.*

5) Hetmanenko, V., Delgado, A., Nikama, J., Bauerle, A. & Ylivainio, K. *A rainfall simulation study on trace elements mobilization from soils as affected by bio-based fertilisers.*

6) Kina, M., Santner, J., Eigner, H., Duboc, O., Heller, G., Hernandez-Mora, A., Geyer, S. & Ylivainio, K. *Solubility of heavy metals in European agricultural soils and effect on crop uptake.*

7) Muurinen, J., Markkanen, M., Hultman, J., Ylivainio, K., Jansen, B., Salo, T., Delgado, A., Recena, R., Arkoun, M., D’Oria, A., Keskinen, R. & Virta, M. *Assessing antimicrobial resistance dissemination potential and risks for soil microbiome disturbances caused by bio-based fertilizers according to field trials in Finland, France and Spain.*

8) Mäkinen, T-M., Markkanen, M., Bogdanov, Hultman, J., Virta, M. & Muurinen, J. *Streptomyces in bio-based fertilizers and their role in antimicrobial resistance of agroecosystems.*

9) Muurinen, J., Mäkinen, T-M., Markkanen, M., Ylivainio, K., Jansen, B., Salo, T., Delgado, A., Recena, R., Arkoun, M., D’Oria, A., Keskinen, R., Virta, M. & Hultman, J. *Influence of available carbon in bio-based fertilizers on functional diversity of soil microbiomes and on soil health.*

10) Cantero, J.N., Wester-Larsen, L., Salo, T., Agostini, L., Symanczik, S., Delgado, A. & Jensen, L.S. 2024. *Assessing bio-based fertilizers functionality by fast non-destructive spectroscopic methods.* In preparation for submission to Journal of Material Cycles and Waste Management.

11) Rashid, M.A., Wester-Larsen, L., Agostini, L., Symanczik, S. & Jensen, L.S. 2024. *Quantifying the agronomic and environmental effects of bio-based nitrogen fertilisers in European agriculture through modelling.* In preparation to be submitted to Agricultural Systems.

12) Ylivainio, K., Santner, J., Eigner, H., Duboc, O., Hernandez-Mora, A., Heller, G., Geyer, S., Nikama, J. & Delgado, A. *Phosphorus threshold values and fertilization requirement in Europe.*

13) Frick, H., Bünemann, E.K., Hernandez-Mora, A., Duboc, O., Santner, J., Recena, R., Delgado, A., D’Oria, A., Arkoun, M., Toth, Z. & Ylivainio, K. *Bio-based fertilisers have the potential to replace inorganic conventional P fertilisers across a range European pedoclimatic conditions.*

14) Nieto-Cantero, J., García-López, A.M., Recena, R., Sánchez-Rodríguez, A.R., Zurita-Luque, M., Barrón, V., del Campillo, M.C., Quintero, J.M., & Delgado, A. *Effect of bio-based phosphorus fertilizers on biofortification and root architecture of durum wheat in a rainfed agrosystem under Mediterranean climate.*

15) Smol, M., Anrudnik M. *Farmers acceptance of BBFs in the selected European countries.*



Report (not peer reviewed)

- 1) Eurola, M., Alainen, T., Berlin, T., Ekholm, P., Erlund, I., Hietaniemi, V., Mannio, J., Mykkänen, S., Pulkkinen, M., Root, T., Seppänen, M., Siimes, K., Venäläinen, E-R. & Ylivainio, K. 2022. Report of the Selenium Working Group 2022. <https://doi.org/10.5281/zenodo.7370986>
- 2) Kratz, S. & Hermann, L. 2020. Report on the legal framework governing the use of nutrient rich side streams (NRSS) as biobased fertilisers (BBFs) - EU legislation. Julius Kühn-Institut (JKI), Bundesforschungsinstitut für Kulturpflanzen. Berichte aus dem Julius Kühn-Institut. <https://doi.org/10.5073/berjki.2020.208.000>

4.3. PhD, Master's and Bachelor's theses:

Total of 5 persons started their PhD thesis and were employed by the LEX4BIO project. By the end of May 2024, Lærke Wester-Larsen had finalized her studies, whereas rest of the PhD candidates will finalise their thesis by the end of 2024 or early 2025.

- 1) Lærke Wester-Larsen, 2024. Novel biobased nitrogen fertilizers. Risk of nitrogen losses, agronomic performance & effects on soil quality. PhD thesis, University of Copenhagen, Faculty of Science, Denmark, January 2024. https://zenodo.org/records/10964347_2.
- 2) Alicia Hernández Mora, estimated 2024. Fertilization efficiency, solubility and compliance testing of phosphorus recycling fertilizers. PhD thesis, University of natural resources and life sciences Vienna, Austria. Department of crop sciences. Institute of Agronomy.
- 3) Benedikt Müller, estimated 2024. Closing nutrient cycles for the bioeconomy with novel bio-based fertilizers. PhD thesis, University of Hohenheim, Institute of Crop Science, Faculty of Biobased Resources in the Bioeconomy.
- 4) Yang Dong, 2024. Evaluating the impact of bio-based fertilizers (BBFs) on the environmental behaviors of pharmaceuticals in soil: screening, degradation, and uptake by crops.
- 5) Ari Kurniawati, estimated 2024. Bio-based fertilizer effects on soil properties and plant production to support a circular economy. PhD thesis, Hungarian University of Agriculture and Life Sciences, Institute of Agronomy, Hungary.

Both Master's and Bachelor's theses were prepared under supervision of LEX4BIO partners. Below is the list of theses produced during the time period of 1.6.2019 - 31.5.2024.

- 1) Pedersen, E. 2021. Assessment of N₂O emissions from biobased fertilizers. Master's thesis, UCPH supervised by Lars Stoumann Jensen & Lærke Wester-Larsen.
- 2) Agostini, L. 2021. Testing and evaluation of laboratory methods for the assessment of mineralizable nitrogen from bio-based fertilizers. Master thesis, FiBL supervised by Sarah Symanczik & Else Bünemann.
- 3) Grüning, V.K. 2021 Ecotoxicological evaluation of organic fertilizers – problems and possible solutions. Master thesis at the University of Göttingen, supervised by Sophia Albert & Elke Bloem.
- 4) Thiel, M. 2022 Antibiotic residues in biobased fertilizers from wastewater treatment plants and the elimination potential of sewage sludge composting and struvite precipitation. Master thesis at the TU Braunschweig, supervised by Sophia Albert & Elke Bloem.
- 5) Guglielmetti, M. 2020. Verfügbarkeit von Phosphor in Recyclingdüngern. Bachelor thesis, FiBL supervised by Sarah Symanczik & Else Bünemann.



- 6) Gund, C. 2020. Mittelfristige Verfügbarkeit von Phosphor in Recyclingdüngern. Bachelor thesis, FiBL supervised by Sarah Symanczik & Else Bünemann.
- 7) Massariolo, A. Pflanzenverfügbarkeit von Phosphor in Recyclingdüngern. Bachelor thesis, FiBL supervised by Sarah Symanczik & Else Bünemann.
- 8) Max, Z. 2023 The sorption of pharmaceuticals in four different bio-based fertilizers. Bachelor at University van Amsterdam, supervised by Yan Dong & Boris Jansen.
- 9) Ole, M. 2023 The sorption of pharmaceuticals in soils. Bachelor at University van Amsterdam, supervised by Yan Dong & Boris Jansen.
- 10) Luka, S. 2024 The influence of bio-based fertilizers on the degradation of pharmaceuticals in soils. Bachelor at University van Amsterdam, supervised by Yan Dong & Boris Jansen.

4.4. Dissemination of project results at scientific conferences

All partners enthusiastically participated in many scientific conferences and other dedicated events to showcase the work performed in LEX4BIO and its findings, through oral presentations or conference poster presentations:

1. May 2020 - Dominika Szoldrowska, Marzena Smol, Review the possibility of using municipal, industrial and agricultural wastes as a sources of biogenic raw materials in the fertilizer industry, Abstract, May 2020, Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Pracownia Surowców Biogenicznych, Kraków, nr ORCID 0000-0003-4383-9685; AGH Kraków, Wydział Zarządzania, Kraków, nr ORCID 0000-0001-5833-2954.
2. July 2019 - Abstract/poster of LEX4BIO activities presented in the International Phosphorus Workshop (IPW9), Ylivainio, K., Bünemann, E., Santner, J., Ehmann, A. and Delgado, A. Bio-based fertilisers for securing crop P requirement in the EU.
3. September 2019 - Ylivainio, K., Santner, J., Hermann, T. and Tóth, G. Phosphorus fertilization requirement in Europe. Abstract/poster of LEX4BIO activities presented during the DGT2019, 6th Conference on Diffusive Gradients in Thin Films.
4. 14 – 16 December 2020 - 1st International Conference Strategies toward Green Deal Implementation - Water and Raw Materials, with LEX4BIO presented as following:
5. Oral presentation: Dominika Szoldrowska, Marzena Smol, Kari Ylivainio, Awareness, attitudes and behaviours of farmers regarding the use of fertilizers from various waste streams, session SUSTAINABLE DEVELOPMENTS OF REGIONS, 14 December 2020.
6. Dominika Szoldrowska, Marzena Smol, Kari Ylivainio, Awareness, attitudes and behaviours of farmers regarding the use of fertilizers from various waste streams, Conference proceedings, ISBN 978-83-959215-5-1, page 37.
7. Promotion materials of LEX4BIO project in Conference proceedings (dedicated page), ISBN 978-83-959215-5-1, page 175.
8. LEX4BIO was presented during the European Sustainable Nutrient Initiative meeting (ESNI 2020: Fertilizing Product Regulation (FPR) a part of the Circular Economy Plan, experiences from EU projects





(17.12.2020)) meeting. Kari Ylivainio presented LEX4BIO and the title of the presentation was “Efficient and safe use of bio-based phosphorus fertilisers in the EU, (https://www.biorefine.eu/wpcontent/uploads/2021/03/bulletin_november_2020.pdf).

9. 15 – 16 November 2021- Berlin Sewage Sludge Conference - Conference language: German (geographical scope mainly Germany, Austria, Switzerland), approx. 220 participants, w.vivis.de/konferenzen/bksk/, 20 min oral presentation of LEX4BIO by Andrea Bauerle (UHOH): Motivation, Aims & Scope, Project structure, Work Packages, first results of WP2 container study.
10. Marzena Smol from Mineral and Energy Economy Research Institute of the Polish Academy of Sciences (PAS) - leader of WP7 was invited speaker with presentation “Bio-based fertilisers (BBF) in agriculture - achievements and trends” during 4th International Symposium, CIMEE22 on Materials Electrochemistry and Environment CIMEE 22 during September 17-19, 2020 at Beirut, Lebanon & online.
11. Katarzyna Kraj and Marzena Smol from Mineral and Energy Economy Research Institute of the Polish Academy of Sciences (PAS) - leader of WP7 presented poster “Social acceptance of the use of waste from the water and sewage sector - the perspective of farmers in the Małopolskie voivodship” during MonGOS International Conference: Water and Sewage in the Circular Economy Model, took place physically in Cracow (Poland) on 30 June and 1 July 2022.
12. Conference Book abstract – Katarzyna Kraj and Marzena Smol, Social acceptance of the use of waste from the water and sewage sector - the perspective of farmers in the Małopolskie voivodship, MonGOS International Conference, Water and Sewage in the Circular Economy Model Abstract Book, p.102, Cracow, 2022; Mineral and Energy Economy Research Institute, Polish Academy of Sciences, ISBN: 978-83964171-7-6.

Cross-H2020-seminar LEX4BIO & FERTIMANURE « Bio-based fertilizers of the Future », 9 December 2021, online 9.00-11.00 CET – during 2nd International Conference “Strategies toward Green Deal Implementation: Water, Raw Materials and Energy” organized by the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences;




FERTIMANURE


Cross-H2020-seminar **LEX4BIO & FERTIMANURE** « Bio-based fertilisers of the Future »

2 nd International Conference
**Strategies toward
Green Deal Implementation**
Water, Raw Materials & Energy



**Mineral and Energy
Economy Research
Institute**
Polish Academy of Sciences

Where?	When?	Cost
Online	9 December 2021 9.00-11.00 CET	Free of charge



LEX4BIO

Optimising bio-based fertilisers in agriculture - Providing a knowledge basis for new policies

The project aims to develop a universal, science-based toolkit for optimising the use of BBFs in agriculture and to assess their environmental impact in terms of non-renewable energy use, greenhouse gas emissions and LCA impact.


FERTIMANURE

Innovative nutrient recovery from secondary sources - Production of high-added value FERTILISERS from animal MANURE

FERTIMANURE will obtain reliable and safe fertilizers that can compete in the European fertiliser market

2 nd International Conference Strategies toward Green Deal Implementation

The seminar will be held as part of the 2nd International Strategies toward Green Deal Implementation: Water, Raw Materials & Energy



These projects have received funding from the European Union's Horizon 2020 research and innovation programme under grant agreements No. 818309 (LEX4BIO) and No. 862849 (FERTIMANURE).




Agenda

- **Kari Ylivainio**, Natural Research Institute Finland (LUKE), Finland
 - **Laja Llenas Argelaquet**, BETA Technological Centre, UVIC-UCC

LEX4BIO project – goals and assumptions

FERTIMANURE project – goals and assumptions
- **Supta Das**, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Amsterdam, Netherland
 - **Nagore Guerra Gorostegi**, BETA Technological Centre, UVIC-UCC

Concentrations of organic contaminants in bio-based fertilizer treated soil

FERTIMANURE Spanish on-farm pilot. Recovery of bio-based fertilisers from pig slurry
- **Marzena Smol & Katarzyna Kraj**, Mineral and Energy Economy Research Institute, Polish Academy of Sciences (MEERI), Poland
 - **Oscar Schoumans**, Wageningen University & Research

Barriers and drivers for usage of bio-based fertilisers – perspective of stakeholders

FERTIMANURE Dutch on-farm pilot. Recovery of bio-based fertilisers from cattle manure

Moderator: Marzena Smol, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland



Both projects have received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818309 (LEX4BIO) & No. 862849 (FERTIMANURE). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.



Cross-H2020-seminar LEX4BIO & FERTIMANURE 2022 « Bio-based fertilizers of the Future », 7 December 2022, online 11.00-12.30 CET – during the 3rd International Conference “Strategies toward Green Deal Implementation: Water, Raw Materials and Energy” organized by the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences.



CROSS-H2020-SEMINAR LEX4BIO & FERTIMANURE
“Bio-based fertilisers of the Future”



Marzena Smol

Head of Division of Biogenic Raw Materials, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland



Kari Ylivainio

Natural Resources Institute Finland (Luke)



Laia Llenas Argelaguet

BETA Technological Center



Ivona Sigurnjak

University of Ghent, Belgium



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Nicolas Estoppey

Norwegian Geotechnical Institute Norway

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3rd International Conference
Strategies toward
Green Deal Implementation
Water, Raw Materials & Energy

13. Conference Book abstract –Marzena Smol, Bio-based fertilisers (BBF) in agriculture - achievements and trends, International Conference, 4th International Symposium, CIMEE22 on Materials Electrochemistry and Environment CIMEE 22, Abstract Book, p.35, Beirut, Lebanon & online, 2022; Website: www.cimee-scienc.org.
14. Conference Book abstract – Katarzyna Kraj and Marzena Smol, LEX4BIO – Optimising bio-based fertilisers in agriculture – Providing a knowledge basis for new policies, 2nd International Conference on Strategies toward Green Deal Implementation – Water, Raw Materials & Energy (ICGreenDeal2021), Abstract Book, p.56, ISBN 978-83-963280-3-8.
15. Conference Book abstract – Kari Ylivainio, Barriers and drivers for usage of bio-basted fertilisers – perspective of stakeholders, 2nd International Conference on Strategies toward Green Deal



- Implementation – Water, Raw Materials & Energy (ICGreenDeal2021), Abstract Book, p.58, ISBN 978-83-963280-3-8.
16. Conference Book abstract –Marzena Smol, Introduction - Bio-based fertilisers of the Future, 3th International Conference on Strategies toward Green Deal Implementation – Water, Raw Materials & Energy (ICGreenDeal2022), Abstract Book, p.80, ISBN 978-83-67606-00-4.
 17. Conference Book abstract – Kari Ylivainio, LEX4BIO project scope, 3th International Conference on Strategies toward Green Deal Implementation – Water, Raw Materials & Energy (ICGreenDeal2022), Abstract Book, p.81, ISBN 978-83-67606-00-4.
 18. Conference Book abstract – Boris Jansen and Nicolas Estoppey, Potential risks related to the use of BBFs, 3th International Conference on Strategies toward Green Deal Implementation – Water, Raw Materials & Energy (ICGreenDeal2022), Abstract Book, p.84, ISBN 978-83-67606-00-4.
 19. 22 November 2021 - Presentation of LEX4BIO by Elke Bloem at a visit by representatives of the Turkish Government as part of the FAO project “Enhancement of soil and fertilizer management in Turkey” - Title of the presentation: Introduction into specific research projects dealing with organic fertilization & fertilization with recycling products.
 20. May 2022 - LEX4BIO at the WETSUS Phosphorus Symposium in Leeuwarden, the Netherlands - Ludwig Hermann from Proman (PM), who leads Work Package 6 in LEX4BIO, gave an overview of the general objectives of the project in his presentation “LEX4BIO – characterizing and optimizing bio-based fertilisers” (BBFs), and explained the concept, structure and expected results of the project. Dorette Müller-Stöver included in her presentation on “Bio-based phosphorus fertilizers – potentials and barriers” the first results of a pot experiment with 32 BBFs and wheat as a model plant, which was conducted by master student Nadine Abu Zahra in Jakob Santner’s group at BOKU.
 21. 15 – 19 May 2022, Copenhagen, Denmark. 32nd annual European Society of Environmental Toxicology and Chemistry conference. Poster presentation by Yan Dong from University van Amsterdam. Simultaneously screening of pharmaceuticals and pesticides in 15 BBFs.
 22. 30 – 31 May 2022 - LEX4BIO was presented at Biorefine’s Conference in Ghent, Belgium with a presentation of Kari Ylivainio, LEX4BIO coordinator, entitled ‘Optimizing the use of bio-based fertilizers in crop production’.
 23. “Plant nutrient and harmful heavy metal concentrations in agricultural soils of EU27 and UK” poster presented first important results of LEX4BIO project at the 22nd World Congress of Soil Science in Glasgow, 2022 – Kari Ylivainio, LUKE.
 24. September 2022 - Poster “Process factors affecting the contamination of struvite by selected antibiotics” was presented at the German Soil Science Society Annual Conference, Trier by Dr Elke Bloem of the Julius Kühn-Institut (JKI), the German Federal Research Centre for Cultivated Plant.
 25. Dr. Toth Zoltan, MATE was invited to participate in online workshop "Phosphorus Recovery - challenges and perspectives in V4" organized by Mineral and Energy Economy Research Institute of the Polish Academy of Sciences and Bay Zoltan Research Institute, as a part of project “How to stay alive in V4? Phosphorus Friends Club builds V4’s resilience” (PhosV4; Visegrad Grand) and presented goals, results



and experiences MATE partners obtained in LEX4BIO Project (6 May 2022, online).
<https://www.phosv4.eu/events/workshop-phosphorus-recovery-challenges-and-perspectives-in-v4>



Zoltán TÓTH

MATE - HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES
Expert in Sustainable Agricultural Production



HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES

Ph.D. Zoltán Tóth earned his MSc in Agronomy at Pannon University of Agricultural Sciences in 1955. He received a Ph.D. degree in Crop and Horticultural Sciences at University of Veszprém in 2021. His teaching activity includes soil management and land use, crop production, sustainable agricultural production, basics of agriculture and consequences of field technologies in plant protection. Research activities of Tóth Zoltán are connected with long-term field experiments (fertilization, residue management, soil tillage and rotation), impact of soil management on soil physical, chemical and biological properties, mitigating the effect of abiotic stress on crops by field technologies. Moreover he is partner in H2020 projects: ISQAPER, SOILCARE, LEX4BIO, SOILGUARD.

26. Dr. Toth Zoltan, MATE was invited to participate in online workshop "Inventory of Phosphorus Raw Materials in V4" organized by Mineral and Energy Economy Research Institute of the Polish Academy of Sciences and Brno University of Technology, as a part of project "How to stay alive in V4? Phosphorus Friends Club builds V4's resilience" (PhosV4; Visegrad Grand) and presented goals, results and experiences MATE partners obtained in LEX4BIO Project (15 Nov 2022, online).
<https://www.phosv4.eu/events/workshop-inventory-of-phosphorus-raw-materials-in-v4>
27. January 2023 - LEX4BIO outputs presented at the Danish Plant Congress 2023 - the leader of LEX4BIO research activities on the agronomic efficiency of bio-based fertilisers as N source for crops, Lars Jensen, UCPH, was invited to talk about bio-based fertilisers, new EU Fertilizing Products Regulation (FPR), and results on potential ammonia loss and fertiliser value from such bio-based fertilisers.
28. June 2022 - members of LEX4BIO project participated in the 4th European Sustainable Phosphorus Conference held in Vienna, Austria with three presentations in the New Fertilisers for Nutrient Sustainability session.
29. Conference Book abstract – Hermann, L., Raw materials recovery in water and sewage sector – current trends and future perspectives in the circular economy model, MonGOS International Conference,



Water and Sewage in the Circular Economy Model Abstract Book, p.49-50, Cracow, 2022; Mineral and Energy Economy Research Institute, Polish Academy of Sciences, ISBN: 978-83964171-7-6.

30. Bünemann E.K. et al. Bio-based fertilizers as efficient alternative phosphorus sources for closing nutrient cycles. 4th European Sustainable Phosphorus Conference (ESPC4), 20-22 June 2022, Vienna, Austria.
31. Tampio E. et al. Mapping the availability of nutrient-rich side-streams – mission impossible? 4th European Sustainable Phosphorus Conference (ESPC4), 20-22 June 2022, Vienna, Austria.
32. Hernandez-Mora et al. Assessing the accuracy of different extraction methods to predict plant P availability of novel recycled P fertilizer products. 76. ALVA-Jahrestagung. 31.5.2022.
33. Ylivainio K. Potential of bio-based fertilisers for achieving the goals set by the Farm to Fork strategy and effects for farmers and consumers. 29.3.2022 ESNI.
34. Results on potential ammonia volatilization measured on 39 N biobased fertilizers in a lab study (<https://doi.org/10.1016/j.jenvman.2022.116249>) were presented at the World Congress of Soil Science in Glasgow August 2022.
35. Nicolas Estoppey, Gøril Aasen Slinde, Gabriela Castro, Alexandros G. Asimakopoulos, Hans Peter H. Arp, Gerard Cornelissen. Assessment of the risk caused by PCBs, PAHs, PCDD/Fs, and PFASs in bio-based fertilizers (BBFs) from various waste origins and obtained through different valorisation methods. Society of Environmental Toxicology and Chemistry (SETAC) Dublin – SETAC Europe 33rd Annual Meeting (30 April – 4 May 2023).
36. 30th April – 4th May 2023, Dublin, Ireland. 33rd annual European Society of Environmental Toxicology and Chemistry conference. Poster presentation by Yan Dong from University van Amsterdam. Degradation of pharmaceuticals in soil and amended soil with bio-based fertilizers (BBFs).
37. 28 August – 1 September 2023, the Netherlands, fifth edition of the Wageningen Soil Conference, - LEX4BIO partner Dr. Boris Jansen, University of Amsterdam attended the event and presented work from results from the risk assessment of the application of biobased fertilizers (BBF). His presentation entitled “Advanced screening methods for potential soil pollution introduced via biobased fertilizers” featured results from the screening of 13 low-risk commercial BBFs for pollutants in two field trial soils, from Finland and Spain respectively, for pollution after BBFs application.
38. 28th August – 1st September 2023, Landau, Germany. 12th Young Environmental Scientist: European Society of Environmental Toxicology and Chemistry conference. Oral presentation by Yan Dong from University van Amsterdam. How bio-based fertilizers (BBFs) influence sorption of pharmaceuticals in soil.
39. 2 – 8 September 2023, German Soil Science Society Annual Conference, Halle - Dr. Elke Bloem of the Julius Kühn-Institut (JKI), the German Federal Research Centre for Cultivated Plants attended the conference and presented a poster with results from the field research work of LEX4BIO entitled



“Organische Dünger im Praxistest- Erkenntnisse aus den ersten 3 Jahren” (Organic fertilizers in the field test – results from the first 3 years).

40. 6 - 8 December 2023, International Fertiliser Society Conference, Cambridge, UK - a scientific poster, output from work package 4 “Agronomic efficiency of BBFs as N source for crops”, first-authored by Muhammad Adil Rashid, UCPH was presented with the title “Evaluating the Performance of Biobased Nitrogen Fertilizers using Dynamic Modelling”. It featured work aimed at increasing the understanding of BBFs agronomic and environmental performance. The poster was among the top 10 finalists running up for the 2023 Brian Chambers International Award for Early Career Researchers in Crop Nutrition.
41. Poster presentation at the Bioeconomy Austria Summit held in November 2023 in St Pölten, Austria – LEX4BIO partner Dr. Olivier Duboc, University of Natural Resources and Life Sciences, Vienna (BOKU), involved in the work activities regarding the assessment of the agronomic efficiency of BBFs as P source for crops, presented the poster titled “Potential of recycled phosphorus fertilizers”.
42. 14 - 15 December 2023, 4th International Conference “Strategies Toward Green Deal Implementation – Water, Raw Materials & Energy”, online - LEX4BIO results were presented to an audience of students, PhD candidates, scientists and researchers from all over the world. The presentation’s title was “Analysing the drivers and barriers to bio-based fertiliser (BBFs) adoption in farming practices – Polish case study”. It was developed by partners Magdalena Andrunik, Dominika Szoldrowska, Paulina Marcinek, and Marzena Smol, all members of the Mineral and Energy Economy Research Institute, Polish Academy of Sciences.
43. 16 – 17 January 2024, 3rd Summit of the Organic and Organo-mineral Fertilisers Industry (SOFIE3) held in Brussels – LEX4BIO was represented by its coordinator Kari Ylivainio who spoke about the agronomic efficiency of organic fertilizers in various growing conditions in Europe, based on the research results achieved within the project.
44. 12 – 14 September 2023, RAMIRAN 2023 Conference, Cambridge, UK - Lucilla Agostini of FiBL presented interesting N bioavailability results for a selection of novel biobased fertilizers (BBF) that have been investigated in WP4. Andrea Bauerle of the University of Hohenheim reported on results obtained from the field trial testing the effect of biobased N fertilizers and different soil tillage on yield of barley.
45. 26 – 28 February 2024, Phosphates conference in Poland - LEX4BIO partner Marzena Smol, Professor and Head of the Division of Biogenic Raw Materials, Mineral and Energy Economy Research Institute of the Polish Academy of Sciences presented results of from the project regarding producers and farmers’ attitudes to production and usage of bio-based fertilizers. She was also a speaker on the panel



discussion “Towards sustainable fertilizers” during the second day of the event, which was facilitated by our friends from the European Sustainable Phosphorus Platform (ESPP).

46. 7-8 March 2024, Utrecht, Netherland. 20th edition of Dutch Research Council Netherlands Earth science conference (NWO NAC). Oral presentation by Yan Dong from University van Amsterdam. How bio-based fertilizers (BBFs) influence the degradation of pharmaceuticals in soil.
47. 5-9 May 2024, Seville, Spain. 34rd annual European Society of Environmental Toxicology and Chemistry conference. Poster presentation by Yan Dong from University van Amsterdam. A new insight of the influence of bio-based fertilizers (BBFs) on the degradation of pharmaceuticals in soil.
48. 20 – 21 March 2024, Antwerp, Belgium [ManuREsource 2024 Conference](#) – **pre-FINAL event** for LEX4BIO. The project ran two parallel sessions, each featuring four presentations:

Session 1: Agronomic performance of bio-based fertilizers and their potential to replace mineral fertilizers in the EU, https://cdn.digisecure.be/vcm/2024319122510572_preliminary-program-parallel-sessions-2024-with-abstracts.pdf

E. Tampo, M. Arkoun, E. K. Bünemann, S. Kratz, S. Luostarinen, B. Müller, A. D’Oria, M. Steffens, J. Schick, A. Bauerle. Availability of nutrient-rich side streams and potential of biobased fertilisers for crop growth and soil health in Europe.

E.K. Bünemann, H. Frick, S. Symanczik, A. Hernández Mora, O. Duboc, J. Santner, H. Eigner, A. Delgado, R. Recena Garrido, M. Arkoun, A. D’Oria, Z. Toth, K. Ylivainio. Potential of bio-based phosphorus fertilizers to replace conventional fertiliser in Europe.

B. Müller, L. Wester-Larsen, L.S. Jensen, T. Salo, R. Recena Garrido, M. Arkoun, A. D’Oria, I. Lewandowski, T. Müller, A. Bauerle. Agronomic performance of nitrogen-rich, bio-based fertilizers across European field trial sites.

L. Agostini, A. Hernández Mora, Olivier Duboc, L. Wester-Larsen, T. Salo, D. Müller-Stöver, L. S. Jensen, S. Symanczik, E.K. Bünemann, H. Eigner, J. Santner, K. Ylivainio. Compliance methods to determine the agronomic performance of bio-based fertilisers.

Session 2: Stakeholders acceptance and potential effects of bio-based fertilizers on the environment, food safety and health, https://cdn.digisecure.be/vcm/2024319122510572_preliminary-program-parallel-sessions-2024-with-abstracts.pdf

M. Smol, M. Andrunik, D. Szoldrowska, P. Marcinek. Survey on opinions and attitudes of selected stakeholders about bio-based fertilisers.

N. Estoppey, G. Cornelissen, J. Parsons, Y. Dong, R. Keskinen, T. Salo, J. Suomi, M.D.R. Dominguez Carrasco, J. Muurinen, M. Virta, E. Bloem, S. Albert, K. Ylivainio, B. Jansen. Contaminants and antibiotic resistance genes in bio-based fertilizers (BBFs): low risk for soils and crops.

L.S. Jensen, M.A. Rashid, J. Nikama, B. Müller, A. Bauerle, A. Delgado, L. Wester-Larsen, D. Müller-Stöver, T. Salo, K. Ylivainio. Quantifying nitrogen and phosphorus losses from bio-based fertilisers in European agriculture through experimentation and modelling.

R. Hermann, J. Tanzer. Life cycle assessment of BBF production – applying the Lex4Bio LCA-Convention.



49. 16 – 17 April 2024, Brussels, Belgium, NERM 2024 – **FINAL conference** - presenting key outcomes of the project. LEX4BIO participated with a plenary keynote presentation and 6 oral presentations at 3 parallel sessions, highlighting quality assessment of secondary fertilisers, application, sustainability assessment, stakeholder and farmer acceptance, market uptake and business model.

Project's representatives also took part in the Expert Panel discussion on "Path to market of Bio-based fertilisers", while the final panel with RUR-08 project coordinators dedicated on "Nutrient recovery and biobased fertilisers – Future R&D Needs and roadmap" was opened by LEX4BIO coordinator. Full program of the event: https://phosphorusplatform.eu/images/Events/NERM/NERM_programme.pdf.

Parallel session II: BBFs Testing results from sister projects, https://www.phosphorusplatform.eu/images/Events/NERM/NERM%20programme_Parallel%20sessions.pdf.

- 1) Lærke Wester-Larsen, Benedikt Müller, Andrea Bauerle, Tapio Salo, Mustapha Arkoun, Aurélien D'Oria, Antonio Delgado, Ramiro Recena Garrido, Sarah Symanczik, Zoltán Toth, Lars Stoumann Jensen, Hanna Frick, Else K. Bünemann, Alicia Hernández Mora, Olivier Duboc, Jakob Santner, Herbert Eigner, Kari Ylivainio. Agronomic performance of N- and P-BBFs.
- 2) Lucilla Agostini, Lærke Wester-Larsen, Tapio Salo; Dorette Müller-Stöver; Lars Stoumann Jensen; Sarah Symanczik; Alicia Hernández Mora, Olivier Duboc; Else K. Bünemann; Kari Ylivainio; Herbert Eigner; Jakob Santner. Compliance methods for N- and P-BBFs.

Parallel session II: Other BBF testing and nutrient budgets

- 3) Boris Jansen, John Parsons, Yan Dong, Nicolas Estoppey, Gerard Cornelissen, Riikka Keskinen, Tapio Salo, Johanna Suomi, Maria del Rosario Dominguez Carrasco, Johanna Muurinen,; Marko Virta5, Elke Bloem, Sophia Albert. Biobased fertilizers (BBFs) generally do not pose an ecotoxicological risk to soils and crops.
- 4) Andrea Bauerle, Mustapha Arkoun, Else K. Bünemann, Sylvia Kratz, Sari Luostarinen, Benedikt Müller, Aurélien d'Oria, Markus Steffens, Elina Tampio, Judith Schick. Availability of nutrient-rich side streams and potential of biobased fertilisers for crop growth and soil health in Europe.
- 5) Lars Stoumann Jensen, Muhammed Adil Rashid, Johanna Nikama, Benedikt Müller, Andrea Bauerle, Antonio Delgado, Lærke Wester-Larsen, Dorette Müller-Stöver, Kari Ylivainio. Quantifying nitrogen and phosphorus losses from bio-based fertilisers in European agriculture through experimentation and modelling.

Parallel session II: Sustainability, market and acceptance of BBFs

- 6) Ludwig Hermann, Ralf Hermann, Marzena Smol, Magdalena Andrunik. Environmental and socio-economic impacts of biobased fertilisers.

50. 26 – 31 May 2024, Montreal, Quebec, Canada. 7th Environmental Dimension of Antimicrobial Resistance conference (EDAR7). Johanna Muurinen and Marko Virta from University of Helsinki (UH) will present results from WP 5.3. (Antimicrobial resistance risk) under session "Environmental management & AMR". Full list of authors: Johanna Muurinen, Melina Markkanen, Jenni Hultman, Kari Ylivainio, Boris Jansen, Tapio Salo, Antonio Delgado Garcia, Ramiro Recena Garrido, Mustapha Arkoun,



Aurelien D’Oria, Riikka Keskinen & Marko Virta. Title of the talk: Antimicrobial resistance dissemination potential of bio-based fertilizers according to field trials.

51. Marzena Smol, Magdalena Andrunik, Paulina Marcinek, Dominika Szofdrowska, Socioeconomic recommendations encouraging social acceptance to use bio-based fertilisers (BBFs), World Conference on Soil, Water, Energy and Air (EUWCSWEA), 6.5.2024, online.

LEX4BIO’s outputs will also be presented at conferences after the project has ended. Following abstracts have been approved by the organisers:

1. Ylivainio, K., Santner, J., Duboc, O., Jauhainen, L. Recena, R., Heller, G., Horn, D., Eigner, H., Else Bünemann, E., Hernandez-Mora, A., Nikama, J., Hämylä, O., Delgado, A. Phosphorus status of the agricultural fields in Europe (accepted as poster). Will be presented during the 10th International Phosphorus Workshop (IPW10, <https://dacbres.bzon.uk/event/10th-international-phosphorus-workshop-ipw10/>), hold in Dundee, Scotland (26-30.8.2024).
2. Recena, R., García-López, A.M., Quintero, J.M., Becerra, I, M., Nieto, J., Ylivainio, K., Hernandez-Mora, A., Santner, J., Bünemann, E.K., Delgado, A. Phosphorus forms in Biobased fertilizers across the European Union: implications for fertilizer use efficiency. (Accepted as poster). Will be presented during the 10th International Phosphorus Workshop (IPW10, <https://dacbres.bzon.uk/event/10th-international-phosphorus-workshop-ipw10/>), hold in Dundee, Scotland (26-30.8.2024).
3. García-López, A.M., Nieto, J., Recena, R., Quintero, J.M., Delgado A. Agronomic efficiency of various Bio-based fertilizers in phosphorus deficient soil. Will be presented during the 10th International Phosphorus Workshop (IPW10, <https://dacbres.bzon.uk/event/10th-international-phosphorus-workshop-ipw10/>), hold in Dundee, Scotland (26-30.8.2024).
4. Nieto, J., García-López, A.M., Recena, R., Sánchez-Rodríguez, A.R., Zurita-Luque, M., Barrón, V., del Campillo, M.C., Quintero J.M., Delgado A. Effect of bio-based phosphorus fertilization on biofortification and root architecture of durum wheat in a rainfed agrosystem under Mediterranean climate. Will be presented during the XVIII congress of the European Society for Agronomy, hold in Rennes, France (26-30.8.2024).
5. 17 – 21 June 2024, Aarhus, Denmark, 22nd Nitrogen workshop. Oral presentation will be given by Lærke Wester-Larsen titled 'Agronomic performance of Nitrogen-rich, biobased fertilizers across European field trial sites' Poster presentation will be given by by Lars Stoumann Jensen titled 'Quantifying Nitrogen Losses from Bio-Based Fertilisers in European Agriculture through Experimentation and Modelling'.
6. 18 – 23 August 2024, Cape Town, South Africa. 19th International symposium on microbiology ecology (ISME19). Johanna Muurinen and Marko Virta from University of Helsinki (UH) will present results from WP 5.3. (Antimicrobial resistance risk) in a poster. Full list of authors: Johanna Muurinen, Melina Markkanen, Jenni Hultman, Kari Ylivainio, Boris Jansen, Tapio Salo, Antonio Delgado Garcia, Ramiro Recena Garrido, Mustapha Arkoun, Aurelien D’Oria, Riikka Keskinen &



Marko Virta. Title of the talk: Antimicrobial resistance dissemination potential of bio-based fertilizers according to field trials.

4.5. National Dissemination Forums, Fairs and Technical Events

LEX4BIO partners from research institutes and Universities from Finland, Denmark, Germany, Poland, Austria, Hungary, Switzerland, Netherlands, Belgium and Spain set up National Dissemination Forums (NDFs) for knowledge-exchange among relevant stakeholders. The participants in the NDFs were representatives of ministries of agriculture and environment, advisory services, farmers unions and representatives from the industry and non-governmental organisations (NGOs) like fertiliser industries, research institutes, nutrient platforms, universities, associations of organic farmers and others. This approach proved to be efficient in securing dissemination at large to industry and end-users through the provided possibility for direct communication, real-time dialogue and mutual inspiration. End-user involvement from the early stages of the project was considered critical for the project's sustainability and it continued until the end, to ensure wide acceptance of project's recommendations on BBFs use as an alternative to the mineral fertilizers. This engagement was two-fold:

1. Input from the end-users to the consortium: During the implementation of the field trials, end-users visited the demonstration sites, giving farmers direct access and visibility to the field work and results, while enabling the collection of real time feedback, impressions and concerns. Farmers' opinion was sought through the developed and conducted by LEX4BIO Survey on barriers towards replacing conventional fertilisers with biobased alternatives.
2. Input from the project to the end-users: Dissemination of tailored communication materials to specialised magazines, updating end-users on work progress and new available opportunities in the field of agronomic performance.

An important task of LEX4BIO was building an inventory of current and novel promising BBFs and conduct trials and analysis to a selection of these BBFs. For this reason, the relevant industries specialised in fertiliser and BBF production were considered a key asset. They were reached through integrating major organisations in the National Dissemination Forums as well as direct communication activities.

In support of the dissemination effort, each partner committed to attend at least one event/fair/conference during the project lifetime to meet stakeholders and discuss and present with them the project and hand out information brochures. Field day events were organised for farmers, relevant industry and scientists, for exploring the growth trials.

Almost all relevant partners implemented NDFs and/or field days during the project's duration. It's important to note that due to COVID-19 the NDFs in 2020 and 2021 were delayed. The first NDF meeting set the basis for the creation of the Policy roadmap (D8.5).

Chronological list of NDF and field trial activities follows:



1. In Finland, LEX4BIO was first presented (M18) at a national event organised by the SuMaNu-project (<https://balticsumanu.eu/>)
2. The first NDF meeting of LEX4BIO in Denmark took place in June 2019, shortly after LEX4BIO launch, where the general objectives, planned activities and expected results were promoted.
3. The first NDF Meeting in Germany took place on 15th of November 2019. The most important nutrient rich side streams in Germany were discussed, how to evaluate these sources and how to close nutrient cycles best. Legal aspects were a topic of discussions as well as safety aspects. A presentation from the Nutri2Cycle project revealed links for cooperation.
4. A meeting was held on 5 October 2020 in Spain. Three relevant companies producing compost were invited and attended the meeting. Until then, composting had been the main transforming process for valorizing relevant residues. Regarding the use, companies producing compost, in some cases branches of large service companies, such as VALORIZA, offered the product as “soil amendment” rather than “fertiliser” taking into account all the potential effects to soil functioning (organic matter supply).
5. In 2021, a Danish NDF meeting was held on 1st of July in collaboration with UCPH at an experimental farm, where the participants communicated LEX4BIO outcomes and results of the project so far. In total, 31 people participated in the event, with a program including both a field trip and discussion. The field trip in the morning visited several sites: LEX4BIO field trials with N-effect of a number of BBFs, which were conducted simultaneously in 5 places in Europe and demonstration of measurements of nitrous oxide and carbon sequestration in field trials with catch crops and BBFs. Finally, the long-term CRUCIAL field trial about recycling society's organic residues - sewage sludge, household compost, human urine and various livestock manures, focusing on soil carbon build-up, contaminants and potential risks. The meeting program in the afternoon contained talks by Lars Stoumann Jensen and subsequent discussion about i) the new EU Fertilising Product Regulation, which entered into force in 2022 - What is it and what impact will it have on the fertilizer market and farmers uptake? and ii) introduction to the activities in EU-H2020 project LEX4BIO as well as the Nutri2Cycle and FertiCycle projects. This NDF event was very successful and gave the participants good insight into the issues and challenges of BBF development, production, use and markets.
6. National Dissemination Forum, Austria, June 22 – the Austrian NDF took place at the University of Natural Resources and Life Sciences (BOKU), bringing 17 participants together in a hybrid in-presence–online meeting from research organizations, agriculture chambers, fertilizer industries, water and energy service providers, environmental consultants, and the Ministry of Agriculture. The NDF was embedded in a “Nutrient Recycling” Seminar, where other similar projects like Systemic, RecaP and Nutribudget were also presented.
7. NDF in Finland, Aug 22 – the second NDF meeting organized by LUKE in Finland. All stakeholders that participated in the first meeting were invited to join among which present were the Ministry of Agriculture and Forestry (MMM), agriculture advisory services (ProAgria), farmers union (MTK), fertilizer’s industry (YARA, Biolan), Finnish Food Authorities and the biggest provider of municipal water supply and waste manager in Finland (HSY). During the meeting activities and preliminary results



of WPs 1, 2, 3, 4 and 5 were presented and a field visit to phosphorus (WP3) and nitrogen (WP4) field sites were conducted.

8. NDF in Denmark, July 22 – the 3rd LEX4BIO NDF in Denmark was set up and coordinated by the University of Copenhagen (UCPH) at the advisory organization LandboNord in northern Jutland and was attended by a total of 24 participants. The morning activities included experimental field site visits starting with the field trial with different forms of P starter fertilizer (incl. biobased) for spring barley. In the afternoon, the day continued with a workshop seminar on the following topics:
 - Current soil-plant nutrient availability issues – participants brought up for discussion common problems and challenges from their daily work.
 - A larger fraction of Danish livestock slurry (+30%) is now being anaerobically digested, and this is expected to increase further in the coming years. How is this affecting the slurry digestate fertilizer value, and how do we overcome the problems with decreasing fertilizer value due to increasing proportion of DM rich co-substrates? – a presentation by T. Birkmose and subsequent discussion.
 - Is there a need for more biobased and carbon-neutral recycling fertilisers in a time of increasing prizes and supply-crisis? – a presentation of preliminary outcomes of the Nutri2Cycle and LEX4BIO project by Lars S. Jensen and subsequent discussion.
 - Demand for new field trials and studies in the next year presented by T. Birkmose.
9. Open Day at the University of Hohenheim (UHOH), Jul 22 - LEX4BIO team from the University of Hohenheim presented the field experiment and the project in an exhibition stand with flyers, fertilizer samples, posters and guided tours.
10. NDF in Switzerland, Nov 22 –Dr. Else K. Bünemann-König, Head of the Department of Soil Sciences at the Research Institute of Organic Agriculture (FiBL) and work package leader in LEX4BIO made a presentation at the Autumn Conference on Soil, Fertilizers and Environment in Olten, Switzerland entitled “Availability of nitrogen and phosphorus in commercial and recycled fertilizers – results from the EU project LEX4BIO: EU fertilizer regulation with product function categories and component material categories; Efficiency of bio-based fertilizers and impact on soil quality”. The event was attended by 32 participants and featured 10 speakers, covering federal and cantonal offices, private industry, (applied) universities, agricultural research institutes and agricultural schools.
11. Field Day in Germany, 12 May 23 – organized by JKI - a fertilizer trial where different organic fertilizers were tested for their agronomic performance was presented. Local organic fertilizers such as composts (biowaste, green waste, sewage sludge), digestates (mixed and from pig manure), sewage sludge and poultry dung were tested in comparison to straw as a control and a mineral fertilizer control. In a second trial different fertilizers from waste water treatment plants (three different struvites – $MgNH_4PO_4 \times 6H_2O$) were tested in comparison to mineral phosphorus (P) fertilization and plots without P application or without P and Mg application to differentiate between P or magnesium (Mg) effects. About 45 visitors (journalists, operators from wastewater treatment plants and composting facilities, scientists and farmers) were listening to the first results of the trials and were visiting the oilseed rape field under splendid sunny conditions. The sampling strategy of the trials were presented as well as



the methodology of investigation. The different fertilizer samples were exhibited to get an impression, how much of the material is needed to fertilize the field and how the fertilizers look like and smell;

12. Final National Dissemination Forum, Denmark, July 2023 – the members of the Fertilizers Network met on July 4th for a full-day workshop to share new ideas, results and discuss current challenges and novelties in the field of fertilization, to include technologies for fertilizer production and application. The event was held at the experimental site of the advisory organization VKST in Zealand, eastern Denmark and was attended by 30 participants.
13. Field Day in Switzerland, 23 May 2023 - the Research Institute of Organic Agriculture (FiBL) organized a field visit for the advisory group to their long-term recycled fertilizer field trial in Wallbach, Switzerland, which is part of WP4 validation trials in LEX4BIO project. The event was attended by 15 participants, representatives of federal offices, private industry, farmers, (applied) universities and agricultural research institutes.
14. During the field days, the agronomic efficiency of BBFs was presented to various stakeholders. Kari Ylivainio was invited to present LEX4BIO during the informal consultation session of the HELCOM Agri Group in April 2022 and November 2022. During these consultations LEX4BIO's results were presented and final outcomes of LEX4BIO will be presented during the consultation in October 2024.
15. Luke presented LEX4BIO results during a seminar in Helsinki called "Maataloustieteen päivät 2024" (Agricultural Science Days) organized by "The Scientific Agricultural Society of Finland", 10 – 11 January 2024.
16. LEX4BIO partners Lars Stoumann and Lærke Wester-Larsen presented results on N fertiliser value and soil quality impacts of the range of biobased fertilisers tested in LEX4BIO at DeliSoil – EU Soil Mission first Living Lab workshop in Denmark, held in the last week of January 2024. This was a great opportunity to discuss LEX4BIO outcomes with Danish stakeholders from the organic waste recycling industry, farmers, advisors and authorities.
17. UCPH held a webinar in February 2024 for Danish stakeholders in the biobased fertiliser sector, representing companies that supplied LEX4BIO project with N-BBFs for five main field trial sites across Europe, for two growing seasons in accordance with a common protocol.
18. NDF was organized by MEERI PAS 14 March 2024 in Lubliniec (Poland), Prof. Marzena Smol, presenting on behalf of the LEX4BIO project, introduced the project's scope and activities, along with highlighting the preliminary results of farmer surveys. The audience predominantly comprised farmers from the Silesia district of Poland. The discussion highlighted significant challenges faced by Polish agriculture, mirroring concerns shared by farmers across the region.
19. All NDF meetings were compiled on MS7.5 by PAS (report) and used for drafting the policy recommendations (D7.6).

V. KNOWLEDGE MANAGEMENT: EXPLOITATION, TECHNOLOGY TRANSFER AND IPR MANAGEMENT

LEX4BIO is expected to have a vast impact on the sustainable production and use of organic residuals and BBFs in Europe. **The objective was to develop a strategy which would ensure effective**



exploitation of project outputs and sustainability of the proposed solutions to replace mineral fertilisers and increase resources efficiency through three sub-objectives:

- 1) Results are transferred successfully, and the knowledge is applied,
- 2) There is an increased potential for impact from the transfer,
- 3) It is possible to measure and demonstrate the impact of the transfer.

A clear exploitation plan was developed, looking to maximise impact and market uptake of technologies and solutions developed in the project. The exploitation plan was first based on the preliminary draft presented in the H2020 LEX4BIO proposal, where diverse results were identified for exploitation at larger scale.

During setting-up stage, a preliminary draft of the exploitable results was generated by LEX4BIO partners, which were updated towards the project's end to reflect the current state of play (Table 2).



Table 2. Exploitation of Project Results

Results	Targets	Exploitation opportunities within LEX4BIO	Exploitation opportunities outside LEX4BIO
Analyses and analytical testing methods	H ₂ O, NAC, Bicarbonate, Iron Bag, EUF, DGT Ion exchange membranes	Screening of BBFs to understand their behaviour in soils	Use as new methods for BBF compliance testing to improve the BBF characterization
Advanced compliance methods for BBF and soil P testing	DGT, EUF and modified Olsen P evaluated for improved soil P testing.	Estimation of P fertilization requirement in the EU and potential of BBFs for replacing mineral P fertilizers.	Estimating agronomic efficiency of various BBFs as well as future novel P-BBFs in various climatic and soil conditions.
Advanced compliance methods for BBF N testing	C and N mineralisation characteristics and prediction by NIR / FTIR	Estimation of mineral N fertilizer replacement value of BBFs and impacts on soil C storage.	Estimating agronomic fertilizer replacement value of current and future novel N-BBFs in various climatic and soil conditions.
Convention for comparable LCAs of fertilizing materials	Making LCAs of bio-based fertilisers more comparable	No direct exploitation opportunities within the project	By adopting the convention in other projects, the target of higher comparability is achieved
Models of logistic and socioeconomic impacts	Development of models of logistic for BBFs at regional/interregional scale & defining of socioeconomic impact	Improvement of logistic of BBFs usage at regional/interregional scale & socioeconomic factors for usage of BBFs	Knowledge transfers outside LEX4BIO consortium and policy making

IPR management strategy. The management of Intellectual Property Rights (IPR) was strictly ruled by the Consortium Agreement (CA) which includes all provisions related to the management of IPR including ownership, protection and publication of knowledge, access rights to knowledge and pre-existing know-how as well as questions of confidentiality, liability and dispute settlement.

In the CA, the Partners had identified the background knowledge included and excluded. The CA regulated the ownership of results. The CA also regulated the transfer of results ownership. Each Signatory Party may transfer ownership of its own Foreground following the procedures of the Grant Agreement Article 30.

5.1. Dissemination and communication in support of knowledge transfer

The objectives of LEX4BIO were introduced to the wider audience during the first half of the project through the NDFs and attended seminars and conferences. From the start, we collaborated closely with Biorefine Cluster Europe (BCE), including participation of Prof. Erik Meers (founder of the BCE) to the kick-off meeting organized in Hämeenlinna, Finland, for getting acquainted with the project.



Information on LEX4BIO was presented on EIP-AGRI database. IPR issues were regularly discussed during the General Assembly meetings of the project. In the project shared repository (Tiimeri), a special Excel workbook was created for partners to continuously fill in any innovation or IPR issue as it aroused. LEX4BIO community on ZENODO was created and a link to it was shared on the website. Suitable channels and mediums for transferring upcoming results to wider audience kept being explored.

VI. POLICYMAKER INVOLVEMENT AND ROADMAP BASIS FOR FUTURE POLICIES

The first tangible result ensuing from project's activities and its objective for policy recommendations for the future regulation and use of BBFs was the development of the **Policy Roadmap (D8.5)** in M22.

LUKE produced a position paper for the policy makers at the European Parliament entitled "Circular bioeconomy: tools for resilient primary production and security of supply with added value ion and the use of forest resources" and authors: Johanna Buchert, Antti Asikainen, Johanna Kohl, Jani Lehto, Kari Ylivainio, Tuula Jyske, Kimmo Rasa, Mika Mustonen. https://jukuri.luke.fi/bitstream/handle/10024/552226/Bryssel_position_paper_A4_web.pdf?sequence=1&isAllowed=y. Their contribution to the EU Circular Economy Action plan highlighted **3 key messages**:

1. Bio-based fertilisers can significantly improve food security
2. Biomasses and their side streams can be valorised to added value products
3. Diversity provides resilience and security to energy systems

LEX4BIO participated in producing a Joint Position of European Projects for the EC. Title of the paper was "On the need for an unambiguous definition by the European Commission regarding the waste/manure status of ammonium salts derived from off-gas cleaning associated to treatment of manure or manure-derived products".

Partner Lars Stoumann Jensen (WP4 leader) was invited by the Committee on Agriculture and Rural Development of the European Parliament (DG AGRI) at a public hearing on fertilizers and circularity in agriculture under the theme of "Reducing impacts of fertilizers from production to end-use – increasing circularity in agriculture", held on 29 November 2022. His presentation entitled "Developing new bio-based fertilizers from organic waste upcycling for optimal use in agriculture" took place during the first panel dedicated to the development of new technologies for new fertilizers based on recycled nutrients from organic waste.

LEX4BIO contributed with scientific expertise in the drafting of the consensus Position Paper on the definitions of "biobased fertiliser" or "Bio-Based Nutrient". Following the European Commission's communication on the use of the term "Bio-Based Plastic", the European Sustainable Phosphorus Platform notes that the term Bio-Based Fertiliser is already in use in a number of R&D activities and sees a need for a similar discussion regarding "nutrients of solely biological origin" in the EU Fertilising Products Regulation.

https://www.phosphorusplatform.eu/images/download/Proposed%20ESPP%20position%20Bio-Based%20Fertilisers%20v8_2_23.pdf.



LEX4BIO partners from the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences (PAS) took part in ESPP's workshops on Nutrient Recycling Policy on 13 and 14 March 2024, held in Brussels and online. The first workshop was titled "Policy tools to support market pull for recycled nutrients" and was dedicated on identifying policy tools to support market pull for recycled nutrients which could achieve consensus across industry and users. A summary of the discussions was presented by LEX4BIO partner Ludwig Hermann, Proman Management GmbH at the ManuResource Conference later in the same month. The second workshop was "Proposing UWWT Directive targets for P and N recovery", which elaborated ambitious, feasible and consensus proposals for regulatory targets for phosphorus and nitrogen reuse-recycling from municipal wastewater.

During ManuResource 2024 Conference LEX4BIO participated in a roundtable discussion organized by ESNI under the overarching topic of "Setting the path for future nutrient recovery and recycling in the EU: Main challenges and knowledge gaps for Research and Innovation."

Lastly, the final conference NERM ended with a policy session with DGs the focus of which was discussion of two position papers on "BBF fertilizers' alignment with the EU regulation" and "BBF market barriers" that were compiled jointly by RUR-08 call projects, co-organizing the conference along with ESPP and BCE.

VII. OUTCOMES

LEX4BIO's partners have had dissemination activities towards different stakeholder groups, including farmers, consumers, industry, and policy makers. Awareness of BBF potential on agriculture has increased and we have shown BBFs potential in agriculture and demonstrated their safety concerning food production, human health as well as from environmental point of view. Great interest towards BBFs exist and results showed that BBFs can be efficiently and safely use for replacing mineral fertilisers. This is important for Europe, being dependent on imported fertilisers. Interest towards BBFs increased especially after EU decided to reduce dependency on natural gas originating from Russia, main component for producing nitrogen fertilisers.

Work conducted in LEX4BIO provides a solid base for further developing BBF utilisation in agriculture. Increased knowledge of BBFs potential in various growing conditions will provide means for improving farming practices and targeting BBFs, based on their properties, to regions with best agronomic performance and minimizing potential risks related to their use. Results will provide knowledge for fertiliser industry to produce site-specific BBFs in the EU and enhance circular economy by better utilising nutrients from different side-streams. Also, with the knowledge acquired, policies can be further adjusted for improving nutrient circulation. These actions are greatly supported by the deliverables and scientific publications published in highly ranked journals. Furthermore, PhD, Master's and Bachelor's theses produced in LEX4BIO provides future experts related to circular economy and especially on the field of BBFs.



7.1. Audience Reach

Table 3. Audience Reach

Target audience	KPI	Outcome
EC & national decision-making bodies, regulatory bodies	20 4 specific presentations during seminars and international events including policymakers 4 articles published in non-scientific magazines	608 Achieved: 8 documents produced + Policy Roadmap Achieved: 5 articles + 1 TV interview
End-users (farmers, consumers)	5 000 Visits to demonstration sites and field days Popular articles at national and local level	2 015 827 (includes the audience of media outlets that had featured LEX4BIO work, targeted at general public, media and citizens)
Scientific community	100	22 302 reached
Industry	150	1853 reached

7.2. Communication Tools

Table 4. Communication Tools Outcome

DEC tool – Partner in charge	KPI	Outcome
DEC plan – EP	1	Achieved + 3 updates
Logo – EP	1	Achieved – colour & black and white version
Official project website – EP	Continuously maintained and updated	Achieved + Optimized navigation and structure
Social media – EP	2 accounts Regular updates	Achieved 3 accounts (FB, LI, X) Total followers >1000
Project brochure – EP	2	Achieved 3
Project newsletter – EP	8	Achieved
Animated video on results	0	1
Press release & public articles	2 – 3 during the project lifespan	Achieved 3 press releases 5 blog articles



7.3. Website Analytics

The total number of users of LEX4BIO website since its launch in 2019 is 5400 as most of them are equally acquired through direct (2.1K) and referral channels (2.1K). The second most popular landing page to Home (4K views) is the one with the deliverables (674 views), while the average rate of user engagement with the website content is 50%. A total of 659 file download events were accounted.

7.4. Dissemination and Communication Activities

Table 5. Scientific Dissemination Activities

Activity	KPI	Outcome
Organisation of a Conference		3
Organisation of a workshop (to include NDFs, field days, other events)	2 fairs & NDFs	7 NDFs 2 field days 1 university open day
Radio/TV campaign		2
Conference Participation	3 conferences	27
Participation in other events		15
Scientific Publications	15	17
Workshops, national events		6
Webinar		1

VIII. CONCLUSION

LEX4BIO has utilised different channels for dissemination and communication during the project's lifetime and various stakeholders, including farmers, consumers, researchers, and policy makers have been reached. LEX4BIO has produced vast amount of new information for optimising the use of BBFs in agriculture, and shown their potential for replacing mineral fertilisers. Furthermore, uncertainty about the safety of BBFs, one of the main obstacles for their wider usage, has been demonstrated to be on a level that does not compromise food safety. With a proper management of BBFs, environmental losses of both N and P are not elevated as compared to mineral fertilisers.

Uptake of results from LEX4BIO will reduce EU's dependency on imported mineral fertilisers and provides means for increasing resilience against food crises in the current unstable geopolitical situation. Results can also be utilized in other regions of the world with limited access to mineral fertilisers. This concerns especially sub-Saharan Africa where the availability of mineral fertilisers is low and BBFs, especially those with high organic carbon content, may provide extra benefit.



It is noteworthy that this report is complemented by:

- D8.1 “Communication, dissemination and exploitation plan”
- D8.2 “Portfolio of communication materials and the general project website”
- D8.3 “Synergy report and action plan”
- D8.4 “Project newsletters compiled”
- D8.5 “Policy roadmap”



IX. ANNEXES

9.1. Newsletter number 7



LEX4BIO aims to identify and quantify nutrient-rich side-streams and evaluates technologies for producing safe, efficient and regionally targeted bio-based fertilisers in the EU. LEX4BIO will provide policy recommendations for achieving a higher use efficiency of bio-based fertilisers and socioeconomic improvements for the rural population.

[Click here to discover our project objectives](#)



Word from Kari Ylivainio, LEX4BIO coordinator

Welcome to next to the last newsletter of LEX4BIO!

The past six months have been busy time for evaluating the data collected and preparing both deliverables and scientific articles from the project's outcomes. The second review meeting in September further showed that that we are on a right track and all activities have been conducted on time.

Now LEX4BIO has reached its final phase where the main emphasis is on disseminating the results to various stakeholders. Field, greenhouse and laboratory trials have provided new information about the potential of bio-based fertilizers (BBF) to substitute mineral fertilizers in various climatic and soil conditions across the EU. From the consumer point of view, potential effect on food and human safety has been evaluated, along with the potential environmental losses of both phosphorus and nitrogen. Conclusions will be collected and condensed for policy recommendations to enhance the use of BBFs and replace the use of mineral fertilizers and support circular economy in the EU.



Results of LEX4BIO will be presented both at national and international dissemination events in 2024. The **final international events for dissemination** take place during the ManuREsource conference in March in Antwerp, Belgium and Nutrients in Europe Research Meeting (NERM) 2024 in Brussels in April.

By following us on social media, including LEX4BIO's webpage (www.lex4bio.eu), you will stay up to date with our final events and publications.

NATIONAL DISSEMINATION FORUMS

With weather warming up and days growing longer, LEX4BIO partners started organizing planned field days. The idea behind these events is to demonstrate to interested stakeholders the potential of bio-based fertilizers for agriculture. Two field days were conducted in May.



Follow the link to discover more about the final LEX4BIO NDF in Denmark

<https://lex4bio.eu/2023/07/06/lex4bio-final-national-dissemination-forum-ndf-in-denmark/>

RESULTS



Second Press Release is out

***For Immediate Release to Media
From LEX4BIO Project
July 4, 2023***

by admin_lex4bio / Jul 4, 2023 / News & Event



BIO-BASED FERTILIZERS DERIVED FROM VARIOUS NUTRIENT-RICH SIDE STREAMS HAVE POTENTIAL TO EFFICIENTLY AND SAFELY REPLACE MINERAL FERTILIZERS

LEX4BIO RESULTS PUBLISHED

Food security in Europe is strongly related to reducing the continent's dependency on imported fossil fertilizers, the production of which harms the environment with the use of scarce non-renewable resources and high energy consumption. The extensive laboratory and field trial experiments conducted by LEX4BIO's soil scientists demonstrated that biobased fertilizers can be an attainable alternative to conventional mineral fertilizers and can contribute to reaching the ambitious goals of the EU Green Deal and Farm to Fork strategy as well as improve Europe's self-sufficiency in food production.

Nitrogen (N) and phosphorus (P) are vital nutrients for crop production and therefore evaluating their demand in Europe across varying soil and climatic conditions is considered a key output of LEX4BIO project and an essential enabler for the better utilization of BBFs from environmental and economic point of view.

The full press release can be downloaded from [here](#).

Second Review Meeting



In September, LEX4BIO had its second Review Meeting online and we were pleased to hear the positive evaluation given to the consortium's work by both the Project Officer and the reviewing expert.

Given the complexity of the project, the impediments faced during the Covid 19 pandemic and the unpredictability of climatic conditions, which directly affect the results of the field trials, we cannot but consider this an outstanding achievement made possible thanks to the absolute dedication of all partners and their concerted efforts in working towards the accomplishment of the project's goals and objectives.

Project's deliverables were assessed as being of high quality, expected to have a significant impact on our knowledge about bio-based fertilisers (BBF) in agriculture – their benefits, limitations and potential risks, how to enhance their utilization and what advantages they can potentially bring to stakeholders involved in work resulting in the production of organic waste or other nutrient-rich side streams (NRSS).



We commit to keep the hard work going and present final results during ManuResource conference in March and NERM 2023 in April that will contribute to advancing the circular bio-economy and preserving European soils healthy and fertile.

Last in-person Consortium Meeting in Seville





The last LEX4BIO in-person transnational consortium meeting was held in the beautiful city of Seville, Spain hosted by the University of Seville, Prof. Antonio Delgado and his team.

For two and a half days we had the opportunity to share the outcomes of the project as far as N and P **efficiency** of BBFs is concerned, BBFs effects on soil organic carbon sequestration, the use of NRSS as a safe and sustainable source for organic fertilizers, the ecotoxicological tests to identify risks posed by a wide range of possible contaminants and the advancements towards the delivering of a coherent BBF policy framework.

Special time was allotted to defining LEX4BIO key messages derived from the project's experimental and analytical work as well as coordinating and organizing the planned presentations during our two final dissemination events in March and April, so that they are tailored to the relevant target groups of stakeholders, presenting the abundance of project's outputs in a coherent manner.

Follow our [LinkedIn](#) page for more photos and updates.

Dissemination to the scientific community

LEX4BIO presented at the fifth edition of the Wageningen Soil Conference, the Netherlands



From August 28 to September 1, 2023, the Dutch [Wageningen University](#) hosted the fifth edition of the Wageningen Soil Conference – an international scientific conference gathering an audience of mainly scientists but also subject matter experts from research institutes and Dutch government agencies.



LEX4BIO partner Dr. Boris Jansen, University of Amsterdam attended the event and presented work from work package 5 dedicated to the risk assessment of the application of biobased fertilizers (BBF). His presentation entitled “Advanced screening methods for potential soil pollution introduced via biobased fertilizers” featured results from the screening of 13 low-risk commercial BBFs for pollutants in two field trial soils, from Finland and Spain respectively, for pollution after BBFs application.

[Continue reading](#)

LEX4BIO at the RAMIRAN 2023 CONFERENCE

We were thrilled with the opportunity to present project results at RAMIRAN 2023 Conference held in Cambridge, 12 – 14 September.



Lucilla Agostini of FiBL presented interesting N bioavailability results for a selection of novel biobased fertilizers (BBF) that have been investigated in WP4.

Andrea Bauerle of the University of Hohenheim reported on results obtained from the field trial testing the effect of biobased fertilizers and different soil tillage on yield of barley.

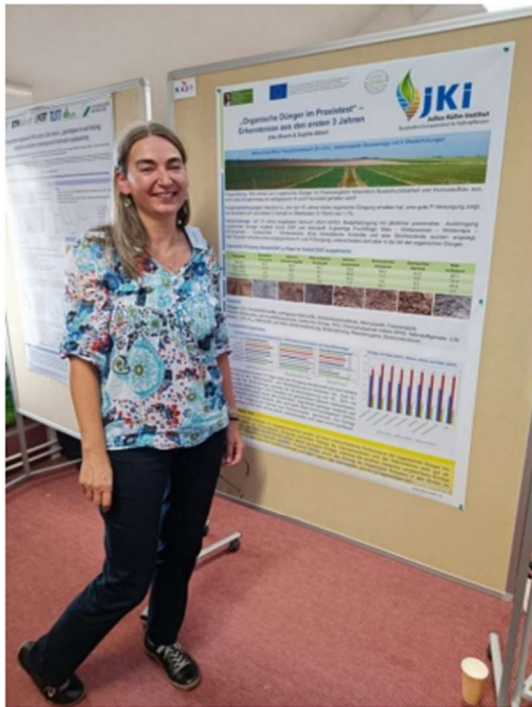


The conference was an exciting opportunity to share with fellow researchers the gained insight on the potential of BBFs in the context of the circular economy and it was equally inspiring to hear about all the great science that is going on in the world of organic resources.



LEX4BIO poster presentations

German Soil Science Society Annual Conference



For a second consecutive year, Dr. Elke Bloem from Julius Kühn-Institut (JKI), the German Federal Research Centre for Cultivated Plants attended the German Soil Science Society's Annual Conference, held in Halle beginning of September. She presented a poster with results from the field research work of LEX4BIO with a poster entitled "Organische Dünger im Praxistest- Erkenntnisse aus den ersten 3 Jahren" (*Organic fertilizers in the field test – results from the first 3 years*).

[Read more](#)

International Fertiliser Society Conference, UK

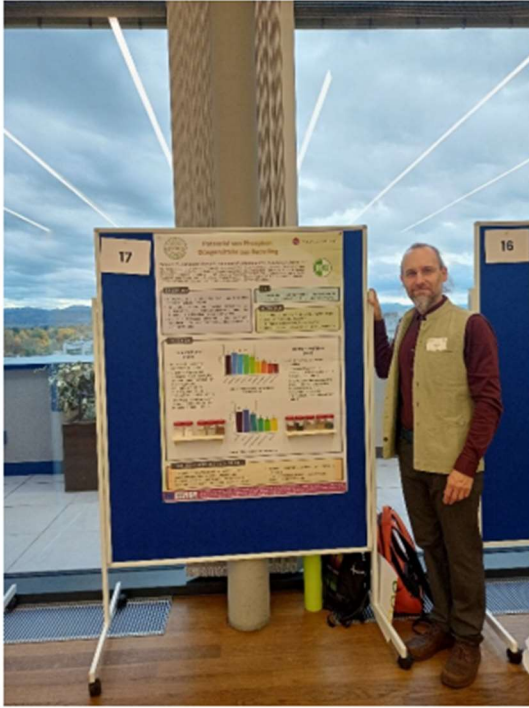
A scientific poster, output from work package 4, titled "Evaluating the Performance of Biobased Nitrogen Fertilizers using Dynamic Modelling", was presented at the International Fertiliser Society's 2023 Conference held in the United Kingdom, 6 – 8 December.

We are proud that the poster first-authored by Muhammad Adil Rashid was among the top 10 finalists running up for the 2023 Brian Chambers International Award for Early Career Researchers in Crop Nutrition.

Read [more](#)



Austrian Bioeconomy Summit 2023



LEX4BIO partner Dr. Olivier Duboc from the University of Natural Resources and Life Sciences, Vienna (BOKU), presented a scientific poster titled “Potential of recycled phosphorus fertilizers”, at the Bioeconomy Austria Summit held in November in St Pölten.

The event positions itself as the central gateway to the Austrian bioeconomy, represented by a dynamic network of more than 250 organizations from regional clusters and platforms, economic actors, research institutions and political and social groups.

[Read more](#)

Curious to read or download all LEX4BIO posters presented at conferences throughout the project's lifetime?

[Follow the link](#)

SCIENTIFIC PUBLICATIONS BY LEX4BIO



Organic contaminants in bio-based fertilizer treated soil: Target and suspect screening approaches

Authors: Supta Das, Rick Helmus, Yan Dong, Steven Beijer, Antonia Praetorius, John R. Parsons, Boris Jansen

Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Amsterdam, Netherlands; Van 't Hoff Institute for Molecular Sciences, University of Amsterdam, Amsterdam, Netherlands

Follow the link to read the full paper published in Chemosphere
<https://doi.org/10.1016/j.chemosphere.2023.139261>

Simultaneous detection of pesticides and pharmaceuticals in three types of bio-based fertilizers by an improved QuEChERS method coupled with UHPLC-q-ToF-MS/MS

Authors: Yan Dong, Supta Das, John R. Parsons, Antonia Praetorius, Eva de Rijke, Rick Helmus, J. Chris Slootweg, Boris Jansen

Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, the Netherlands, Van 't Hoff Institute for Molecular Sciences, University of Amsterdam, PO Box 94157, 1090 GD Amsterdam, the Netherlands

Follow the link to the full
publication <https://doi.org/10.1016/j.jhazmat.2023.131992>

LEX4BIO in the spotlight



In August, the Finnish newspaper [Turun Sanomat](#) dealing with the topic of how to reduce the loads of [phosphorus](#) from agricultural [fertilization](#) to the Baltic Sea published an article featuring LEX4BIO project.

We were pleased that our results were mentioned in the context of the European farmed lands' needs of phosphorus fertilization and the additional information it produces about the most suitable recycled fertilizers for each region, depending on soil characteristics, to ensure food safety.



Enjoy reading the article in Finnish <https://www.ts.fi/puheenvuorot/6088213>

Where to find us?

LEX4BIO FINAL EVENTS

NERM 2024
16-17 April 2024
Brussels & hybrid

FINAL EVENT for
LEX4BIO project

NERM 2024
(Nutrients in Europe Research Meeting)

Towards closing nutrient cycles for a sustainable future, from R&D to implementation

co-organised by ESPP and H2020 projects FERTIMANURE, LEX4BIO, RUSTICA, SEA2LAND, WALNUT and Biorefine Cluster Europe





LEX4BIO Consortium is pleased to invite you to its final event – NERM 2024 (Nutrients in Europe Research Meeting) which will take place in Brussels and online, 16 – 17 April 2024.

The event is dedicated to closing nutrient cycles for a sustainable future - from Research and Development to implementation. It will additionally comprise research students meeting on April 15 and site visits to Fertimanure and Walnut nutrient recovery facilities on the afternoon of April 17.

NERM is jointly organised by ESPP, LEX4BIO and other Horizon 2020 projects like FERTIMANURE, Rustica EU Project, SEA2LAND H2020-EU, WaLNUT and Biorefine Cluster Europe.

What shall NERM cover:

- key outcomes of recent nutrient recycling R&D under Horizon 2020, LIFE, Interreg and other funding programmes
- roadmap for future nutrient recycling R&D needs
- nutrient recovery technologies and recycled fertiliser production
- quality, application and use, stakeholder acceptance of secondary fertilisers from nutrient recovery to market

Studying any of these topics and would like to present your results through an oral presentation or a poster?

Check out the preliminary programme of the event. We look forward to seeing you and your colleagues there.



A month earlier, in March, LEX4BIO, in cooperation with sister FERTIMANURE project, will present project's outputs to the scientific community, actors involved in manure management and policy makers at the MANUResource 2024 Conference.

International conference on manure management and valorization

MARCH 20 – 21 – (22)
Antwerp, Belgium

2024

www.manuresource.org

vcm
GHENT UNIVERSITY
inagro
ncm

LEX4BIO will organize two parallel sessions of four presentations under the following topics:

- Agronomic performance of bio-based fertilizers and their potential to replace mineral fertilizers in the EU
- Stakeholders' acceptance and potential effects of bio-based fertilizers on the environment, food safety and health

The deadline for abstract submission is 15 January 2024.

Registration is open <https://registrations.vcm-mestverwerking.be/en/events>



AND MORE



Right with the start of the New Year, LEX4BIO partners are going to Brussels to attend the 3rd Summit of the Organic and Organo-mineral Fertilisers Industries in Europe (SOFIE3) as our focus will be the agronomic efficiency of organic fertilizers in various growing conditions in Europe.

Back to back with SOFIE3, on January 18, the European Sustainable Phosphorus Platform (ESPP) is organizing a meeting on Defining “Bio-Based Fertilisers” and FPR “solely biological origin”.

The meeting will bring together the European Commission, industry and fertilisers associations, research projects and stakeholders to discuss:

The meeting will bring together the European Commission, industry and fertilisers associations, research projects and stakeholders to discuss:

- relevance of bio-based definitions for markets and policy making
- existing official bio-based vocabulary (CEN, ISO, ASTM, plastics sector, industry labels)
- what comparable methodologies could be applied to recycled nutrients in fertilisers and in other applications?
- possible coherence with the EU Fertilising Products Regulation terminology “of solely biological origin”
- proposed joint position and discussion of next steps, possible input to policy makers, to CEN

Check the Programme [here](#).



Networking as key to maximising LEX4BIO impact

Since the beginning of LEX4BIO project, networking activities have been undertaken to ensure cross-cooperation with relevant projects and clusters at EU scale.

LEX4BIO represented by coordinator Kari Ylivainio (LUKE) at #ESNI



The European Sustainable Nutrient Initiative (ESNI) Conference, launched by the Biorefine Cluste Europe (BCE) in 2019 brings together EU projects, stakeholders and EU officials with the ambition to keep nutrient management high on the EU agenda.

The ESNI community is a successor of the Nutrient Recycling Community, comprising 4 Working groups led by European projects and discussing major challenges with an impact on the nutrient recycling and recovery. At present, the following working groups are active:



In September 2023, Brussels hosted the **4th European Sustainable Nutrient Initiative (ESNI) Conference**, attended by more than 170 people with various backgrounds, to include researchers, stakeholders and policy makers, to discuss sustainable nutrients.

The event started with insightful presentations by representatives of the **European Commission**, addressing nutrient recycling, FPR, and Mission Soil. Discussions then moved into emerging nutrient recycling technologies, examined policy and stakeholder viewpoints, all aimed at facilitating the introduction of recycled nutrient products into the market.

LEX4BIO is online: From its outset, LEX4BIO project has been benefiting from a large on-line visibility. The website dedicated to the project was launched in November 2019 to provide publicly accessible information on project's goals and objectives, work activities progress and results. Over the entire duration of LEX4BIO, you will be able to download directly from our web platform, **all public deliverables and outcomes LEX4BIO accomplished.**



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You can update your preferences or unsubscribe from this list.

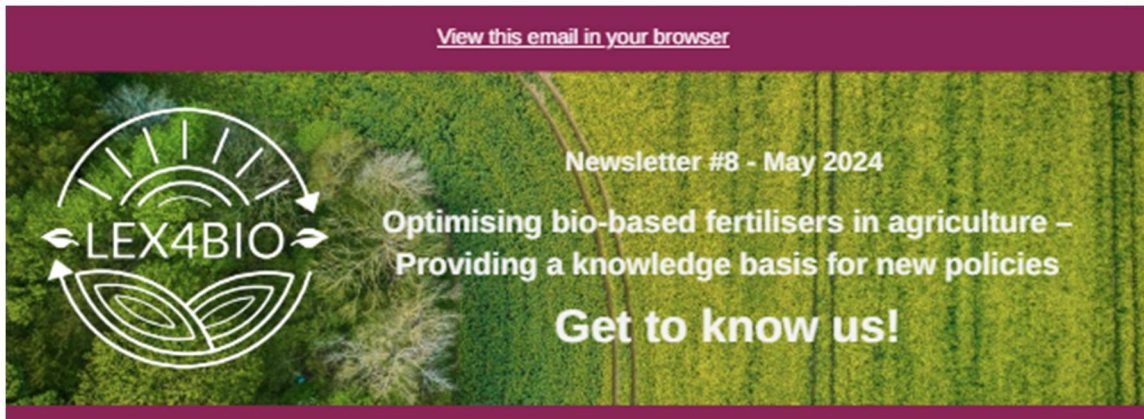
You are receiving this e-mail as you are part of the LEX4BIO community!

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818309 (LEX4BIO). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.





9.2. Newsletter number 8



LEX4BIO aims to identify and quantify nutrient-rich side-streams and evaluates technologies for producing safe, efficient and regionally targeted bio-based fertilisers in the EU. LEX4BIO will provide policy recommendations for achieving a higher use efficiency of bio-based fertilisers and socioeconomic improvements for the rural population.

[Click here to discover our project objectives](#)



Word from Kari Ylivainio, LEX4BIO coordinator

LEX4BIO project started in June 2019 and soon draws to a close, in May 2024. During these five years, we have evaluated various bio-based fertilisers considering their agronomic efficiency, potential environmental losses and effect on food and feed safety while ensuring human health.

The last six months were focused on dissemination and communication activities while at the same time preparing almost half of all project deliverables. LEX4BIO arranged two final events in March and April 2024. During the ManuResource conference in Antwerp, LEX4BIO presented main outcomes during the two parallel sessions. Audience included participants from scientific community and policy makers from both national and EU level. Also, round-table discussions took place during the conference and one of the discussion points was the challenges for evaluating agronomic performance of bio-based fertilisers. Second event was organized in Brussels, together with all five sister projects and ESPP and Biorefine Cluster Europe, compiling recent knowledge about nutrient recycling from various nutrient-rich side-streams. This event was more oriented towards policy makers but scientific community was presented as well.



Last review process of LEX4BIO will be finalized in early autumn after which all the public deliverables will be available on our website (www.lex4bio.eu). All publications will be also publicly available in Zenodo under [LEX4BIO community](#). I hope you find these publications interesting to further enhance the utilization of bio-based fertilizers.

LEX4BIO Final Events

Our results dissemination effort focused on two prominent events in the field of agronomy and soil science where project partners presented to the scientific community, stakeholders involved in nutrient recycling and soil management, and policy makers, the key outputs and conclusions derived from a five-year research work dedicated to optimising biobased fertilisers in agriculture.

ManuREsource International Conference on Manure Management and Valorisation 2024

manuREsource  **Key Outcomes presented**

2 parallel LEX4BIO sessions

 **Wednesday, 20 March**  **14:45 – 16:00**
16:15 – 17:30



The sixth edition of the ManuREsource conference was held in Antwerp, Belgium, 20 - 21 March and LEX4BIO participation was organized in cooperation with four other sister projects (RUR-08).

LEX4BIO ran two parallel sessions, each featuring four presentations, as follows:

Session 1: Agronomic performance of bio-based fertilizers and their potential to replace mineral fertilizers in the EU

- Availability of nutrient-rich side streams and potential of biobased fertilisers for crop growth and soil health in Europe
- Potential of bio-based phosphorus fertilizers to replace conventional fertiliser in Europe
- Agronomic performance of nitrogen-rich, bio-based fertilizers across European field trial sites
- Compliance methods to determine the agronomic performance of bio-based fertilisers

Session 2: Stakeholders acceptance and potential effects of bio-based fertilizers on the environment, food safety and health

- Survey on opinions and attitudes of selected stakeholders about bio-based fertilisers
- Contaminants and antibiotic resistance genes in bio-based fertilizers (BBFs): low risk for soils and crops
- Quantifying nitrogen and phosphorus losses from bio-based fertilisers in European agriculture through experimentation and modelling
- Life cycle assessment of BBF production – applying the Lex4Bio LCA-Convention



The talks of all speakers on the various outcomes of LEX4BIO gained interesting questions by different stakeholders in the audience, leading to engaging discussions ranging from broad perspectives on the possibility to replace all artificial fertiliser use in the EU with bio-based fertilisers, to a detailed exchange of ideas about the intricacies of performing life cycle assessments.

ManuREsource is an international conference hosted by the Flemish Coordination Centre for Manure Processing, Ghent University and Inagro. The sixth edition is organized in collaboration with NCM, the Dutch Center of Expertise for Valorization of Manure, a partnership between the national and regional governments, the agriculture and the agribusiness in the Netherlands.

Nutrients in Europe Research Meeting (NERM) 2024



Nutrients in Europe Research Meeting (NERM) was LEX4BIO's final conference and pinnacle closing event for the project. It was co-organized by ESPP and FERTIMANURE, LEX4BIO, RUSTICA, SEA2LAND and WALNUT projects funded under Horizon 2020 Programme (RUR-08) and was conducted in Brussels on April 16 and 17, 2024 with the ambition to **outline the path towards closing nutrient cycles for a sustainable future under the tagline "From R&D to implementation"**. An engaging and enriching two-day experience, disseminating key outcomes of latest research on nutrient recovery technologies and recycled fertiliser production, but also deliberating on the quality, application and stakeholder acceptance of secondary fertilisers as well as sketching a roadmap for future nutrient and fertiliser recycling R&D needs.

With six parallel session presentations, LEX4BIO speakers walked conference participants through the whole lifecycle of the project, with talks on nitrogen (N) and phosphorus (P) bio-based fertilisers' (BBF) agronomic performance, findings on potential risks of BBF use posed to soils and crops, the availability of nutrient-rich side-streams and the effect of BBFs on crop growth, quantification of P and N losses through experimentation and modeling, and last but not least, the environmental and socio-economic impact of BBFs.



LEX4BIO participants in NERM enjoyed a social dinner at a cool Brussels' cafe, enjoying cozy conversations, delicious local dishes and good craft beer.

Read the Press Release dedicated to the final conference [here](#)



More dissemination and visibility

LEX4BIO presented at SOFIE3 Conference, Belgium



The 3rd Summit of the Organic and Organo-mineral Fertilisers Industry SOFIE3 held in Brussels in January 2024 was a tremendous success.

Lex4bio Project was represented by its coordinator Kari Ylivainio who spoke about the agronomic efficiency of organic fertilizers in various growing conditions in Europe, based on the research results achieved within the project.

All attendees greatly appreciated the organization of this excellent event, bringing together the scientific community, industry and policy makers to compare notes in their important mission of shaping the future of a balanced and sustainable organic-based crop nutrition.



Back-to-back with SOFIE3, on January 18, the European Sustainable Phosphorus Platform (ESPP) organized a meeting on Defining "Bio-Based Fertilisers" and FPR "solely biological origin" which brought together the European Commission, industry and fertiliser associations, research projects and stakeholders into a discussion of:

- relevance of bio-based definitions for markets and policy making
- existing official bio-based vocabulary (CEN, ISO, ASTM, plastics sector, industry labels)
- what comparable methodologies could be applied to recycled nutrients in fertilisers and in other applications?
- possible coherence with the EU Fertilising Products Regulation terminology "of solely biological origin"
- proposed joint position and discussion of next steps, possible input to policy makers, to CEN



LEX4BIO Project at Agricultural Science Days 2024, Helsinki



Our colleagues from Natural Resources Institute Finland / Luonnonvarakeskus presented interesting results from the field trials conducted in LEX4BIO.

The Agricultural Science Days 2024 were held on January 10 -11, 2024. The program included the latest research results from various fields of the #AgriculturalSciences.

The event welcomed more than 600 participants - researchers, teachers, entrepreneurs and experts in administration, counseling and the business world.

[More on the event](#)



LEX4BIO Project at DeliSoil – EU Mission Soil project

LEX4BIO partners Lars Stoumann Jensen and Lærke Wester Larsen enjoyed the opportunity to present project's results at DeliSoil - EU Mission Soil Project first Living Lab workshop in Denmark. Lærke presented results on N fertiliser value and soil quality impacts of the range of bio-based fertilisers she had tested in LEX4BIO. It felt great to present and discuss LEX4BIO outcomes with Danish stakeholders from the organic waste recycling industry, farmers, advisors and authorities, and we hope our findings would prove useful to colleagues from the DeliSoil Living Lab.





LEX4BIO project results presented at the 4th International Conference “Strategies Toward Green Deal Implementation – Water, Raw Materials & Energy”



On December 14-15, 2023, LEX4BIO results were presented at the “4th International Conference “Strategies Toward Green Deal Implementation – Water, Raw Materials & Energy,” organised by the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences. The conference was held virtually and gathered over 500 participants. The audience included students, PhD candidates, scientists and researchers from all over the world – Poland, Taiwan, India, Bangladesh, Georgia, Morocco, Spain, Italy, Lithuania, Greece, Egypt, Algeria, Thailand, and Pakistan, among others.

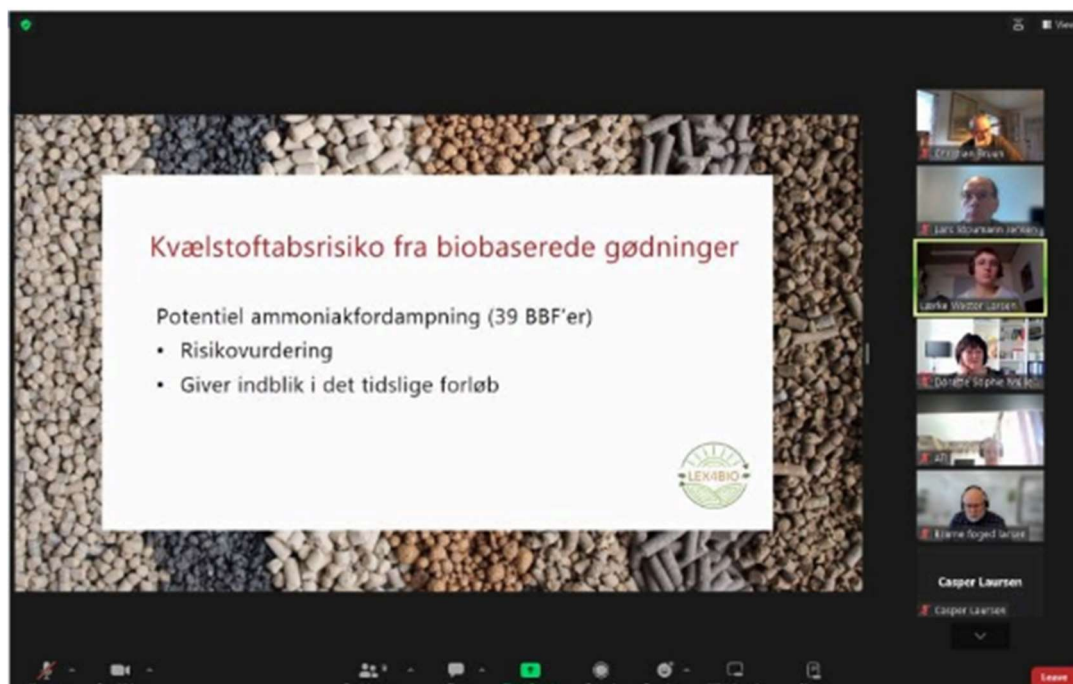
The aim of the conference was to address the issue of climate change and explore preventive measures, including innovative technological, environmental, economic and social solutions that align with the Green Deal Strategy.

LEX4BIO presentation, entitled “Analysing the drivers and barriers to bio-based fertiliser (BBFs) adoption in farming practices – Polish case study”, was produced by partners Magdalena Andrunik, Dominika Szoldrowska, Paulina Marcinek, and Marzena Smol, all members of the Mineral and Energy Economy Research Institute, Polish Academy of Sciences.

[Continue reading](#)



UCPH WEBINAR



LEX4BIO colleagues from the University of Copenhagen held a webinar for Danish stakeholders in the biobased fertiliser sector. The participants represented companies that supplied LEX4BIO Project with N-BBFs for five main field trial sites across Europe, for two growing seasons in accordance with a common protocol.

Everyone was interested to hear the results and conclusions from the team's work on assessing the agronomic efficiency of BBFs as N source for crops.

To learn more about the potential ammonia volatilisation from 39 different novel biobased fertilizers on the European market – A laboratory study using 5 European soils, follow the [link](#).

LEX4BIO project presented at the Phosphates Conference 2024, Poland

LEX4BIO partner Marzena Smol, Professor and Head of the Division of Biogenic Raw Materials, Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, participated at the Phosphates Conference 2024 in Warsaw, Poland, from 26 to 28 February 2024.



Her presentation focused on the results of LEX4BIO project regarding producers and farmers' attitudes to production and usage of bio-based fertilisers. She was also a speaker on the panel discussion "Towards sustainable fertilizers" during the second day of the event, which was facilitated by our friends from the European Sustainable Phosphorus Platform (ESPP).

[Continue reading](#)

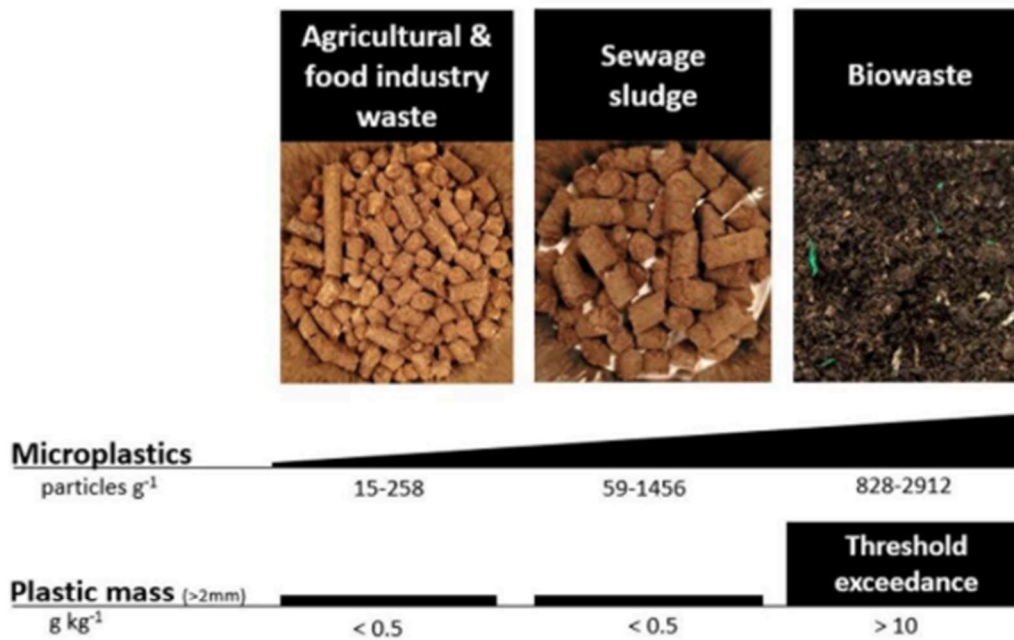
The final LEX4BIO poster was presented at NERM conference in a poster session with the rest of the participating sister RUR-08 projects.



Download the poster with the conclusions from the project [here](#).

SCIENTIFIC PUBLICATIONS BY LEX4BIO

Exposure assessment of plastics, phthalate plasticizers and their transformation products in diverse bio-based fertilizers



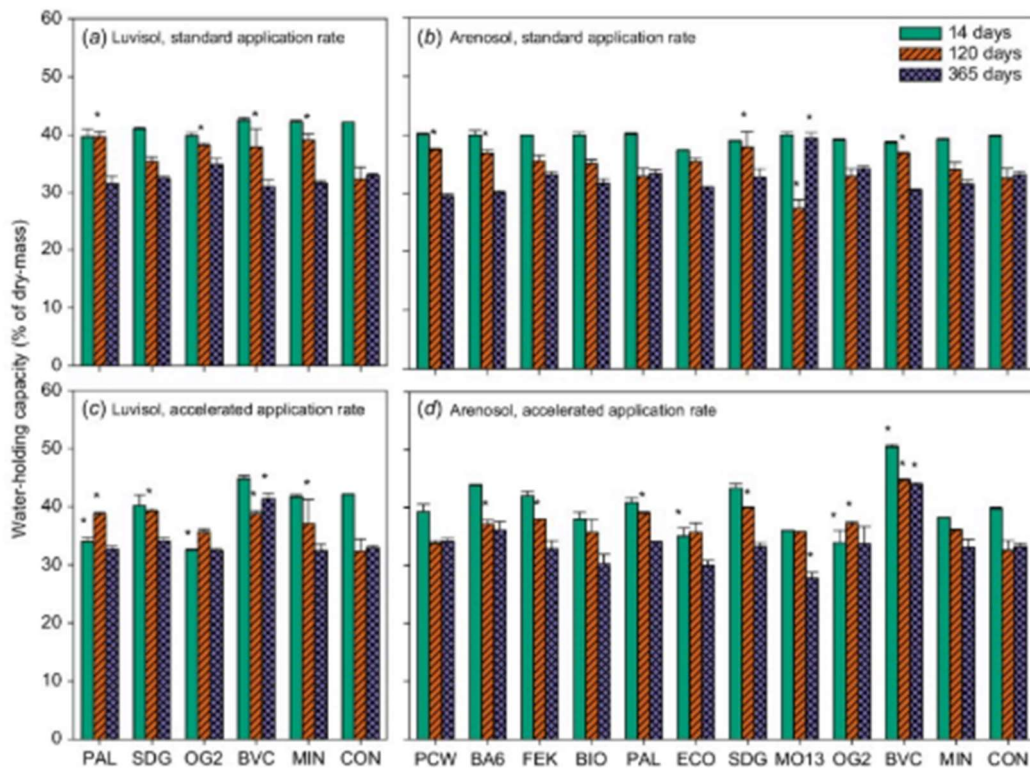
Authors: Nicolas Estoppey, Gabriela Castro, Gøril Aasen Slinde, Caroline Berge Hansen, Mari Engvig Løseth, Katinka Muri Krahn, Viona Demmer, Jørgen Svenni, Teresa-Van-Anh Thi Tran, Alexandros G. Asimakopoulos, Hans Peter H. Arp, Gerard Cornelissen

HIGHLIGHTS

- Fertilizers from biowaste, sewage sludge and agro/food industry waste were assessed.
- Packaging plastic concentrations in biowaste fertilizers exceeded the EU limit.
- Small amounts of non-packaging plastics were found in other fertilizers.
- Low concentrations of DEHP and phthalate metabolites were measured in all fertilizers.
- Phthalate metabolites bioaccumulated in earthworms.

Follow the link to read the full publication <https://doi.org/10.1016/j.scitotenv.2024.170501>

Effects of biobased fertilisers on soil physical, chemical and biological indicators – a one-year incubation study



Authors: Lærke Wester-Larsen, Lars Stoumann Jensen, Johannes Lund Jensen and Dorette Sophie Müller-Stöver



HIGHLIGHTS

- A laboratory study investigating the effects of novel biobased fertilisers on soil quality indicators.
- Overall, the application of biobased fertilisers improved soil quality.
- Compost improved soil quality most, followed by a plant-based fertiliser and a biogas digestate.
- The amount of total and easily degradable carbon added was only related to some positive effects.
- Some but not all effects of long-term field application of compost could be predicted in the laboratory.

Follow the link to read the full publication in Soil Research:

<https://doi.org/10.1071/SR23213>

There are many more publications that are in a process of review currently. If interested in reading them, make sure you follow LEX4BIO community on [ZENODO!](#)



LEX4BIO BLOG – an expert voice

Phosphorus – a finite and strategic resource for agricultural production and food security

by admin_lex4bio | Apr 5, 2024 | Blog



In March 2024 we started a blog section on the project's website, to talk about key aspects of LEX4BIO work in a popular language so that we can reach a broader and more diverse audience and have a greater impact. Our consortium experts contributed articles, offering insights and expert knowledge on bio-based fertilisers, nutrient recycling and agronomic efficiency.

Enjoy reading them all [here](#).



LEX4BIO VIDEO

What is a more compelling way to tell a story about P and N than a video?

For broadening the reach and enhancing the understanding of LEX4BIO key outputs, we developed a professional animated video featuring in a visually appealing way the need for the research within LEX4BIO, the solutions it offers through its achieved results, impact in the context of circular economy and Green Deal as well as considerations for the way ahead. The video targets policy makers, industry stakeholder groups and general public and was launched in March 2024.

It was played during the final events of LEX4BIO, NERM and ManuResource, and is uploaded to the website for all minds curious about soil and agriculture to watch it





Networking as key to an amplified impact

Since the beginning of LEX4BIO project, networking activities have been undertaken to ensure cross-cooperation with relevant projects and clusters at EU scale.

ESNI round table discussions at ManuREsource 2024

The ESNI Community was represented at the ManuREsource Conference through four dynamic round table discussions. These sessions focused on the pivotal role of manure in driving the transition towards a circular economy and sustainable resource management.

The insightful discussions were facilitated by the four dedicated ESNI Working Groups:

1. Technologies for nutrient recycling coordinated by FERTIMANURE

2. Agronomic performance of fertilising products coordinated by LEX4BIO

3. Sustainability assessment coordinated by NOVAFERT

4. Policy coordinated first by NUTRI2CYCLE and currently led by RENU2CYCLE

Each session provided invaluable insights and strategies to accelerate the adoption of sustainable practices in nutrient management, contributing to the broader goal of fostering a circular economy.





Workshops on Nutrient Recycling Policy by ESPP



European Sustainable Phosphorus Platform

Workshops on Nutrient Recycling Policy

13 March 2024 - Policy tools to support market pull for recycled nutrients

14 March 2024 - Proposing UWWT Directive targets for P and N recovery

www.phosphorusplatform.eu

LEX4BIO joined the European Sustainable Phosphorus Platform (ESPP)'s Workshops on Nutrient Recycling Policy held on 13 and 14 March in Brussels and online.

Over the two days the event comprised two sessions. The first, dedicated to policy tools to support market pull for recycled nutrients which could achieve consensus across industry and users. LEX4BIO project partner Ludwig Hermann, Proman Management GmbH presented a summary of the discussions of the market-pull policies at the ManuREsource Conference that took place the following week.

The second session elaborated on a proposition for the UWWT Directive targets for P and N recovery. It sought ambitious, feasible and consensus proposals for regulatory targets for phosphorus and nitrogen reuse-recycling from municipal wastewater.



**With this, LEX4BIO
story ends.**

**Thank you for being our loyal
readers and supporters. We hope
our paths cross again on the journey
of making our planet greener!**





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