

## D9.6 Practice Abstracts M36



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## Document Summary

**Deliverable Title:** D9.6 Practice Abstracts M36

**Version:** V1

**Deliverable Lead:** Iniciativas Innovadoras (INI)

**Related Work package:** WP9 Dissemination & Communication

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**Reviewer(s):** All SEA2LAND partners

**Dissemination level:**

PU, Public

**APPROVED BY:** Miriam Pinto (NEIKER)

**Grant Agreement Number:** 101000402

**Programme:** Horizon 2020 H2020-RUR-2020-1. Topic: CE-RUR-08-2018-2019-2020 - Closing nutrient cycles

**Start date of Project:** 01-01-2021

**Duration:** 48 months

**Project coordinator:** NEIKER-INSTITUTO VASCO DE INVESTIGACION Y DESARROLLO AGRARIO SA

## Abstract

This deliverable contains the resume and contents of the 31 practice abstracts already developed under the Project's activity. 37 more are expected to be delivered in the third and last batch resulting in a total of 100 practice abstracts by the end of the project.

## Disclaimer

The views expressed, and responsibility for the content of this publication, lie solely with the authors. The European Commission /REA is not liable for any use that may be made of the information contained herein.

## Glossary

<b>ABT</b>	AQUABIOTECH LIMITED
<b>AZTI</b>	FUNDACION AZTI – AZTI FUNDAZIOA AZTI
<b>BARNA</b>	BARNA SA
<b>CAPA</b>	CHAMBRE D'AGRICULTURE DES PYRÉNÉES ATLANTIQUES
<b>CATAR</b>	CENTRE REGIONAL D'INNOVATION ET DE TRANSFERT DE TECHNOLOGIE AGRORESSOURCES
<b>CAVIAR</b>	PIRINEA SL CAVIAR
<b>COPEMO</b>	SOCIETÀ COOPERATIVA PESCATORI MOLLUSCHICOLTORI
<b>D</b>	Deliverable
<b>ECRI</b>	EESTI TAIMEKASVATUSE INSTITUUT
<b>EIP-AGRI</b>	European Innovation Partnership
<b>FERTINAGRO</b>	FERTINAGRO BIOTECH SL
<b>FIBL-CH</b>	FORSCHUNGSINTITUT FÜR BIOLOGISCHEN LANDBAU STIFTUNG
<b>GRONN</b>	GRONN GJODEL AS
<b>INI</b>	INICIATIVAS INNOVADORAS SAL
<b>INIA</b>	INSTITUTO DE INVESTIGACIONES AGROPECUARIAS
<b>INPT</b>	INSTITUT NATIONAL POLYTECHNIQUE DE TOULOUSE
<b>IPS</b>	IPS KONZALTING DOO ZA POSLOVNE USLUGE
<b>ISQ</b>	INSTITUTO DE SOLDADURA E QUALIDADE
<b>M</b>	Month
<b>METK</b>	CENTRE OF ESTONIAN RURAL RESEARCH AND KNOWLEDGE
<b>NEIKER</b>	INSTITUTO VASCO DE INVESTIGACIÓN Y DESARROLLO AGRARIO SA
<b>NIBIO</b>	NIBIO – NORSK INSTITUTT FOR BIOØKONOMI
<b>NLR</b>	NORSK LANDBRUKSRADGIVING NORD NORGE
<b>NUTRI</b>	NUTRILOOP OU
<b>PA</b>	Practice Abstract
<b>UGENT</b>	UNIVERSITEIT GENT
<b>ULB</b>	UNIVERSITÉ LIBRE DE BRUXELLES
<b>UMIL</b>	UNIVERSITÀ DEGLI STUDI DI MILANO
<b>UNIVPM</b>	UNIVERSITA POLITECNICA DELLE MARCHE UNIVPM
<b>UVIC-UCC</b>	FUNDACIO UNIVERSITARIA BALMES UVIC-UCC
<b>WP</b>	WORK PACKAGE

## 1 Introduction

The European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI) was launched by the European Commission (EC) in 2012. This initiative aimed to help all EU countries to provide their citizens with a more competitive economy, better jobs, and life standards, fostering a competitive and sustainable agriculture and forestry sector that "achieves more from less".

The EIP-AGRI adheres to the "interactive innovation model", which brings together specific actors (e.g., farmers, advisors, researchers, businesses, etc.) to work in multi-actor projects to find a solution for a specific issue or develop a concrete opportunity. In this sense, communicating about projects activities and results is much easier by a common format (see Figure 1) which facilitates the knowledge flow and enables contacting farmers, researchers and all the other actors involved in innovation projects. The EIP common format consists of a set of basic elements characterising the project, including practice abstracts (PAs). The format is developed with the aim to enable contact with partners, incentivize efficient knowledge exchange and disseminating the results of the project in a concise and easily understandable way to practitioners.

All the PAs generated during the life cycle of SEA2LAND project will be periodically uploaded to the EIP-AGRI, where the information is shared at the EU level, via the EIP-AGRI project database, a unique repository which supports the dissemination of results of all interactive innovation projects. In addition, these PAs will be a useful dissemination tool to share the updates and outcomes of SEA2LAND with the EIP-AGRI subgroup of innovation.

This document presents 31 PAs that have been mainly developed based on the outcomes of the deliverables and results obtained in the demonstration pilots during the last months of the project.

## 2 Methodology

PAs are short summaries of around 1000 - 1500 characters (word count – no spaces) which describe the main information/recommendations and serve end users in their daily practice. All PAs have been prepared following the guidance and Common Format of EIP-AGRI (see Figure 1) in the shape of an Excel template. Every PA must be accompanied by a short title of no more than 150 characters.

This deliverable presents the abstract practices with another design that has been prepared in order to publish them on the project website. However, this design contains the main information as required in the EIP-AGRI format (see Figure 2):

- Main results/outcomes of the activity (expected or final).
- Main practical recommendations such as the main added value/benefit/opportunities to the end user.

Both the summary and the title may be also provided in the native language of the coordinator or one of the partners. However, an English version of PAs must always be available. In addition to the PAs, the Excel template contains general information about the project, including keywords, list of partners and contacts, website and audio-visual material.

Please note that the following practice abstracts have not yet been validated by EIP-AGRI.

**EUROPEAN COMMISSION**  
 DIRECTORATE-GENERAL FOR AGRICULTURE AND RURAL DEVELOPMENT

Directorate H. Sustainability and Quality of Agriculture and Rural Development  
**H.5. Research and Innovation**

**EIP-AGRI Common format for interactive innovation projects**

The interactive innovation approach under the European Innovation Partnership Agricultural Productivity and Sustainability (EIP-AGRI)<sup>[1]</sup> fosters the development of demand-driven innovation, turning creative new ideas into practical applications thanks to interactions between partners, the sharing of knowledge and effective intermediation and dissemination.

The EIP **common format** consists of a set of basic elements characterising the project and **includes one (or more) "practice abstract"(s)**. The format was developed with two main objectives:

- (1) to enable contacting partners and incentivise efficient knowledge exchange, and
- (2) to disseminate the results of the project in a concise and easy understandable way to practitioners.

The common format allows providing information all along the life-cycle of the project. **The content of the common format can be updated at any moment** when useful, for instance in an intermediate phase of the project. Project information should at least be available at the beginning (describing the situation at the start of the project, including project title and objectives) and at the end of the project (describing the results/recommendations resulting from the project, including a final project report and one or more practice abstracts).

▶ EIP-AGRI Common format

INSTRUCTIONS

PROJECT INFORMATION

PARTNERS

KEYWORDS

AUD

Figure 1. EIP-AGRI Common format

A	B	C	D	E	G	H	I	
Practice "abstract" 1:	Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.							
<p><b>Short summary for practitioners in english on the (final or expected) outcomes</b> (1000-1500 characters, word count – no spaces).</p> <p>This summary should at least contain the following information:</p> <ul style="list-style-type: none"> <li>- Main results/outcomes of the activity (expected or final)</li> <li>- The main practical recommendation(s): what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?</li> </ul> <p>This summary should be as interesting as possible for farmers/end-users, using a <u>direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.</p>		Recommended	0 character(s) / 1500					
<p><b>Short summary for practitioners in native language</b></p>		Mandatory	0 character(s) / 1500					
▶ EIP-AGRI Common format	INSTRUCTIONS	PROJECT INFORMATION	PARTNERS	KEYWORDS	AUDIOVISUAL MATERIAL	WEBSITES	PA1	PA2

Figure 2. EIP-AGRI template for PA

### 3 Summary of Practice Abstracts

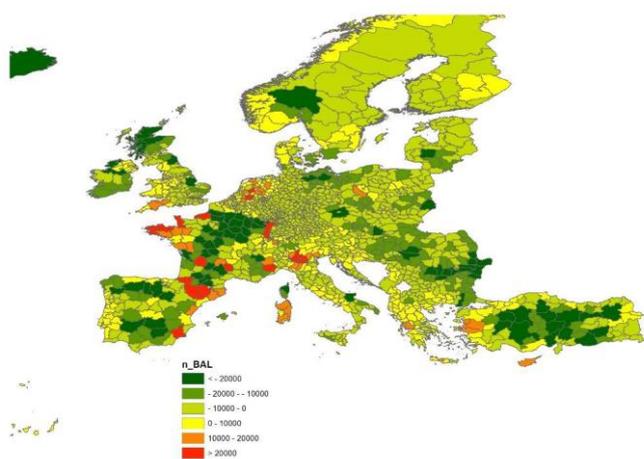
Nº	Title of the Practice Abstract	Partner	Language
1	Map Viewer of nutritional imbalance in European soils	NEIKER	English / Spanish
2	Phosphorous imbalance in Europe	NEIKER	English / Spanish
3	Biobased fertilizer (BBF) obtained from marine microalgae grown in fish processing side-streams	NEIKER	English / Spanish
4	Biobased fertilisers from fish viscera: Fish oil as a co-product	BARNA	English / Spanish
5	Baltic pilot presentation	NUTRI	English / Norwegian
6	Protocol to produce biobased fertilisers	NUTRI	English / Norwegian
7	Formulation of tailor-made fertilisers	NUTRI	English / Norwegian
8	Biobased Fertilisers (BBF) from fish viscera	AZTI	English / Spanish
9	Biorefinery scheme of the Atlantic Sea pilot: Part I -Process description	CATAR	English / French
10	Biorefinery scheme of the Atlantic Sea pilot: Part II - Process efficiency	CATAR	English / French
11	Technical aspects of Adriatic sea pilot	UNIVPM	English / Italian
12	Adriatic pilot public outreach workshop	COPEMO	English / Italian
13	Effluent solids retrieval from Atlantic salmon ( <i>Salmo salar</i> ) reared in Recirculation Aquaculture Systems	ABT	English
14	Potential valorization pathways for the marine aquaculture sludge using a biodrying process	UVIC	English / Spanish
15	Normative considerations of fishery and aquaculture by-products as feedstocks for BBFs	UVIC	English
16	New biobased fertilizers with capacity as biostimulant	FERTINAGRO	English / Spanish
17	Bokashi treatment and pelleting of fish sludge	GRONN	English / Norwegian
18	Fish sludge as fertiliser	NIBIO	English / Norwegian

19	sLCA methodology and standards applied to bio-based fertilizers from fisheries/aquaculture wastes	INPT	English / French
20	Quality and safety assessment of fertilising products derived from fishery waste and by-products	UGENT	English / Dutch
21	Nitrogen release dynamics of fertilising products derived from fishery waste and by-products	UGENT	English / Dutch
22	Assessing soil microbial activity in an Estonian field experiment with bio-based fertilizers using the enzyme dehydrogenase activity (DHA) method	METK	English / Estonian
23	Hormone-like activity tests to assess biostimulant effect of protein hydrolysate from shellfish waste	UMIL	English / Italian
24	Fertilizing effect of fish farm by-products on broccoli in Pyrénées Atlantiques, France	CAPA	English / French
25	Identifying environmental hotspots of fertilizers produced from fish and mollusc waste	FIBL-CH	English / German
26	Liming agent	NLR	English / Norwegian
27	Inventory of stakeholders	IPS	English / Croatian
28	Conclusions of the brainstorm session	IPS	English / Croatian
29	IWA Congress	UNIVPM	English / Italian
30	Impact of SEA2LAND fertilizers on Broccoli production under Belgian organic conditions	ULB	English
31	Understanding the value of freshwater aquaculture and fish processing byproducts through agro-innovative approach & technological solutions	CAVIAR	English

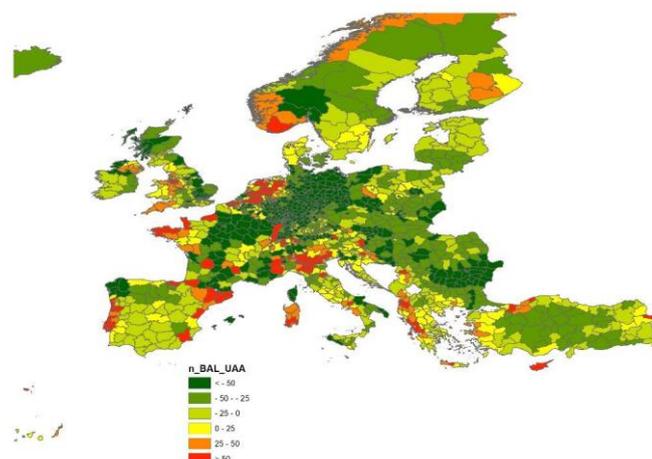
## Map Viewer of nutritional imbalance in European soils

### Main results/ outcomes

The nutrient status of European soils differs according to the parent material, the predominant crops and the management of the soil. Depending on these variables we can find soils with an excess of nutrients and others with a dramatic need of nutrients. **To evaluate these differences a European scale view has been made where the nutrient balance has been mapped on a nut3 level for the whole of Europe.** The budgets or balances used in SEA2LAND include inputs (manure, seeds and planting material and biological fixation) and outputs (removal of nutrients with the harvest of crops, harvest and grazing of fodder, removal and burning of crop residues). The difference between nutrient needs and local nutrient availability is what we have called "balance" trying to highlight the areas that need fertilizers supply and those that have a nutrient surplus. Map on N,P,K, Ca and Mg imbalances has been obtained. The results obtained are an approximation based on available data,



BAL: Nitrogen balance (Inputs minus Outputs) (tonnes N))



BAL\_UAA: Nitrogen balance per hectare

### Practical recommendations

The maps obtained can be a very useful tool for advisory services to delimit the areas most in need of fertilization as well as to determine the specific fertilizers needed in each area, while fertilizer producers can focus on the areas most in need and the nutrients most needed in each area, while politicians can use this type of mapping to define action measures in specific areas.

### Further information

[www.sea2landgisviewer.eu](http://www.sea2landgisviewer.eu)

### About this abstract

**Authors:** Miriam Pinto Tobalina, Ainara Artetxe

**Date:** November 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

The project is running from January 2021 to December 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



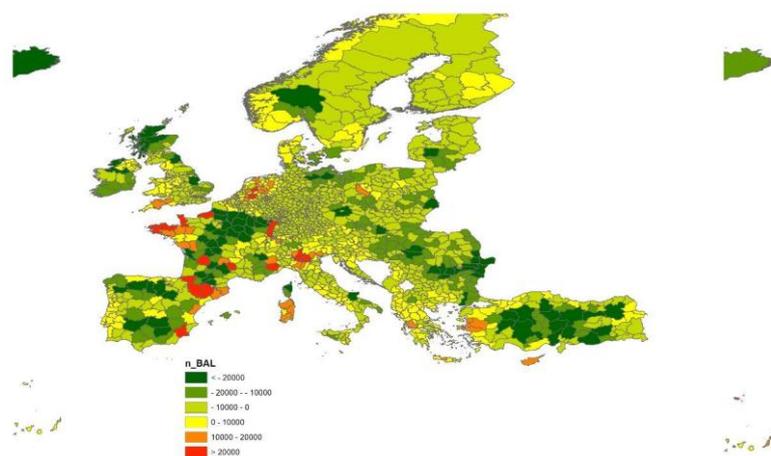
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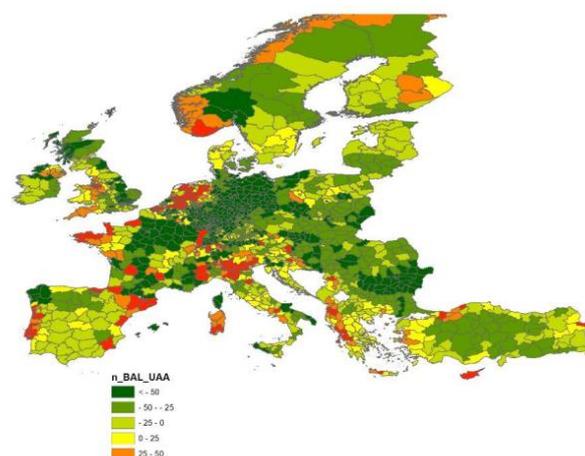
# Visor cartográfico del desequilibrio nutricional de los suelos europeos

## Resultados

El estado nutricional de los suelos europeos difiere en función del material parental, los cultivos predominantes y la gestión del suelo. Dependiendo de estas variables podemos encontrar suelos con un exceso de nutrientes y otros con una necesidad importante de nutrientes. **Para evaluar estas diferencias se ha realizado un visor a escala europea donde se ha cartografiado el balance de nutrientes a nivel nut3 para toda Europa.** Los balances utilizados en SEA2LAND incluyen entradas (estiércol, semillas y material de siembra y fijación biológica) y outputs (eliminación de nutrientes con la cosecha de cultivos, cosecha y pastoreo de forrajes, eliminación y quema de residuos de cultivos). La diferencia entre las necesidades de nutrientes y la disponibilidad local de los mismos es lo que hemos denominado "equilibrio", tratando de destacar las zonas que necesitan suministro de fertilizantes y las que tienen un excedente de nutrientes. Se ha obtenido un mapa sobre los desequilibrios de N,P,K, Ca y Mg. Los resultados son una aproximación basada en los datos disponibles en cada área



BAL: Balance de nitrógeno (Entradas menos Salidas) (toneladas de N)



BAL\_UAA: Balance de nitrógeno por hectárea

## Recomendaciones prácticas

Los mapas obtenidos pueden ser una herramienta útil para que los servicios de asesoramiento delimiten las zonas más necesitadas de fertilización, así como para determinar los fertilizantes específicos necesarios en cada zona, mientras que los productores de fertilizantes pueden centrarse en las zonas más necesitadas y en los nutrientes más necesarios en cada área, y los políticos pueden utilizar este tipo de cartografía para definir medidas de actuación en zonas concretas.

## Más información

[www.sea2landgisviewer.eu](http://www.sea2landgisviewer.eu)

## Acerca de este resumen

**Authors:** Miriam Pinto Tobalina, Iratxe Urreta, Sonia Suarez/ NEIKER

**Date:** Noviembre 2023

**SEA2LAND** es una acción colaborativa de innovación financiada por la UE en el marco del programa Horizonte 2020. El proyecto tiene como objetivo proporcionar soluciones para ayudar a superar los desafíos relacionados con la producción de alimentos, el cambio climático y la reutilización de residuos. Basado en el modelo de economía circular, SEA2LAND promueve la producción de fertilizantes a gran escala en la UE a partir de materias primas propias. Se espera que esta solución reduzca el desequilibrio de nutrientes del suelo en Europa.

El proyecto se ejecuta desde enero de 2021 hasta diciembre de 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



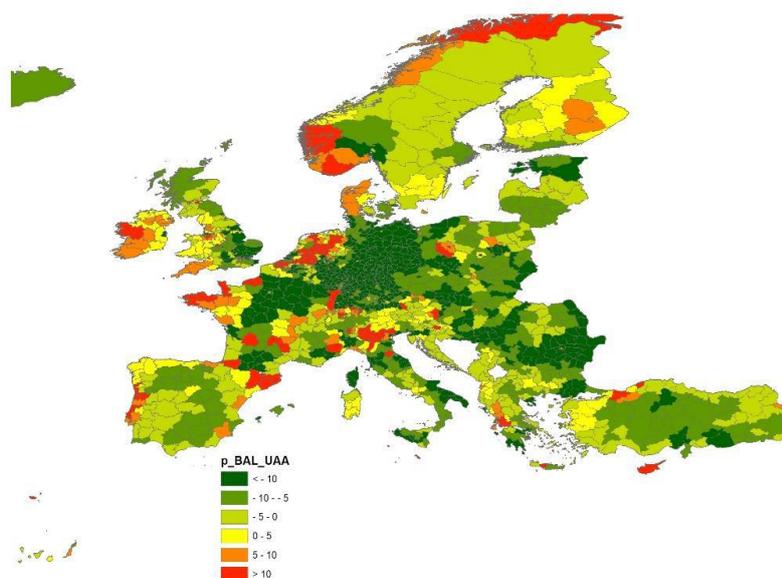
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## Phosphorous imbalance in Europe

### Main Results/ Outcomes

Using the geographical viewer developed in SEA2LAND, maps of the P requirements of the most common crops across Europe in Nut 3 and of the potential P inputs (from local organic residues) have been produced for the different geographical areas. In this way, the imbalance between P needs and "local" P available at this level has been calculated for the whole of Europe. As can be seen, the results show that the Central European area is, in general terms, a net P demander (green areas), while the surplus is mainly located in coastal and mountain areas... this could be due to the decoupling of agricultural and livestock areas.



BAL\_UAA: Phosphorus balance per hectare UAA (kg of P/ha)

### Practical recommendations

When defining fertilisation guidelines, the availability of P in the soil, which may have been caused by decades of phosphorus fertiliser application, must be taken into account. The present work only specifies whether or not crop needs can be covered by certain organic residues from the surroundings

### Further information

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### About this abstract

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**Date:** November 2023

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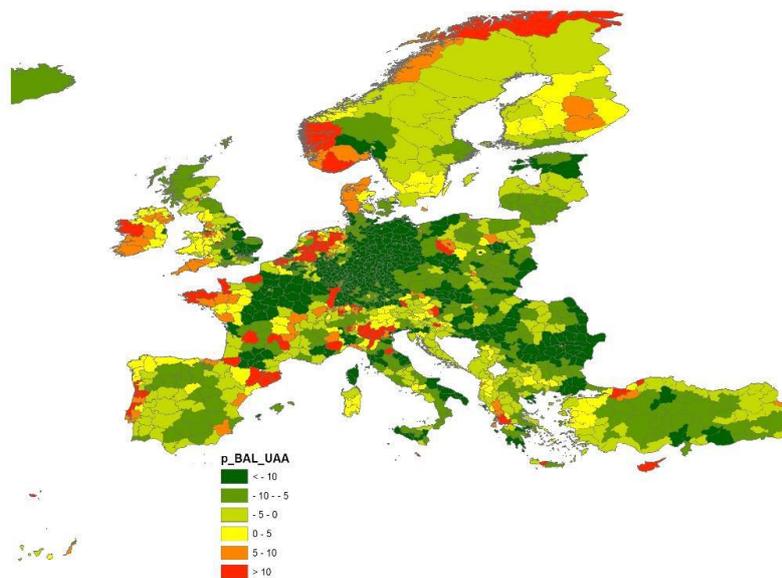
**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



## Balance de fósforo en Europa

### Resultados

Utilizando el visor geográfico desarrollado en SEA2LAND, se han elaborado mapas de las necesidades de P de los cultivos más comunes en toda Europa en el Nut 3 y de las aportaciones potenciales de P (procedentes de residuos orgánicos locales) para las diferentes áreas geográficas. De esta forma, se ha calculado el desequilibrio entre las necesidades de P y el P "local" disponible a este nivel para toda Europa. Como puede observarse, los resultados muestran que la zona centroeuropea es, en términos generales, demandante neta de P (zonas verdes), mientras que el excedente se localiza principalmente en zonas costeras y de montaña. Esto podría deberse al desacoplamiento de las zonas agrícolas y ganaderas.



BAL\_UAA: Phosphorus balance per hectare UAA (kg of P/ha)

### Recomendaciones prácticas

A la hora de definir las directrices de fertilización, debe tenerse en cuenta la disponibilidad de P en el suelo, que puede deberse a décadas de aplicación de fertilizantes fosforados. En el presente trabajo sólo se especifica si las necesidades de los cultivos pueden cubrirse con determinados residuos orgánicos del entorno..

### Más información

<https://www.frontiersin.org/articles/10.3389/fpls.2023.1073546/full>

### Acerca de este resumen

**Autoras:** Miriam Pinto Tobalina, Ainara Artetxe/ NEIKER

**Fecha:** Noviembre 2023

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# Biobased fertilizer (BBF) obtained from marine microalgae grown in fish processing side-streams

## Main Results/ Outcomes

Nitrogen-rich microalgal biomass, cultivated in brines from tuna canneries, was subjected to enzymatic hydrolysis to obtain a BBF (plant biostimulant). The obtained product contained 0.59% (w/v) total nitrogen and 32 g/L of total aminoacids, with 75% of them (24 g/L) in free form. The aminogram shows a complete profile of available amino acids (Fig 1).

This 100% algal-based product includes a diverse range of nutritive components and trace elements that are released during the hydrolysis process, such as carbohydrates (1.5% w/w), phosphorus (0.06% w/v), minerals (Ca, Cd, Co, Cu, Cr, Mg, Mn, Na, Zn and S), sterols, vitamins, and essential fatty acids. These nutrients primarily originate from the brine that supports microalgae growth.



Figura 1: Enzymatic hydrolysis of algae biomass and amino acid profile of the obtained product (BBF-biostimulant)

## Practical recommendations

Microalgae are currently acclaimed for their value as bio-based fertilizers, biostimulants, and other agrochemicals suitable for the replacement of synthetic alternatives. Algal-based BBFs can be used for foliar application and/or as soil amendments at recommended dosages of 1-3 ml/L for foliar application, and 5 L/ha for soil use. However, since these products have a partially non-specific composition, the usage dosage must be carefully established for each specific cultivar.

## Further information

<https://www.frontiersin.org/articles/10.3389/fpls.2023.1073546/full>

## About this abstract

**Authors:** Miriam Pinto Tobalina, Iratxe Urreta, Sonia Suarez/ NEIKER

**Date:** November 2023

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## BBF obtenido a partir de microorganismos marinos crecidos en salmuera de conserveras

### Resultados

La biomasa de microalgas producida empleando salmuera de conserveras de atún como medio de crecimiento, se sometió a hidrólisis enzimática para obtener un fertilizante/bioestimulante (BBF). El producto obtenido presenta un contenido total de nitrógeno del 0.59% (v/v) y 32 g/L de aminoácidos totales, de los cuales un 75% (24 g/L) está en forma libre. El aminograma de la Fig 1 muestra el perfil completo de aminoácidos disponibles.

Este producto 100% a base de algas incluye una amplia gama de componentes nutritivos y elementos de traza que se liberan durante el proceso de hidrólisis, como carbohidratos (1,5% p/p), fósforo (0,06% p/v), minerales (Ca, Cd, Co, Cu, Cr, Mg, Mn, Na, Zn y S), esteroides, vitaminas y ácidos grasos esenciales. Estos nutrientes se originan principalmente de la salmuera que favorece el crecimiento de las microalgas.



Figura 1: Hidrólisis enzimática de la biomasa de algas y perfil de aminoácidos del hidrolizado (BBF-Biofertilizantes)

### Recomendaciones prácticas

Hoy en día hay un auge en el uso de microalgas para la obtención de fertilizantes de origen biológico, bioestimulantes y otros agroquímicos que pueden reemplazar o complementar alternativas sintéticas.

Los BBF obtenidos a partir de microalgas se pueden emplear mediante aplicaciones foliares y/o como enmiendas para el suelo. En general, las dosis recomendadas son de 1-3 ml/L para aplicación foliar y 5 L/ha para uso en el suelo. No obstante, debido a la composición parcialmente inespecífica de estos productos, es recomendable hacer ensayos para determinar las dosis específicas de uso más adecuadas para diferentes cultivos.

### Más información

<https://www.frontiersin.org/articles/10.3389/fpls.2023.1073546/full>

### Acerca de este resumen

**Authors:** Miriam Pinto Tobalina, Iratxe Urreta, Sonia Suarez/ NEIKER

**Date:** Noviembre 2023

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El proyecto se ejecuta desde enero de 2021 hasta diciembre de 2024

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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## Biobased fertilisers from fish viscera: Fish oil as a co-product

### Main results / outcomes



**Fig. 1:** Separation of oil by decantation from trout viscera.

When obtaining biofertilizers from fish viscera, one of the first aspects to take into account is their high oil content. In the case of rainbow trout (*Oncorhynchus mykiss*), the oil content of the viscera can reach up to 60% of its fresh weight. In the experiments that have been carried out, it has been observed that the higher the oil content, the lower the yield of biofertilizer obtained. Therefore, it is necessary to separate as much oil as possible in a step prior to the hydrolysis reactions. The quality of the separated oil influences its selling price as a valuable coproduct and therefore the economic feasibility of obtaining biofertilizers from fish viscera.

### Practical recommendations

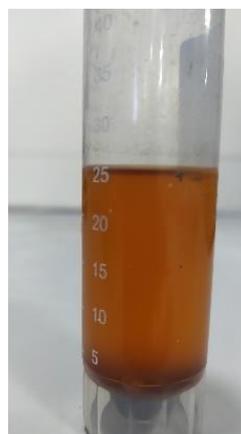
To ensure that the physico-chemical parameters of the separated oil are adequate, it is necessary:

- Avoid, as far as possible, the contact of digestive enzymes with the separated oil.
- Keep the viscera in refrigerated conditions (+4°C).
- Reduce as much as possible the waiting time for processing.

Considering these aspects, we will achieve adequate oil quality values that will allow us to market the oil without additional processes.



**Fig 2:** Oil separated from whole, refrigerated viscera.  
FFA (Free Fatty Acid): 2.7%.  
Peroxides: 3.5 meqO<sub>2</sub>/kg



**Fig. 3:** Oil separated from broken, refrigerated viscera.  
FFA (Free Fatty Acid): 19 %  
Peroxides: 9,8 meqO<sub>2</sub>/kg

### About this abstract

**Authors:** Iñaki Aramburu/BARNA; Carlos Bald/AZTI; Joaquin Romero/FERTINAGRO.

**Date:** November 2023

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# Biofertilizantes a partir de vísceras de pescado: Aceite de pescado como co-producto

## Principales avances / resultados



**Fig. 1:** Separación de aceite mediante decantación a partir de vísceras de trucha

En la obtención de biofertilizantes a partir de vísceras de pescado, uno de los primeros aspectos a tener en cuenta es su elevado contenido en aceite. En el caso de la trucha arco iris (*Oncorhynchus mykiss*) el contenido en aceite en las vísceras puede llegar hasta el 60% de su peso fresco. En los experimentos que se han llevado a cabo, se ha observado que cuanto mayor es la presencia de aceite menor es el rendimiento de obtención de biofertilizante. Por tanto, es necesario separar la mayor cantidad posible de aceite en un paso previo a las reacciones de hidrólisis. La calidad del aceite separado como coproducto de alto valor influye en su precio de venta y por tanto en la rentabilidad de la obtención de biofertilizantes a partir de vísceras de pescado.

## Recomendaciones prácticas

Para conseguir que los parámetros físico-químicos del aceite separado sean adecuados es necesario:

- Evitar, en la medida de lo posible, el contacto de los enzimas digestivos con el aceite.
- Mantener las vísceras en condiciones de refrigeración (+4°C)
- Disminuir en lo posible el tiempo de espera para el procesado.

Teniendo en cuenta estos aspectos conseguiremos unos valores adecuados de acidez que nos permitirán comercializar el aceite sin procesos adicionales.



**Fig. 2:** Aceite separado de víscera entera, refrigerada.  
Acidez: 2,7%  
Peróxidos: 3,5 meqO<sub>2</sub>/kg



**Fig. 3:** Aceite separado de víscera rota, refrigerada.  
Acidez: 19 %  
Peróxidos: 9,8 meqO<sub>2</sub>/kg

## Acerca de este resumen

**Autores:** Iñaki Aramburu/BARNA; Carlos Bald/AZTI; Joaquin Romero/FERTINAGRO.

**Fecha:** November 2023

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## Baltic pilot presentation

### Main results / outcomes

Baltic Sea pilot develops bokashi fermentation technology, which is currently available for home users, into a community scale biowaste recycling solution. It also combines this technology with vermicomposting and granulation. An aim is to achieve an economically viable model.

### Practical recommendations

The technology aims to replace the conventionally used technology of regular composting, thus reducing GHG emissions and providing products with more active microbiology to enhance soil biology. The key features are use of single screw extruder for granulation instead of matrix method and solar-powered tumbler dryer as an environmentally friendly alternative. In addition, a 10 m<sup>3</sup> mixing unit was selected to handle pre-granulation and pre-vermicomposting mass with capacity of 20 000L per month. Vermicomposting unit was enhanced by infrared lights to keep temperature warm with minimal cost and impact.

The following side-stream raw materials were selected for the production: fish waste (salmon scraps: heads, bones, collars, cheeks, spines and bellies); food waste from HORECA; tree leaves; wood burning ash. As a result, BBF-s foliar spray, bokashi granule, vermicompost and IP ferment have been produced.



Figure 1: Field trial with granules



Figure 2: Mixing unit of the pilot plant

### Further information

<https://fb.watch/d6WJsQy9z8/>; [https://www.youtube.com/watch?v=lk9q1y\\_PEl](https://www.youtube.com/watch?v=lk9q1y_PEl);  
<https://nutrilooop.org/horizon2020-sea2land/>; <https://nutrilooop.org/producing-advanced-bio-based-fertilizers/>

### About this abstract

**Authors:** Nutrilooop OÜ

**Date:** December 2023

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## Läänemere piloodi esitlus

### Tulemused

Läänemere piloodi eesmärk on arendada välja majanduslikult äratasuv mudel biojätmete (sh kalajäätmete) bokashi fermenteerimiseks, granuleerimiseks ja vermikompostimiseks, et asendada tavapärase kompostimine keskkonnasõbralikuma alternatiiviga.

### Praktilised soovitused

Hetkel on see tehnoloogia kättesaadav peamiselt kodukasutajatele, kuid piloodis lisatakse kogukondlikule skaalale vastav tööstuslik aste. Selle tulemusel valmisid kolm biopõhist väetist – graanulid, vedelväetis ja vermikompost, millest graanulid valiti välja ka põldkatsete jaoks (vt foto 1). Toormaterjalidest kasutati kalatööstuse jääke (lõhe pead, luud, sisikond), restorani biojätmeid, puidupõletuse tuhka ja puulehti. Tehnoloogiline lahendus hõlmas tavapärase maatriksi meetodi asemel toiduainetööstuse jaoks mõeldud ühe kruviga ekstruuderi kasutamist granuleerimisel ning päikeseenergiaga trummel-kuivati kasutamist niiskuse eemaldamiseks. Eesmärk oli igas tootmisetapis säilitada bokashi fermenteerimise abil saavutatud rikkalik mikrobioloogia. Kasutusele võeti ka suuremate koguste segamiseks sobilik mikser, tootlikkusega kuni 20 000L kuus (vt foto 2). Vermikompostimisel kasutati vajaliku soojuse hoidmiseks infrapunalampe.



Foto 1: Põldkatsed METKis



Foto 2: Substraadi segamine

### Lisainfo

<https://fb.watch/d6WJsQy9z8/>; [https://www.youtube.com/watch?v=Ik9q1y\\_PEl](https://www.youtube.com/watch?v=Ik9q1y_PEl);  
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### Uudiskirja kohta

**Autor:** Nutrilooop OÜ

**Kuupäev:** Detsember 2023

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**Veebileht:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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## Protocol to produce biobased fertilisers

### Main results / outcomes

In Baltic Sea pilot, bokashi fermentation technology has proven to be a safe and economically viable method recycling fish waste in local communities and vermicomposting has proven to be an effective and economically viable method for after-treatment of fermented fish waste.

### Practical recommendations

There are five main steps in producing the biobased fertilizers through bokashi fermentation and vermicomposting technologies. The aim is to replace conventionally used regular composting, thus reducing the GHG emissions and providing products with more active microbiology that enhance the soil biology. The procedure begins with side stream preparation and impurities removal; followed by fermentation, mixing of the organic mass and liquid separation; followed by granulation and drying or vermicomposting and sieving. The main output products are bokashi granules which qualify under the Regulation (EU) 2019/1009 as organic fertilizer; foliar spray which is a potential biostimulant and vermicompost which can be marketed as soil improver/growing medium.



Figure 1 : Mixing unit



Figure 2: Granulation unit

### Further information

<https://fb.watch/d6WJsQy9z8/>; [https://www.youtube.com/watch?v=lk9q1y\\_PEl](https://www.youtube.com/watch?v=lk9q1y_PEl);  
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## Bioväetiste tootmise protokoll

### Tulemused

Läänemere piloodis tõestati kasulike mikroorganismide (bokashi) abil kala- ja restoranijätmetest orgaaniliste väetiste tootmise võimalikkust, turvalisust ning majanduslikku äratasuvust kohalikul skaalal. Vermikompost osutus fermenti järeltöötlemisel efektiivseks meetodiks.

### Praktilised soovitused

Piloodi eesmärk on asendada tavapäraselt kasutatav aunkompostimine fermenteerimise ja saadud fermenti osalise vermikompostimisega, et vältida kuumutamist ning seeläbi toota bioväetised, mis sisaldavad kasulikke mikroorganisme, amino-, fulvo- ja humiinhappeid ning suuremal määral orgaanilist ainet ja toitaineid. Tootmisprotseduur koosneb viiest peamisest etapist, alustades toormaterjalist võimalike võõraste eemaldamisega, millele järgneb fermenteerimine ja orgaanilise massi segamine. Seejärel eemaldatakse fermenti vedelik, mis on juba valmis vedelväetisena kasutamiseks. Seejärel liigub osa fermentist granuleerimise üksusse ning seejärel kuivatise. Teine osa fermentist suunatakse koos puulehtedega vermikompostimisse ning seejärel sõelumisse. Peamised väljundtooted on bokashi graanulid, mis kvalifitseeruvad määruse (EL) 2019/1009 kohaselt orgaaniliseks väetiseks; vedelväetis, mis on potentsiaalne biostimulant ja vermikompost, mida saab turustada mullaparandusaine või kasvusubstraadina.



Foto 1: Substraadi segamine



Foto 2: Granuleerimise katsed

### Lisainfo

<https://fb.watch/d6WJsQy9z8/>; /; [https://www.youtube.com/watch?v=Ik9q1y\\_PEl](https://www.youtube.com/watch?v=Ik9q1y_PEl);  
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### Uudiskirja kohta

**Autor:** Nutriloop OÜ

**Kuupäev:** Detsember 2023

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## Formulation of tailor-made fertilisers

### Main results / outcomes

In the Baltic Sea pilot, three biobased fertilizers (BBFs) such as granules, foliar spray and vermicompost have been formulated through bokashi fermentation of fish waste, HORECA waste, tree leaves and wood burning ash.

### Practical recommendations

The same batch of fish and HORECA waste will be used for all BBFs. Fermentation liquid does not need any additional ingredients and can already be used as a foliar spray. For the vermicompost, adding tree leaves is necessary to achieve an optimal 25-30:1 C-N ratio. For the granules, adding tree leaves to increase the content of C and ~10% wood-burning ash to balance the pH level is necessary. The challenge with the formulation lies in the fluctuation of the content of HORECA food waste stream. Hence, it will not be possible to provide exact nutritional or biostimulative data which would apply to all batches. The solution is to provide respective ranges. In general, the foliar spray has a high level of lactic acid bacteria, although its effect as a biostimulant requires further research; granule is an organic fertilizer with a potential as carbon storage in soils, and contains amino, fulvic and -humic acids; vermicompost is a potential growing medium that also requires further testing.



Figure 1: granules



Figure 2: vermicompost

### Further information

<https://fb.watch/d6WJsQy9z8/>; [https://www.youtube.com/watch?v=lk9q1y\\_PEl](https://www.youtube.com/watch?v=lk9q1y_PEl);  
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## Biojäätmepõhiste orgaaniliste väetiste arendamine

### Tulemused

Läänemere piloodis valmisid kolm biopõhist väetist – graanulid, vedelväetis ja vermikompost. Toomaterjaliks olid: kalatööstuse jäägid, restorani biojäätmed, puidupõletuse tuhk ja puulehed.

### Praktilised soovitusused

Kõik kolm biopõhist väetist kasutavad sama sisendit – fermenteeritud kala- ja restorani jäätmed. Kasulike mikroorganismidega (bokashi) fermenteerimisel eralduv vedelik on juba valmis vedelväetis. Vermikomposti tootmiseks tuleb fermentile lisada puulehti, et saavutada optimaalne 25-30:1 C-N suhe. Graanulite tootmiseks tuleb lisada fermentile lisaks puulehtedele ka puidupõletuse tuhka, et alandada pH taset.

Peamine väetiste formuleerimisega seonduv väljakutse on restorani biojätmete koostise lai varieeruvus, mis ei võimalda tagada kindla toitainesaldusega lõpp-tooteid. Võimaliku lahendusena saab kliendile pakkuda toitainesalduse vahemiku. Graanulid on kõrge orgaanilise aine ja piimhappebakterite sisaldusega ning kvalifitseeruvad orgaaniliseks väetiseks. Vedelväetis sisaldab lisaks piimhappebakteritele ka humiini ja fulvo happeid, kuid selle biostimulandina kasutamine nõuab täiendavaid uuringuid. Vermikompost on potentsiaalne kasvusubstraat.



Foto 1: Graanulid



Foto 2: Vermikompost

### Lisainfo

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## Biobased Fertilisers (BBF) from fish viscera

### Main results/outcomes



Trout evisceration process  
(Source: Caviar Pirinea).

Two different protein hydrolysates have been obtained from trout viscera using commercial enzymes and acid autolysis (silage) at pilot scale (3 x 75 kg per batch and 758 kg of viscera respectively).

While the enzymatic hydrolysis occurs in a few hours in controlled temperature and alkaline pH conditions, silage takes several days at room temperature in strong acidic conditions (pH between 3.5 and 4.0).

The hydrolysates achieved 54 and 49 % (D.M.) of free amino acids respectively. They have been used in the formulation of biobased fertilisers (BBF) with potential bio-stimulant effect. The product formulated with the silage qualifies as organic fertiliser following EU Regulation and is being tested in field trials.

### Practical recommendations

Oil content in rainbow trout viscera varies between 50 and 80% depending on the season. Maximum oil separation before the hydrolysis of the fish viscera is a key factor to improve the hydrolysis performance and to obtain a good quality fish oil as a valuable co-product in both, enzymatic hydrolysis and silage. Ambient temperature determines the duration of the autolysis, the time until the silage liquefies completely. While enzymatic hydrolysis is more efficient in producing FAA, silage can be a cost-efficient alternative. Shelf-life of the resulting bio stimulant products needs to be studied in deeper.



Enzymatic hydrolysis pilot  
(Source: BARNA).



Liquid BBF prototypes  
(Source: FERTINAGRO).



Fish viscera silage  
(Source: AZTI)

### About this abstract

**Authors:** Carlos Bald/AZTI; Mónica Gutierrez/AZTI; Iñaki Aramburu/BARNA; Joaquin Romero/FERTINAGRO.

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# Biofertilizantes a partir de vísceras de pescado

## Principales avances/resultados



Proceso de evisceración de truchas  
(Fuente: Caviar Pirinea).

A partir de vísceras de trucha se han obtenido dos hidrolizados proteicos diferentes utilizando enzimas comerciales y autólisis ácida (ensilado) a escala piloto (3 x 75 kg por lote y 758 kg de vísceras respectivamente). Mientras que la hidrólisis enzimática se produce en pocas horas en condiciones de temperatura controlada y pH alcalino, el ensilado tarda varios días a temperatura ambiente en condiciones de alta acidez (pH entre 3,5 y 4,0). Los hidrolizados alcanzaron el 54% y el 49% (S.S.S.) de aminoácidos libres respectivamente. Se han utilizado en la formulación de fertilizantes con un potencial efecto bioestimulante. El producto formulado con el ensilado cumple con los requisitos para ser abono orgánico según la normativa de la UE y está siendo probado en ensayos de campo.

## Recomendaciones prácticas

El contenido de aceite en las vísceras de trucha arco iris varía entre el 50 y el 80% dependiendo de la temporada. La máxima separación del aceite antes de la hidrólisis de las vísceras de pescado es un factor clave para mejorar el rendimiento de la hidrólisis y obtener un aceite de pescado de buena calidad como un valioso coproducto tanto en la hidrólisis enzimática como en el ensilado. La temperatura ambiente determina la duración de la autólisis, el tiempo hasta que el ensilado se licua por completo. Si bien la hidrólisis enzimática es más eficiente en la producción de FAA, el ensilado puede ser una alternativa rentable. La vida útil de los productos bioestimulantes resultantes se estudiará más a fondo.



Piloto de hidrólisis enzimática  
(Fuente: BARNÁ).



Prototipos de biofertilizantes  
(Fuente: FERTINAGRO).



Ensilado de vísceras  
(Fuente: AZTI)

## Acerca de este resumen

**Autores:** Carlos Bald/AZTI; Mónica Gutierrez/AZTI; Iñaki Aramburu/BARNA; Joaquin Romero/FERTINAGRO.

**Fecha:** November 2023

El proyecto **SEA2LAND** es una acción colaborativa de innovación (IA) financiada por la UE en el marco del programa Horizonte 2020. El proyecto tiene como objetivo proporcionar soluciones para ayudar a superar los desafíos relacionados con la producción de alimentos, el cambio climático y la reutilización de residuos. Basado en el modelo de economía circular, SEA2LAND promueve la producción de fertilizantes a gran escala en la UE a partir de materias primas propias. Se espera que esta solución reduzca el desequilibrio de nutrientes del suelo en Europa.

El proyecto se desarrollará desde enero de 2021 hasta diciembre de 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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# Biorefinery scheme of the Atlantic Sea pilot: Part I - Process description

## Main results / outcomes

The Atlantic case aims at producing BBF's from fish by-products using ThermoMechanoChemical (TMC) fractionation by twin-screw extrusion. Configured as an extraction tool, extrusion represents an industrial continuous process providing simultaneously a solid and a liquid fraction. The use of TMC process for fertilizers production from fish by-products is an innovative approach that enables the recovery of not only BBFs but also fish oil to reach a ZERO-waste process. The biorefinery scheme integrates the extruder as main technology but also includes pretreatment units and downstream processes. The process was developed from TRL4 to TRL7. The optimization of the TMC process included the following operating parameters: screw profile, screw speed, temperature, fish by-products feed rate, L/S ratio, enzymes introduction. The efficiency was evaluated by measuring the yield and selectivity in N, P, K and lipids in the different fractions.

## Practical recommendations

To assess the properties of the final products and to avoid microbial development, the raw materials must be kept under the cold chain: +4°C (direct use) or frozen (delayed fractionation). Up to TRL7, grinding the fish by-products is necessary to introduce them into the extruder. This can be avoided at TRL8-9 on larger extruders. Nevertheless, grinding allows fractioning all fish heads and frames, independently of species and their morphology (size, shape,...). If we want also to process viscera, they should be sorted, to remove impurities such as stones that can severely damage the extruder. And so whatever the TRL.

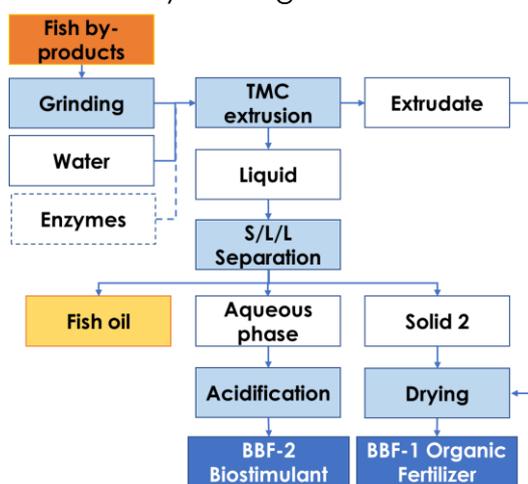


Figure 1: Biorefinery scheme

The solid/liquid separation in the TMC process is very sensitive. Little modification in the operating parameters could be responsible in losing the dynamic equilibrium.

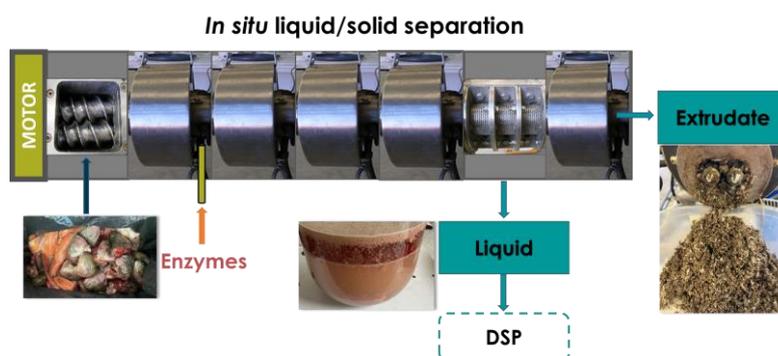


Figure 2: Principle of the fractionation by twin-screw extrusion

## Further information

"Extrusion" in Green Food Processing Techniques: Preservation, Transformation and Extraction, Publisher: Elsevier (2019) DOI: [10.1016/B978-0-12-815353-6.00010-0](https://doi.org/10.1016/B978-0-12-815353-6.00010-0)

## About this abstract

**Authors:** Laure CANDY, Clément CHASTRETTE & Christine RAYNAUD / CATAR

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# Schéma de bioraffinerie du pilote de la zone Atlantique: Partie I – Description du procédé

## Résultats principaux

L'unité pilote Atlantique vise à produire des engrais biosourcés (BBFs) à partir de sous-produits de la pêche et de l'aquaculture en utilisant le fractionnement thermomécánico-chimique (TMC) par extrusion bi-vis. Configurée comme un outil d'extraction, l'extrusion représente un processus industriel continu fournissant simultanément une fraction solide et une fraction liquide. L'utilisation du procédé TMC pour produire des engrais à partir de co-produits de poissons est une approche innovante qui permet de récupérer non seulement les BBFs mais aussi l'huile de poisson, afin d'obtenir un procédé ZERO déchet. Le schéma de bioraffinerie intègre l'extrudeur en tant que technologie principale, mais aussi des unités de prétraitement et de post-traitement.

Le processus a été développé de TRL4 à TRL7. L'optimisation a porté sur les paramètres : profil et vitesse de vis, température, débit d'alimentation, rapport L/S, introduction d'enzymes. L'efficacité a été évaluée en mesurant le rendement et la sélectivité en N, P, K et lipides dans les fractions.

## Recommandations pratiques

Pour valider les propriétés des BBF's et éviter le développement microbien, les matières premières doivent respecter la chaîne du froid.

Jusqu'à TRL7, il est nécessaire de broyer les co-produits pour les introduire dans l'extrudeur, ce qui peut être évité aux TRL8-9 sur des extrudeurs plus grands. Néanmoins, le broyage permet de fractionner toutes les têtes et arêtes indépendamment de l'espèce et donc de la morphologie.

Si l'on veut également traiter les viscères, il faut les trier afin d'éliminer les impuretés telles que les cailloux qui peuvent gravement endommager l'extrudeuse. Et ce, quel que soit le TRL.

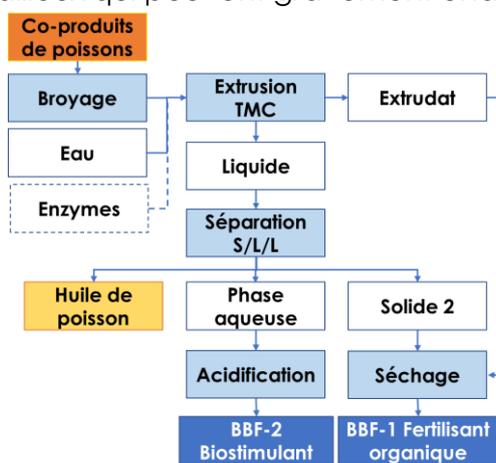


Figure 1: Schéma de bioraffinerie

La separation solide/liquide dans l'extrudeur est très sensible. Une légère modification des paramètres opératoires peut être responsable de la perte de l'équilibre dynamique.

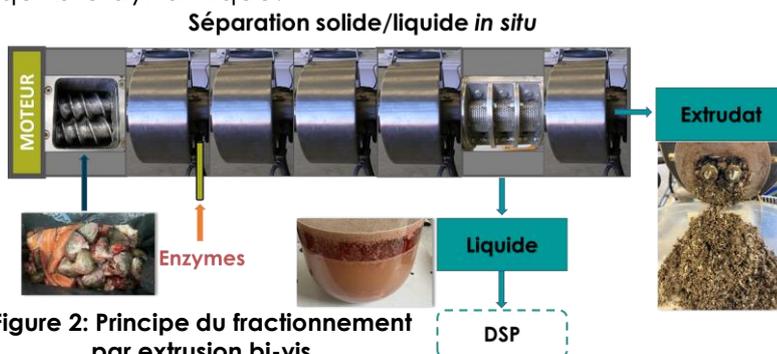


Figure 2: Principe du fractionnement par extrusion bi-vis

## Informations complémentaires

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## Biorefinery scheme of the Atlantic Sea pilot: Part II - Process efficiency

### Main results / outcomes

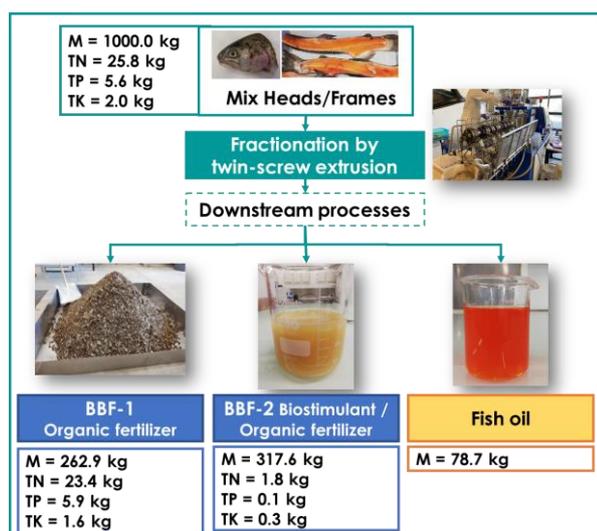
The process was developed from TRL4 to TRL7. The feed rate in Steelhead trout by-products (50/50 heads/frames) were of 5-10 kg/h and 100-200 kg/h respectively.

1000 kg fish by-products provide 2 BBF's: i) BBF-1, a major fraction of 263 kg of an organic solid BBF (97% DM, 9% N/DM), ii) BBF-2, a minor fraction 320 kg of a liquid organic BBF (5% DM, 11% N/DM). The agronomic efficiency was tested in pot trials without formulation and the solid BBF was selected for field trials. BBF-1 is high P available and medium N available and it conforms in terms of quality and safety assessment for organic fertilizer. BBF-2 is high N available even if not concentrated enough to be directly used as fertilizer.

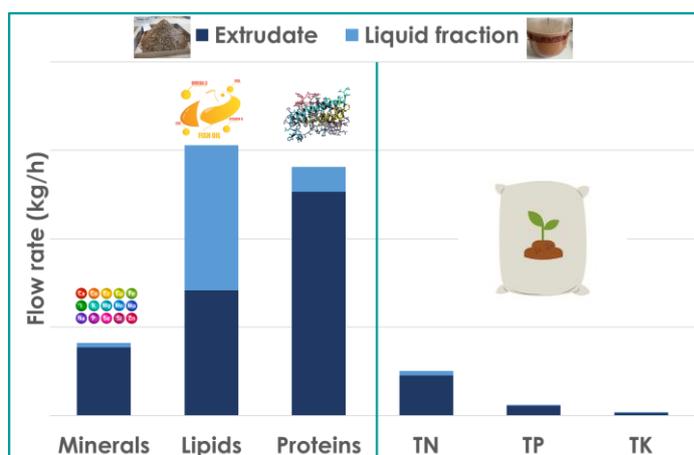
In addition, the process generates about 80 kg of fish oil, rich in omega 3 (5.1% in EPA+DHA) and also in the red carotenoid astaxanthin (11 mg/kg) which makes it highly prized in the food and feed sectors.

### Practical recommendations

To consider BBF-2 as: i) a liquid organic fertilizer or ii) a biostimulant rich in free amino-acids, it should respectively: i) be concentrated to reach a 40-50% DM content or ii) undergo an enzymatic batch hydrolysis followed by concentration and stabilization (acidification) steps.



**Figure 1:** Overall mass distribution in the Atlantic biorefinery



**Figure 2:** Mass balance distribution in the TMC processing unit

### Further information

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## Schéma de bioraffinerie du pilote de la zone Atlantique: Partie II – Efficacité du procédé

### Résultats principaux

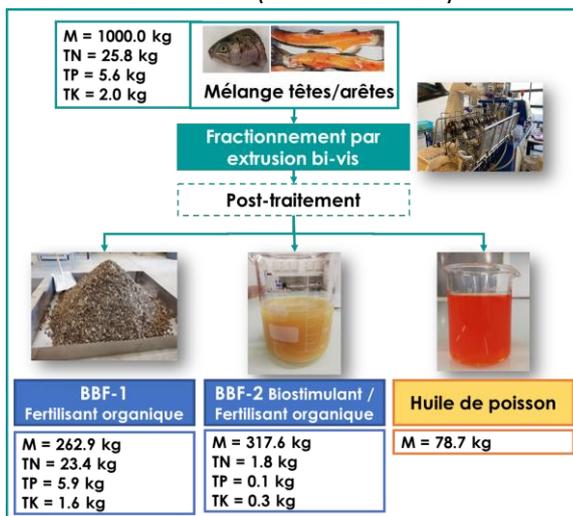
Le procédé a été développé de TRL4 à TRL7. Le débit d'alimentation en co-produits de truite arc-en-ciel (50/50 têtes/arêtes) était de 5-10 kg/h et de 100-200 kg/h respectivement.

1000 kg de co-produits de poisson ont fourni 2 BBF : i) BBF-1, une fraction majoritaire de 263 kg d'un BBF organique solide (97% MS, 9% N/MS), ii) BBF-2, une fraction minoritaire de 320 kg d'un BBF organique liquide (5% MS, 11% N/MS). L'efficacité agronomique a été testée en pot sans formulation et le BBF-1 a été sélectionné pour les essais en champ. Ce dernier présente une forte disponibilité en P et une disponibilité moyenne en N et il est conforme en termes de qualité et sécurité pour l'appellation engrais organiques. Le BBF-2 a une forte teneur en N, même s'il n'est pas assez concentré pour être utilisé directement comme engrais.

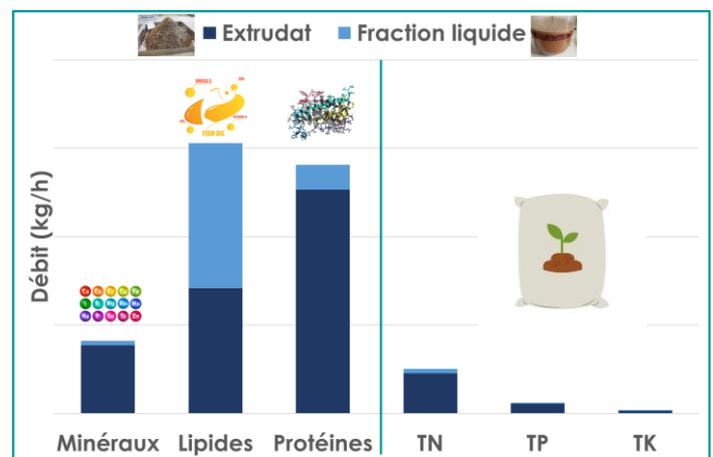
En outre, le processus génère environ 80 kg d'huile de poisson, riche en oméga 3 (5,1% en EPA+DHA) et en astaxanthine, un caroténoïde rouge (11 mg/kg), ce qui la rend très prisée dans les domaines de l'alimentation humaine et animale.

### Recommandations pratiques

Pour considérer le BBF-2 comme : i) un engrais organique liquide ou ii) un biostimulant riche en acides aminés libres, il doit respectivement : i) être concentré pour atteindre une teneur en MS de 40-50% ou ii) subir une hydrolyse enzymatique discontinue suivie d'étapes de concentration et de stabilisation (acidification).



**Figure 1:** Répartition massique globale pour la bioraffinerie de la zone Atlantique



**Figure 2:** Répartition massique des molécules d'intérêt suite au fractionnement par extrusion

### Further information

"Extrusion" in Green Food Processing Techniques: Preservation, Transformation and Extraction, Publisher: Elsevier (2019) DOI: [10.1016/B978-0-12-815353-6.00010-0](https://doi.org/10.1016/B978-0-12-815353-6.00010-0)

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## Technical aspects of Adriatic sea pilot

### Main results / outcomes

Adriatic Sea Pilot aims to optimise the valorisation process of various by-products from seafood processing industries of the port of Ancona (Italy). Hydro-cyclone, hydrolysis reactor, pyrolyser, and composting reactor have been developed to implement a biorefinery based fish and mollusc discards and producing bio-based fertilisers (BBFs) (Figure 1&2).

### Practical recommendations

For the pre-treatment of mollusc discards, hydro-cyclone is used after mollusc shredding, achieving effective separation of inorganic and organic fractions. The latter along with fish wastes (being rich in proteins) are used for enzymatic hydrolysis in a 100-L pilot reactor to produce protein hydrolysates (PH). Their residues along with “renewable” bulking agents (pruning waste and sawdust) are used as feedstock mixture for composting to obtain compost-biochar composite. All these processes will be optimised and evaluated in a comprehensive way, looking for the most eco-efficient and feasible biorefinery scheme. Previous evaluation of this biorefinery has been published in “Waste Management” journal (Andreola et al., 2023).



Figure 1: Pyrolyser

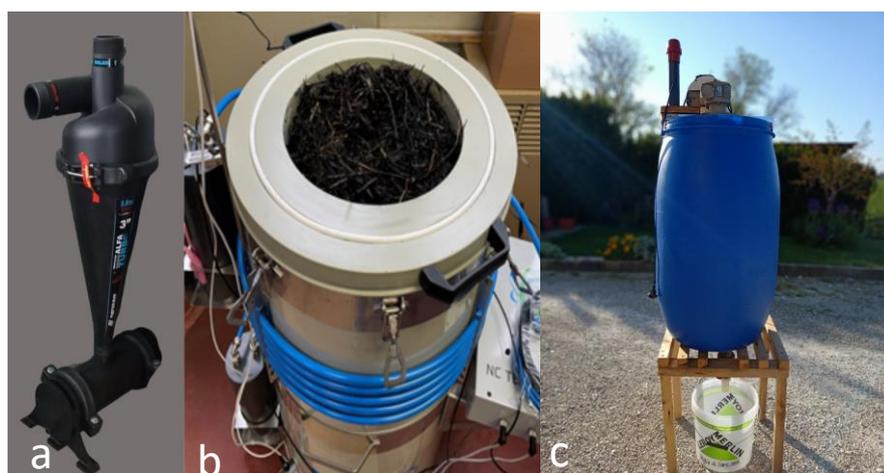


Figure 2: Hydro cyclone (a), Compost reactor (b), Hydrolysis reactor (c)

### Further information

<https://weelab.simau.univpm.it/> <https://www.sea2landproject.eu/>

Andreola et al. Waste Management 166 (2023) 294–304. DOI: 10.1016/j.wasman.2023.05.014

### About this abstract

**Authors:** Università Politecnica delle Marche (UNIVPM)

**Date:** November 2023

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## Aspetti tecnici del progetto pilota del mare Adriatico

### Principali risultati/esiti

Il progetto pilota del Mare Adriatico mira ad ottimizzare il processo di valorizzazione di vari sottoprodotti provenienti dalle industrie di lavorazione dei prodotti ittici del porto di Ancona (Italia). Sono stati sviluppati un idrociclone, un reattore di idrolisi, un pirolizzatore e un reattore di compostaggio per implementare una bioraffineria basata sugli scarti di pesce e molluschi sulla produzione di fertilizzanti biobased (BBF) (Figura 1 e 2).

### Raccomandazioni Pratiche

Per il pretrattamento degli scarti dei molluschi, dopo la triturazione dei molluschi viene utilizzato un idrociclone, che consente di ottenere un'efficace separazione delle frazioni inorganiche e organiche. Queste ultime, insieme agli scarti di pesce (ricchi di proteine), vengono utilizzate per l'idrolisi enzimatica in un reattore pilota da 100 litri per produrre idrolizzati proteici (PH). I loro residui, insieme ad agenti di carica "rinnovabili" (scarti di potatura e segatura), sono utilizzati come miscela di materie prime per il compostaggio, al fine di ottenere composti di compost e biochar. Tutti questi processi saranno ottimizzati e valutati in modo completo, alla ricerca dello schema di bioraffineria più eco-efficiente e fattibile. La precedente valutazione di questa bioraffineria è stata pubblicata sulla rivista "Waste Management" (Andreola et al., 2023).



Figura 1: Pirolizzatore

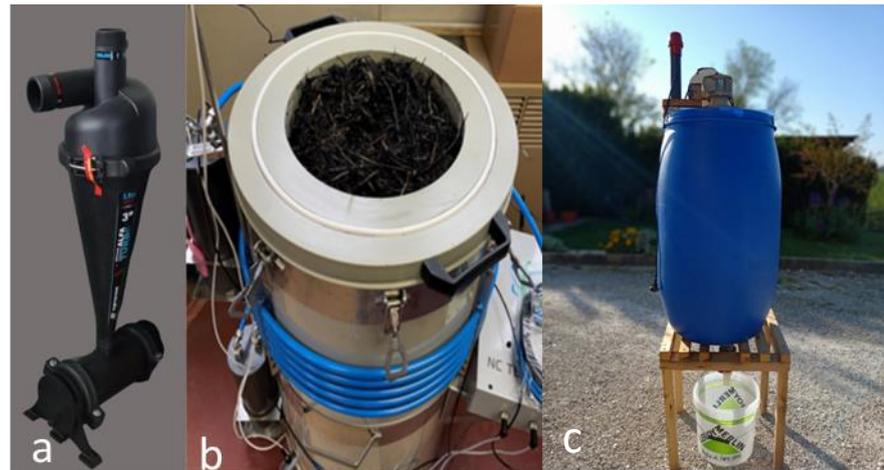


Figura 2: Idrociclone (a), Reattore di compostaggio (b), Reattore di idrolisi (c)

### Ulteriori informazioni

<https://wveelab.simau.univpm.it/>

<https://www.sea2landproject.eu/>

Andreola et al. Waste Management 166 (2023) 294–304. DOI: 10.1016/j.wasman.2023.05.014

### Informazioni dell'estratto

**Autori:** Università Politecnica delle Marche (UNIVPM), COPEMO

**Data:** Novembre 2023

Il progetto **SEA2LAND** è un'azione collaborativa di innovazione (IA) finanziata dall'UE nell'ambito del programma Horizon 2020. Il progetto mira a fornire soluzioni per aiutare a superare le sfide legate alla produzione alimentare, al cambiamento climatico e al riutilizzo dei rifiuti. Si basa sul modello dell'economia circolare. SEA2LAND promuove la produzione di fertilizzanti su larga scala nell'UE a partire da materie prime proprie. Questa soluzione fissa come obiettivo di ridurre lo squilibrio dei nutrienti nel suolo Europeo. Il progetto è iniziato a gennaio 2021 e terminerà a dicembre 2024.

**Sito Web:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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## Adriatic pilot public outreach workshop

### Main results / outcomes

UNIVPM and COPEMO co-organized a workshop at the port of Ancona (Italy) in May 2023 to disseminate about the fish and aquaculture sectors in the region, the technologies involved and the biofertilizers that can be obtained in the framework of SEA2LAND project.

### Practical recommendations

The workshop focused on disseminating the SEA2LAND project to the stakeholders. Representatives from different stakeholders' sectors such as fisheries and aquaculture processing companies, research, public authorities, business and financial advisors, communication and social media participated. Apart from the SEA2LAND project description (structure, methods, and goals) and each pilot scheme (by-products, technologies and final BBF), other topics like agronomic values of fish by-products, and the application of sustainable and circular economy approaches in the aquaculture sector were also presented. During the brainstorming session, participants showed high interest in the potential nutrient recovery as an environmental benefit of by-product stabilisation and in future steps of the project, with the main concern of cost and economic viability of technologies, as well as the feasible scale of these kinds of biorefineries. The workshop also discussed issues related to food losses in the fishery and aquaculture sector, within the framework of HE-FOLOU project. The event was moderated by a representative of the Italian magazine "Il Pesce".



Figure 1: Presentation of the workshop



Figure 2: Presentation of Co.Pe.Mo activities

### Further information

<https://www.sea2landproject.eu/>  
<https://wweelab.simau.univpm.it/>

<https://www.folou.eu/>  
<https://www.copemo.it/en/>

<https://www.pubblicitaitalia.com/it/pesce>

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## Workshop di sensibilizzazione del progetto pilota adriatico

### Principali risultati/esiti

L'UNIVPM e la COPEMO hanno organizzato un workshop presso il porto di Ancona (Italia) nel maggio 2023 per divulgare i settori della pesca e dell'acquacoltura nella regione, le tecnologie coinvolte e i biofertilizzanti che possono essere ottenuti nell'ambito del progetto SEA2LAND.

### Raccomandazioni pratiche

Il workshop si è concentrato sulla divulgazione del progetto SEA2LAND. Hanno partecipato rappresentanti di diversi settori, come le aziende di trasformazione della pesca e dell'acquacoltura, la ricerca, le autorità pubbliche, i consulenti commerciali e finanziari, la comunicazione e i social media. Oltre alla descrizione del progetto SEA2LAND (struttura, metodi e obiettivi) e di ogni schema pilota (sottoprodotti, tecnologie e BBF finale), sono stati presentati anche altri argomenti come i valori agronomici dei sottoprodotti ittici e l'applicazione di approcci sostenibili e di economia circolare nel settore dell'acquacoltura. Durante la sessione di brainstorming, i partecipanti hanno mostrato grande interesse per il potenziale recupero dei nutrienti come beneficio ambientale della stabilizzazione dei sottoprodotti e per le fasi future del progetto, con la preoccupazione principale dei costi e della fattibilità economica delle tecnologie, nonché della scala di fattibilità di questo tipo di bioraffinerie. Il workshop ha anche discusso le questioni relative agli scarti nel settore della pesca e dell'acquacoltura, nell'ambito del progetto HE-FOLOU. L'evento è stato moderato da un rappresentante della rivista italiana "Il Pesce".



Figura 1: Presentazione del workshop



Figura 2: Presentazione delle attività di Co.Pe.Mo

### Ulteriori informazioni

<https://www.sea2landproject.eu/>  
<https://wweelab.simau.univpm.it/>

<https://www.folou.eu/>  
<https://www.copemo.it/en/>

<https://www.pubblicitaitalia.com/it/pesce>

### Informazioni dell'estratto

**Autori:** Università Politecnica delle Marche (UNIVPM), COPEMO

**Data:** Novembre 2023

Il progetto **SEA2LAND** è un'azione collaborativa di innovazione (IA) finanziata dall'UE nell'ambito del programma Horizon 2020. Il progetto mira a fornire soluzioni per aiutare a superare le sfide legate alla produzione alimentare, al cambiamento climatico e al riutilizzo dei rifiuti. Si basa sul modello dell'economia circolare. SEA2LAND promuove la produzione di fertilizzanti su larga scala nell'UE a partire da materie prime proprie. Questa soluzione fissa come obiettivo di ridurre lo squilibrio dei nutrienti nel suolo Europeo. Il progetto è iniziato a gennaio 2021 e terminerà a dicembre 2024.

**Sito Web:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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# Effluent solids retrieval from Atlantic salmon (*Salmo salar*) reared in Recirculation Aquaculture Systems

## Main results / outcomes

ABT aimed to increase the solid removal efficiency of the drum-filter by testing polymers in the wastewater before it enters the drum-filter. All types of filtration provided water of the same quality with the same amount of dry matter, but with less solids when flocculation (with DR-3000GR) was practised.

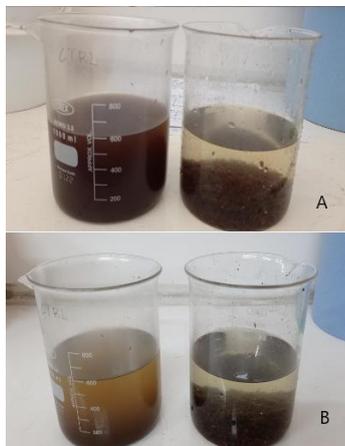
Moreover, the 40 $\mu$  mesh could hold 85% more solids from flocculated wastewater than non-treated wastewater. These quantities of total solids in the concentrated sludge, however, are still too low, to be used as Bio-Based Fertilisers.

Finally, the time needed to achieve draining on the filters is significantly less with flocculation, indicating that drum-filters could produce more filtered water for re-use in the RAS.

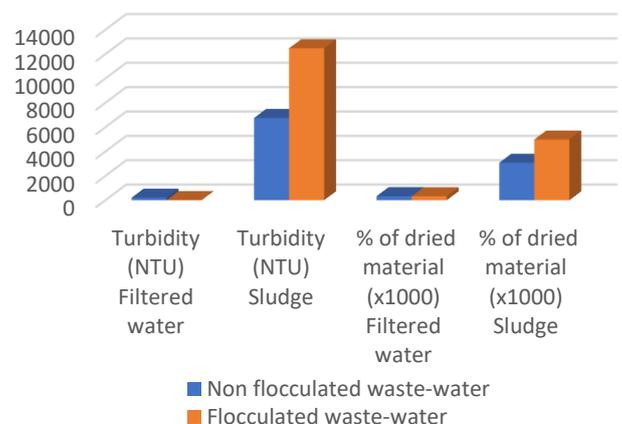
## Practical recommendations

Filter-bags were used to remove solids and slurries and were characterized by a high-rate pollution holding capacity. When filter-bags of 1 $\mu$  are used, there is a need to allow more time for filtration, while for the bags of 5 $\mu$  most of the filtration takes place in the first five minutes. A lot of solids stay in the bags, as they cannot be emptied correctly and fully, and therefore it is not practical to integrate filter-bags before the drum-filters in this case.

The liquid/solid separation usually takes hours when left to gravity alone but can be achieved in minutes or seconds with properly prepared polymers. The polymers' ability to flocculate solids is central to their role in water treatment and can be even more effective when combined with a coagulant. These environmentally friendly polymers, could flocculate solid particles, increase their size and therefore increase the efficiency of the drum-filter. By applying filter-bags to the wastewater leaving the drum-filter after the backwash, farmers could even further decrease their environmental impact



**Figure 1:** A) Untreated wastewater and Flocculated wastewater 1 minute after treatment and B) After 30 minutes.



**Figure 2:** Turbidity and % of dry material of filtered water and upheld sludge, from treated (with flocculants) and non-treated wastewater of Atlantic salmon.

## Further information

<https://aquaeas.org/Program/PaperDetail/40765>

## About this abstract

**Authors:** Athanasios Chantzaropoulos – AquaBioTech Group

**Date:** December 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

The project is running from January 2021 to December 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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# Potential valorization pathways for the marine aquaculture sludge using a biodrying process

## Main results / outcomes

The utilization of marine aquaculture sludge in a biodrying process has demonstrated its efficacy as a viable feedstock. This technology offers a dual advantage by unlocking two alternative valorization pathways for the sludge. On one front, it enables the production of a valuable solid organo-mineral fertilizer. Simultaneously, the process output material can be subjected to combustion in a biomass boiler, generating energy while preserving the phosphorus (P) and potassium (K) content, in the resultant ashes. These residual ashes can be ultimately valorized as a plant available source of these essential elements. The results of the work developed indicate that the obtained solid material aligns with the nutrient (4.77 % of P) and organic carbon (11.9 %) requisites of the specific Product Function Category (PFC 1(B)(I)) outlined in the EU Fertilizing Products Regulation (EU 2019/1009), making it suitable for use as an organo-mineral fertilizer. In terms of energy evaluation, the balance reveals a net energy gain (368.1 kWh/t) when burning the obtained solids after deducting the energy invested in the biodrying process.

## Practical recommendations

Our know-how about biodrying technology applied to aquaculture sludges can help industrial stakeholders in its satisfactory implementation. First, the addition of a bulking agent (i.e. wood chips) is advised to adjust the porosity and moisture content of the bulk mixture that must be in the range of 50-60%. We propose a temperature-dependent (<35, 35-45, 45-55, 55-70 and >70°C) aeration regime according to the organic matter content of the sludge (0.5, 0.6, 0.8, 1 and 1.5 L min<sup>-1</sup> kg<sub>VS</sub><sup>-1</sup>, respectively for each temperature range). Finally, the efficient combustion in the biomass boiler can be enhanced by the complementary addition of conventional biomass fuel materials (i.e. wooden pellets) with similar heating values.



**Figure 1:** Biodrying reactor.



**Figure 2:** Raw wastewater solid fraction (left) and biodried product (right).

## About this abstract

**Authors:** Pablo Martín Binder, Miguel Martínez, Nagore Guerra – BETA-Technological Center (UVic-UCC).

**Date:** December 2023

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## Posibles rutas de valorización para los lodos de la acuicultura marina mediante un proceso de biosecado

### Principales resultados

La utilización de lodos de acuicultura marina en un proceso de biosecado ha demostrado su eficacia como una materia prima viable. Esta tecnología ofrece una ventaja dual al permitir dos vías alternativas para su valorización. Por un lado, permite la producción de un valioso fertilizante orgánico-mineral sólido. Simultáneamente, el material resultante del proceso puede someterse a combustión en una caldera de biomasa, generando energía y preservando el contenido de fósforo (P) y potasio (K) en las cenizas resultantes. Estas cenizas residuales pueden valorizarse en última instancia como una fuente de estos elementos esenciales disponibles para las plantas. Los resultados del trabajo desarrollado indican que el material sólido obtenido cumple con los requisitos de nutrientes (4,77 % de P) y carbono orgánico (11,9 %) de la Categoría de Función de Producto específica (PFC 1(B)(I)) establecida en el Reglamento de Productos Fertilizantes de la UE (UE 2019/1009), lo que lo hace adecuado para su uso como fertilizante orgánico-mineral. En cuanto a la evaluación energética, el balance revela una ganancia neta de energía (368,1 kWh/t) al quemar los sólidos obtenidos después de descontar la energía invertida en el proceso de biosecado.

### Recomendaciones prácticas

Nuestro conocimiento sobre la tecnología de biosecado aplicada a lodos de acuicultura puede ayudar a los actores industriales en su exitosa implementación. En primer lugar, se recomienda la adición de un agente estructurante (p. ej., astillas de madera) para ajustar la porosidad y el contenido de humedad de la mezcla inicial, que debe estar en el rango del 50 al 60%. Se propone un régimen de aireación dependiente de la temperatura (<35, 35-45, 45-55, 55-70 y >70 °C) de acuerdo con el contenido de materia orgánica del lodo (0,5, 0,6, 0,8, 1 y 1,5 L min<sup>-1</sup> kg<sub>SV</sub><sup>-1</sup>, respectivamente, para cada rango de temperatura). Finalmente, la combustión en la caldera de biomasa puede mejorarse mediante la adición complementaria de materiales convencionales de combustible de biomasa (p. ej., pellets de madera) con un poder calorífico similar.



Figura 1. Reactor de biosecado.



Figura 2. Fracción sólida del lodo de acuicultura marina (izq.) y producto biosecado (der.).

### Acerca de este resumen práctico

**Autores:** Pablo Martín Binder, Miguel Martínez, Nagore Guerra – Centro Tecnológico BETA (UVic-UCC).

**Fecha:** Diciembre 2023

El proyecto **SEA2LAND** es una Acción de Innovación colaborativa (IA) financiada por la UE en el marco del programa Horizonte 2020. El proyecto tiene como objetivo proporcionar soluciones que contribuyan a superar los desafíos relacionados con la producción de alimentos, el cambio climático y la reutilización de residuos. Basado en el modelo de economía circular, SEA2LAND promueve la producción de fertilizantes a gran escala en la UE a partir de materias primas propias. Se espera que esta solución reduzca el desequilibrio de nutrientes del suelo en Europa. El período de ejecución del proyecto es desde Enero de 2021 hasta Diciembre de 2024. **Página web:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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# Normative considerations of fishery and aquaculture by-products as feedstocks for BBFs

## Main results / outcomes

Within the context of the European bioeconomy Action Plan, the European Fertilizing Product Regulation (EU) 2019/1009 (FPR) plays a crucial role in facilitating and encouraging the reintroduction of secondary raw materials and nutrients into food production chains. This regulation contemplates the inclusion of animal by-products (ABPs) and their derivatives, which are excluded from human consumption and currently fall under EU Regulation (EC) No 1069/2009. ABPs are defined as by-products generated within the food production chains when animals are processed and transformed. Those by-products are strictly regulated in the EU in terms of use, storage, processing, and disposal. That means they are subject to the (veterinary) controls and other prerequisites including the obligation for registration, documentation, notification and approval for handling, transport and storage.

The current normative pathways allow the transformation of this kind of by-products into fertilizing products. However, it lacks detailed clarity those streams in which we find some of the by-products generated in the fishery and aquaculture industry. Despite this uncertainty, reaching a clearly defined end-point for ABP in the manufacturing chain is the initial and crucial step for its valorization. Once this end-point is attained, the by-product is no longer subject to controls (such as veterinary), thereby enabling the recycling of its resources.

## Practical recommendations

Animal by-products are classified into specific categories based on their potential risk to public and animal health. The so-called end-point in the manufacturing chain is achieved by applying and certifying authorized transformation processes. In general, pressure sterilization ensures the prevention of risks to public and animal health, thus unlocking potential valorization pathways. Within the Sea2Land project, some of the feedstocks transformed into Bio-Based Fertilizers (BBFs) include aquatic animals and their parts without signs of communicable diseases to humans or animals. This includes fish and shellfish waste, viscera, flesh, heads, and frames which are clearly defined in the mentioned ABP regulation.

However, we find difficult the categorization of other fishery and aquaculture industry-derived by-products valorized in Sea2Land under the definition of ABP. Examples include (i) shells from shellfish with removed soft tissue and flesh, (ii) sludges from wastewater treatment in recirculating aquaculture systems or gathered from open aquaculture systems, and (iii) cooking brines from fish-products in the canning industry. Further clarification and a precise, unambiguous definition of these fish and aquaculture by-products within the ABP Regulation framework are necessary. This clarification would facilitate and potentially enhance the implementation of circular bioeconomy strategies in the fishery and aquaculture sectors, promoting diversified business models and their overall sustainability.

## About this abstract

**Authors:** Nagore Guerra, Miguel Martínez, Pablo Martín Binder,– BETA-Technological Center (UVic-UCC). Bente Foereid, Norwegian Institute of Bioeconomy Research (NIBIO)

**Date:** December 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

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# New biobased fertilizers with capacity as biostimulant

## Main results / outcomes

Fertinagro Biotech conducts a physicochemical analysis of the intermediate products produced at AZTI and BARNA (fish protein hydrolysates) and NEIKER (hydrolysed microalgae biomass) to assess their potential as components for bio-stimulant fertilizer formulations. After observing a high potential in the received products, five specific products are proposed to target a market identified as promising by Fertinagro Biotech:

1. Fertilizer with organic matter, amino acids and humic acids.
2. Solution containing nitrogen, phosphorus, potassium, and amino acids.
3. Foliar application fertilizer with high nitrogen and amino acid content.
4. Foliar application fertilizer with organic matter, humic extract, and amino acids.
5. Fertilizer with microalgae and including humic acids.

## Practical recommendations

During the development process of various fertilizer compositions, special attention was given to the rheological properties of the intermediate products produced by Azti-Barna. This consideration stemmed from the fact that farmers don't always have handling and transfer systems comparable to those in an industrial setup. It's crucial to ensure that the formulations can adapt to practical conditions under which farmers operate, without relying on complex handling systems typically found in industry. The products that have been designed are prepared to meet the needs of any type of crop, from a vegetable to an herbaceous plant to a woody crop.

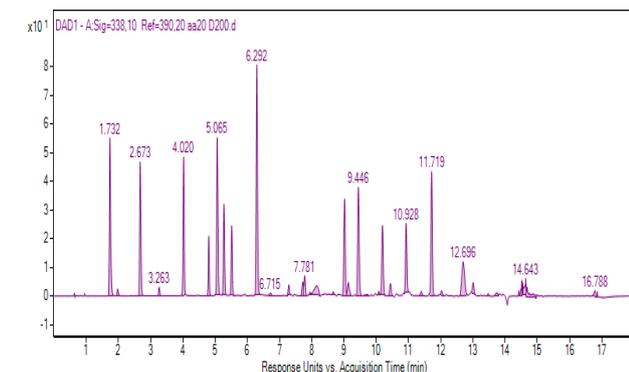


Fig. 1: Aminogram of fertilizer



Fig. 2: Fertilisers production plant (FERTINAGRO)

## About this abstract

**Authors:** Joaquin Romero/FERTINAGRO. Carlos Bald/AZTI ; Iñaki Aramburu/BARNA;

**Date:** December 2023

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# Nuevos fertilizantes biobasados con potencial como bioestimulantes

## Principales avances/resultados

Fertinagro Biotech lleva a cabo un análisis físico-químico de los productos intermedios producidos en AZTI y BARNA (hidrolizados de proteína de pescado) y NEIKER (hidrolizados de microalgas) para evaluar su potencial como componentes de formulaciones de fertilizantes bioestimulantes. Tras la observación de un alto potencial en los productos recibidos, se proponen cinco productos específicos para cubrir un mercado identificado como prometedor por Fertinagro Biotech:

1. Fertilizante con contenido de materia orgánica, aminoácidos y ácidos húmicos.
2. Disolución que contiene nitrógeno, fósforo, potasio y aminoácidos.
3. Fertilizante de aplicación foliar, con elevado contenido de nitrógeno y aminoácidos.
4. Fertilizante de aplicación foliar, con contenido en materia orgánica, extracto húmico y aminoácidos.
5. Fertilizante que incluye microalgas y ácidos húmicos.

## Recomendaciones prácticas

Durante el proceso de desarrollo de las diversas composiciones de fertilizantes, se prestó especial atención a las propiedades reológicas de las materias primas recibidas de Azti-Barna. Esto se debió a la consideración de que los agricultores no siempre cuentan con sistemas de manejo y trasvase comparables a los de una instalación industrial. Es crucial asegurar que las formulaciones sean adaptables a condiciones prácticas en las que los agricultores operan, sin depender de sistemas de manipulación complejos propios de la industria.

Los productos que se han diseñado están preparados para suplir las necesidades de cualquier tipo de cultivo, desde un producto hortícola hasta un herbáceo pasando por un leñoso.

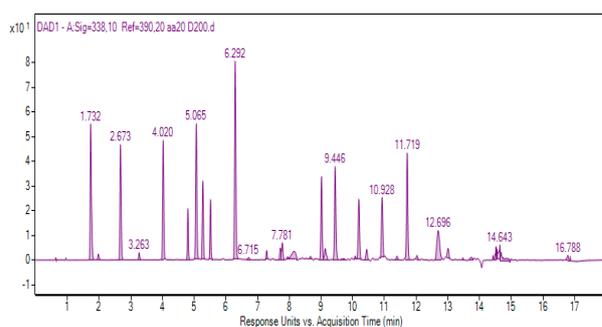


Fig. 1: Aminograma de un fertilizante



Fig. 2: Planta de producción de fertilizantes (FERTINAGRO).

## About this abstract

**Authors:** Joaquin Romero/FERTINAGRO. Carlos Bald/AZTI ; Iñaki Aramburu/BARNA;

**Date:** December 2023

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## Bokashi treatment and pelleting of fish sludge

### Main results / outcomes

A bokashi mix was added to sludge from filtering effluent at a fish farm and left for storage with parallel untreated. The treatment had no significant beneficial effect compared to untreated sludge. This supposedly due to natural fermentation during storage, initiated at the fish farm. Fish sludge was easily pelleted due to a minor fraction of fish oil, originating from fish feed in the water.

### Practical recommendations

Fermentation of fish sludge with bokashi mix was tested to see if this could stabilise, enrich and reduce the loss of nitrogen due to natural denitrification. However there was no effects or benefit as compared to not treated sludge, most likely due to natural processes in fish sludge that make the pH to drop, presumably initiated at fish farm. Conclusion: Fish sludge stabilises itself "going sour". Before drying fish sludge is today added polymers and screw pressed to reduce water content. Energy for drying and polymers are the costly inputs in processing of fish sludge to agriculture today, so any biological pretreatment that may bring the fish sludge to a more solid state is of interest in further work. New approaches where the adding of other curing agents immediately post filtering of the water could therefore be profitable. However this may include the need for changing of the bacterial flora of fish farming systems all together. As fish sludge proved successful in initial growth experiments, dried fish sludge was pelleted for further field experiments.



Figure 1: Bokashi treatment



Figure 2: Pelleted fish sludge

### Further information

[www.gronnjodsel.no](http://www.gronnjodsel.no)

### About this abstract

**Authors:** Tommy C. Olsen - Grønn Gjødsel

**Date:** December 2023

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## Bokashi konservering og pelletering av fiskeslam

### Resultater

En bokashi-mix ble tilsatt slam fra filtrert avløp ved et oppdrettsanlegg og lagt til lagring med parallell ubehandlet. Behandlingen hadde ingen signifikant gunstig effekt sammenlignet med ubehandlet slam. Dette skyldes naturlig gjæring under lagring, som ved anlegget. Rent tørket fiskeslam lot seg enkelt pelletere, takket være en liten rest av olje som stammer fra fiskefor.

### Praktiske forhold og anbefalinger

Fermentering av fiskeslam med bokashimix ble testet for å se om dette kunne stabilisere, berike og redusere tapet av nitrogen ved naturlig denitrifikasjon. Det var imidlertid ingen effekter eller fordeler sammenlignet med ikke-behandlet slam, mest sannsynlig på grunn av naturlige prosesser i fiskeslam som får pH til å synke, antagelig initiert ved oppdrettsanlegg. Konklusjon: Fiskeslam stabiliserer seg selv "og blir surt". Tørking av fiskeslam skjer i dag ved tilsetning av polymerer og pressing for å redusere vanninnhold. Energi til tørking og polymerer er kostbare faktorer i prosessering av fiskeslam til landbruk, så enhver biologisk behandling som kan bringe fiskeslammet til en mer solid tilstand er av interesse. Nye tilnærminger der tilsetning av midler umiddelbart etter filtrering av vannet kan derfor være lønnsomt. Dette kan bety at man bør endre av bakteriefloraen i oppdrettssystemet. Siden fiskeslammet ga gode resultater under vekstforsøk ble dette valgt til videre vekstforsøk på friland i prosjektet.



Figure 1: Bokashi behandling



Figure 2: Pelletert fiskeslam

### Mer informasjon

[www.gronngjodsel.no](http://www.gronngjodsel.no)

### Om dette utdrag

**Forfatter:** Tommy C. Olsen - Grønn Gjødsel

**Date:** December 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

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## Fish sludge as fertiliser

### Main results / outcomes

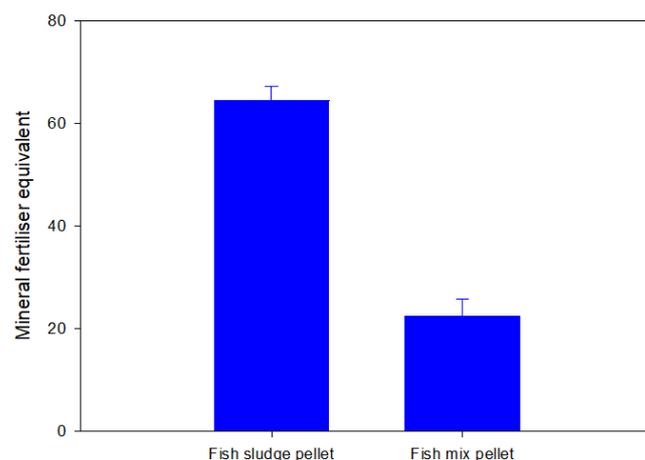
Fish sludge is a residue from aquaculture, containing fish feces and feed spill. It is rich in phosphorus and contain some nitrogen, and it has a good fertilizer effect. However, the ratio between plant nutrients is not balanced to the plant's need, so supplementary fertilization will usually be required.

### Practical recommendations

Fish sludge has been evaluated in a number of pot experiments, and also some field experiments, mainly with cereals or ryegrass as test crop. Results are variable, but they suggest that phosphorus in fish sludge is somewhat less plant available than phosphorus in animal manure, nitrogen is not very plant available the first season in dried fish sludge, but fish sludge digestate is a good nitrogen fertilizer. Fish sludge contains very little potassium, and when using fish sludge as fertilizer it is recommended to supplement with both nitrogen and potassium fertilizers. Some products have been developed with extra mineral nitrogen and potassium to get a balanced fertilizer product. In SEA2LAND we have tested dried fish sludge and mixed product of fish sludge and other substances allowed in organic agriculture in pot experiments and on broccoli in a field experiment. Results are surprisingly positive, suggesting that also the nitrogen effect of the dried fish sludge is good.



**Figure 1:** In SEA2LAND field trial, fish sludge is being tested as fertiliser for vegetables (broccoli).



**Figure 2:** Nitrogen fertiliser effect (% of nitrogen that is plant available) , showing good effect of dried fish sludge.

### Further information

<https://nibio.no/en/projects/producing-advanced-bio-based-fertilizers-from-fisheries-wastes?locationfilter=true>

### About this abstract

**Authors:** Bente Foereid, Norwegian Institute of Bioeconomy Research

**Date:** December 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

The project is running from January 2021 to December 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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## Hovedresultater

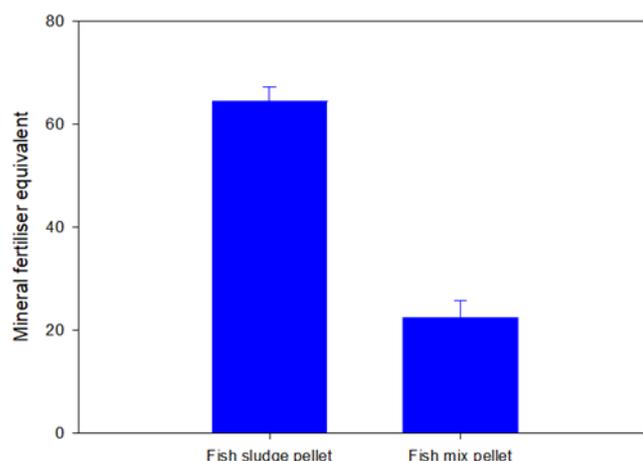
Fiskeslam er et restprodukt fra akvakultur som inneholder fiskeavføring og forspill. Fiskeslam inneholder mye fosfor og noe nitrogen, og det har god gjødslingeffekt. Forholdet mellom næringsstoffer er imidlertid ikke balansert, så supplementerende gjødsling vil oftest være nødvendig.

## Anbefalinger

Gjødslingseffekten til fiskeslam har blitt undersøkt i flere potte- og noen feltforsøk, oftest med korn eller gress som test-plante. Resultatene varierer, men det ser ut til at fosfor i fiskeslam er litt mindre plantetilgjengelig enn fosfor i husdyrgjødsel, nitrogen i tørket fiskeslam er ikke så plantetilgjengelig første sesong, men biorest av fiskeslam er god som nitrogen-gjødsel. Det er lite kalium i fiskeslam, og når fiskeslam brukes som gjødsel anbefales det å tilføre supplement av både kalium og nitrogen. Det finnes slike produkter på markedet, fiskeslam med ekstra nitrogen og kalium så forholdet mellom næringsstoffene blir balansert. I SEA2LAND har vi testet fiskeslam og fiskeslam blandet med andre produkter tillatt i økologisk jordbruk i potte- og feltforsøk. Resultatene er overraskende gode, her finner vi at også nitrogen-effekten i tørket fiskeslam er god.



**Figure 1:** I feltforsøket i SEA2LAND blir fiskeslam testet som gjødsel til grønnsaker (broccocoli).



**Figure 2:** Nitrogen-gjødslingseffekt (% av nitrogen som er plantetilgjengelig) som viser god effekt av tørket fiskeslam.

## Mer informasjon

<https://nibio.no/en/projects/producing-advanced-bio-based-fertilizers-from-fisheries-wastes?locationfilter=true>

## Om dette sammendraget

**Forfatter:** Bente Førøid, Norsk Institutt for Bioøkonomi

**Dato:** Desember 2023

SEA2LAND prosjektet er et Innovation Action (IA) samarbeidsprosjekt finansiert av EU under Horizon 2020. Prosjektet's mål er å finne løsninger på utfordringer i matproduksjon, klima-endringer og avfallsresirkulering. Basert på en modell for sirkulær økonomi, fremmer SEA2LAND produksjonen av gjødsel-produkter fra egne råstoffer i stor skala. Det forventes at dette vil redusere næringsstoff-ubalanse i Europa. Prosjekt-perioden er januar 2021 til desember 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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# sLCA methodology and standards applied to bio-based fertilizers from fisheries/aquaculture wastes

## Main results / outcomes

Methodology for social life cycle assessment (sLCA) is based on the UNEP guidelines with similar steps as environmental LCA (figure 1). After using a participatory approach to decide stakeholder and impact categories to be taken into account, a type 1 or reference scale method was used to align impact indicators with recognized standards or benchmarks.

## Practical recommendations

Generic data is drawn from public databases and the Social HotSpot Database (SHDB), using working hours as an activity variable for semi-quantitative social indicator values. Specific data is sourced from expert viewpoints and stakeholder surveys. Human fundamental rights, UN conventions, and defined social standards (see below) form the benchmark of our adopted scales (figure 2). Hence, aligning social indicators on these scales can reveal potential hotspots across the lifecycle of bio-based fertilizers. This approach encourages responsible sourcing, ensuring price and origin considerations avoid supporting bad social conditions in concerned countries and activity sectors.

### Standards defining reference values for foreground activity sectors:

- **General:** OECD guidelines, SA8000, ISO 26000, AA1000, World Bank, ILO
- **Fishing/Aquaculture:** Global G.A.P, GRI 13 Standards, SSCI, ASC, FOS, MSC, BAP, Certisys®
- **Transformation/Formulation:** Suschem, CEFIC, ECOVADIS, ICCA, Together for Sustainability, ISC3, IFA's *Protect & Sustain* certification
- **Agriculture:** Global G.A.P, GRI Standards, FAO, IISD

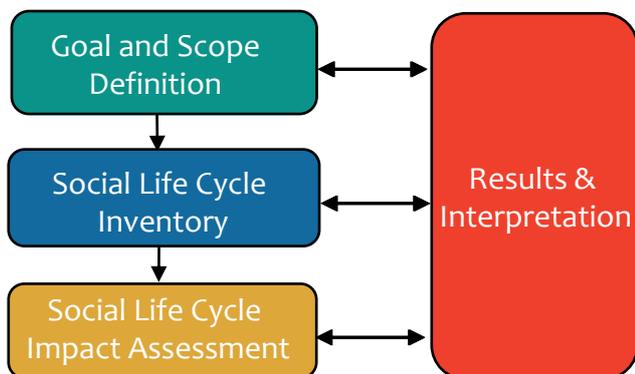


Figure 1: Steps of a social life cycle assessment (sLCA)

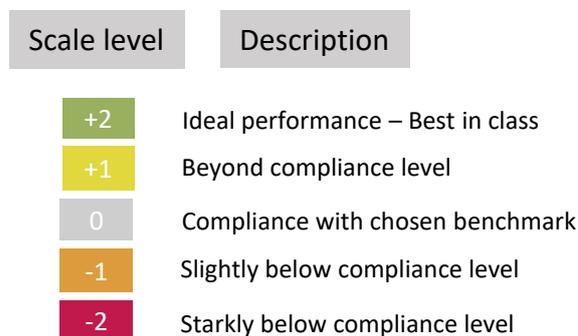


Figure 2: Example of a reference (UNEP, 2020)

## Further information

Benoit Norris, C. et al., 2020. UNEP, Guidelines for Social Life Cycle Assessment of Products and Organizations. International Fertilizer Association, 2023. *Protect&Sustain* [WWW Document]. [www.ifacultureofexcellence.org](http://www.ifacultureofexcellence.org)  
 Potts, J., Wilkings, A., Lynch, M., MacFatrige, S., 2016. State of sustainability initiatives review: standards and the blue economy. [www.iisd.org/system/files/publications/ssi-blue--2016.pdf](http://www.iisd.org/system/files/publications/ssi-blue--2016.pdf)

## About this abstract

**Authors:** Jean-François FABRE, Claire VIALLE, Caroline SABLAYROLLES / Toulouse INP

**Date:** December 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 program. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

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# Méthodologie et standards pour l'ACV sociale des bio-fertilisants issus des déchets de la pêche/aquaculture

## Résultats principaux

La méthodologie de l'ACV (Analyse du Cycle de Vie) sociale des bio-fertilisants est basée sur les lignes directrices de l'UNEP et comporte des étapes similaires à celles de l'ACV environnementale (figure 1). Après avoir utilisé une approche participative pour déterminer les parties prenantes et les catégories d'impact à prendre en compte, une méthode de type 1/échelle de référence est utilisée pour aligner les indicateurs d'impact par rapport à des normes reconnues;

## Recommandations pratiques

Les données génériques sont tirées de bases de données publiques et de SHDB (Social HotSpot Database), en utilisant les heures de travail comme variable d'activité. Les données spécifiques proviennent de points de vue d'experts et d'enquêtes. La déclaration des droits de l'homme, les conventions des Nations Unies et des normes sociales prédéfinies (voir ci-dessous) donnent les points de référence des échelles d'évaluation (figure 2). L'alignement des indicateurs sociaux sur celles-ci peut révéler des points chauds dans le cycle de vie des engrais biosourcés. Cette approche encourage un prix et un approvisionnement responsables, veillant à ne pas soutenir de mauvaises conditions sociales dans les secteurs d'activité et pays concernés.

### Normes/Standards définissant les valeurs de référence pour les secteurs d'activité au premier plan :

- **Critères généraux** : Règles de conduite de l'OCDE, SA8000, ISO 26000, AA1000, World Bank, OMC
- **Pêche/Aquaculture** : Global G.A.P, GRI 13 Standards, SSCI, ASC, FOS, MSC, BAP, Certisys®
- **Transformation/Formulation** : Suschem, CEFIC, ECOVADIS, ICCA, Together for Sustainability, ISC3, IFA's Protect & Sustain certification
- **Agriculture** : Global G.A.P, GRI 13 Standards, FAO, IISD

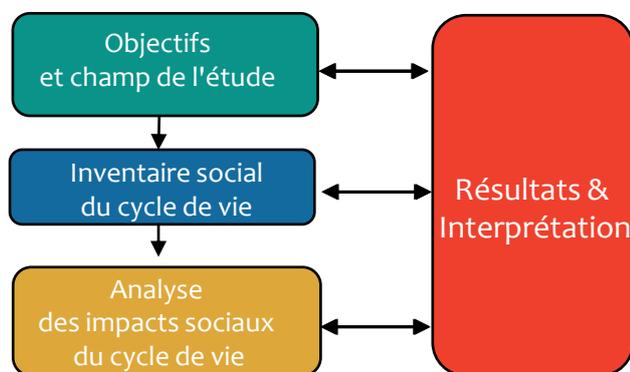


Figure 1 : Etapes d'une analyse des impacts sociaux du cycle de vie (ACV sociale)

Echelons	Description
+2	Performance idéale, au sommet de sa catégorie
+1	Au-dessus des critères de référence
0	Conformité aux critères de référence
-1	Légèrement en-dessous des critères de référence
-2	Fortement en-dessous des critères de référence

Figure 2 : Exemple d'échelle de référence (UNEP, 2020).

## Informations complémentaires

Benoît Norris, C. et al., 2020. UNEP, Guidelines for Social Life Cycle Assessment of Products and Organizations. International Fertilizer Association, 2023. Protect&Sustain [WWW Document]. [www.ifacultureofexcellence.org](http://www.ifacultureofexcellence.org)  
 Potts, J., Wilkings, A., Lynch, M., MacFatrige, S., 2016. State of sustainability initiatives review: standards and the blue economy. [www.iisd.org/system/files/publications/ssi-blue--2016.pdf](http://www.iisd.org/system/files/publications/ssi-blue--2016.pdf)

## A propos de ce résumé

**Auteurs** : Jean-François FABRE, Claire VIALLE, Caroline SABLAYROLLES / Toulouse INP

**Date** : Decembre 2023

Le projet **SEA2LAND** est une action d'innovation collaborative (IA) financée par l'UE dans le cadre du programme Horizon 2020. Le projet vise à fournir des solutions pour aider à surmonter les défis liés à la production alimentaire, au changement climatique et à la réutilisation des déchets. Sur la base du modèle d'économie circulaire, SEA2LAND encourage la production d'engrais à grande échelle dans l'UE à partir de matières premières propres. Cette solution devrait permettre de réduire le déséquilibre des nutriments du sol en Europe. Le projet se déroule de janvier 2021 à décembre 2024.

**Site web** : [www.sea2landproject.eu](http://www.sea2landproject.eu)



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## Quality and safety assessment of fertilising products derived from fishery waste and by-products

### Main results / outcomes

A total of 26 bio-based fertilizers (BBFs) were collected from 7 pilot installations which recovered nutrients from fishery waste and by-products using 9 different technologies. These products were characterized by unified and standardized methodologies. Organic carbon of the BBF products ranged from 0.05% to 46.54% (Fresh weight (FW)). Total N (TN) content of the organic fertilisers ranged from 0.01% to 11.13% (FW), in which ammonium comprised the majority of bioavailable N and nitrate content was negligible. The highest P content of the fertilising products reached up to 12.51% FW, while only one solid organic fertiliser had 5.6% FW of K.

### Practical recommendations

Following the quality and safety assessment of these fertilising products (based on the product function parameters of the Fertilising Products Regulation (EU) 2019/1009), the potential function of 12 products were identified as "organic fertilizer" and 7 as "potential (non-microbial) plant biostimulants". The recovered  $\text{CaCO}_3$  from mussel shells can be potentially used as "liming material", while compost products can be alternatively used for "growing medium" or "soil improver".

Considering its high nutrient content and vast volumes, fish sludge has great potential but should be treated / refined before being applied to soil. In addition to the parameters currently regulated, it is crucial to consider the salinity levels of such fertilising products as well as the possible presence of other micropollutants especially microplastics to warrant their safe use in agriculture. It should be noted that fertilisers derived from fishery waste and/or by-products have not been (yet) included as a component material category in the Regulation (EU) 2019/1009.

**Table 1: Qualification of BBF products and their potential function**

Lead	BBF product	Code	Form	Proposed function	Recommended function
NUTRI	1) Foliar fertiliser	FS	l	Foliar fertiliser	Plant biostimulant
	2) Bokashi pellet	BP	s	Organic fertiliser	Organic fertiliser
	3) Vermicompost and/or substrate	VER	s	Organic fertiliser	Growing media/soil improver*
FERTINAGRO	1) Amino acids, organic matter and humic extract	FER1	s	Plant biostimulant	Plant biostimulant
	2) Foliar fertiliser with N and amino acids	FER2	l	Plant biostimulant	Plant biostimulant
	3) NPK solution with amino acids	FER3	l	Plant biostimulant	Organic fertiliser with potential biostimulating effect
	4) Foliar fertiliser with amino acid, humic extract, organic matter	FER4	l	Plant biostimulant	Plant biostimulant
	5) Fertiliser with humic acids	FER5	l	Plant biostimulant	Plant biostimulant
UNIVPM	1) Hydrolysates	UNI1	l	Plant biostimulant	Organic fertiliser with potential biostimulating effect
	2) Biochar-compost composite	UNI2	s	Growing media/soil improver	Growing media/soil improver
	3) Chitin-rich fertiliser	UNI3	l	Organic fertiliser	Organic fertiliser
	4) $\text{CaCO}_3$	UNI4	s	Liming material	Liming material
NIBIO	1) Fish sludge pelleted fertiliser	FSP	s	Organic fertiliser	Organic fertiliser
	2) Fish mix pelleted fertiliser	FMP	s	Organic fertiliser	Organic fertiliser
CATAR	1) Protein fraction	CAT1	s	Organic fertiliser	Organic fertiliser
	2) Amino acids and peptides	CAT2	l	Plant biostimulant	Plant biostimulant**
	3) Protein fraction, upgraded	CAT3	s	Organic fertiliser	Organic fertiliser
	4) Amino acids and peptides, upgraded	CAT4	l	Plant biostimulant	Plant biostimulant**
UVIC	1) Nutrient-rich concentrate	NRC1	l	Organic fertiliser	Not qualified
	2) Organic amendment	OA1	s	Organic fertiliser	Organic fertiliser***
UVIC (freshwater)	1) Nutrient-rich concentrate	NRC2	l	Organic fertiliser	Not qualified
	2) Organic amendment	OA2	s	Organic fertiliser	Organic fertiliser****
INIA	1) Peptone	Pep	s	Organic fertiliser	Organic fertiliser
	2) Salmon bones flour	SBF	s	Organic fertiliser	Organic fertiliser
	3) Dried fish sludge	DFS	s	Organic fertiliser	Not qualified
	4) Compost	Com	s	Organic fertiliser	Growing media/soil improver

Comments: \*High E. coli content, \*\*Due to low free amino acids content further concentration needed, \*\*\*Pretreatment (further drying) needed to adjust  $\text{C}_{org}$ , \*\*\*\*High E. coli and Zn content.

### Further information

Zhang and Akyol, 2023. D6.1 Composition & quality report of tailor made biobased fertilisers <https://sea2landproject.eu/wp-content/uploads/2023/09/D6.1.pdf>

Zhang et al., 2023. Nutrient recovery and recycling from fishery waste and by-products. Journal of Environmental Management, 348, 119266. <https://doi.org/10.1016/j.jenvman.2023.119266>

### About this abstract

**Authors:** Jingsi Zhang, Çağrı Akyol and Erik Meers (Ghent University)

**Date:** December 2023

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# Kwaliteits- en veiligheidsbeoordeling van bemestingsproducten afkomstig van visserijafval en bijproducten

## Belangrijkste resultaten / uitkomsten

Er werden in totaal 26 biogebaseerde meststoffen (BBFs) verzameld uit 7 proefinstallaties die voedingsstoffen terugwonen uit visserijafval en bijproducten met behulp van 9 verschillende technologieën. Deze producten werden gekenmerkt door uniforme en gestandaardiseerde methodologieën. Organische koolstof van de BBF-producten varieerde van 0,05% tot 46,54% (vers gewicht (FW)). Het totale N (TN)-gehalte van de organische meststoffen varieerde van 0.01% tot 11.13% (FW), waarbij ammonium het grootste deel van de biologisch beschikbare N uitmaakte en het nitraatgehalte verwaarloosbaar was. Het hoogste P-gehalte van de bemestingsproducten bedroeg 12,51% FW, terwijl slechts één vaste organische meststof 5,6% FW K bevatte.

## Praktische aanbevelingen

Na de kwaliteits- en veiligheidsbeoordeling van deze bemestingsproducten (op basis van de product functie parameters van de Bemesting Producten Verordening (EU) 2019/1009) werd de functie van 12 producten geïdentificeerd als "potentiële organische meststof" en 7 als "potentiële (niet-microbiële) biostimulant voor planten". Gerecupereerd CaCO<sub>3</sub> uit mossel schelpen kon potentieel gebruikt worden als kalk materiaal, terwijl compost producten alternatief gebruikt kunnen worden als groeimedium of bodemverbeteraar.

Gezien het hoge nutriënten gehalte en de beschikbare volumes heeft visslib een groot potentieel, al is verdere behandeling/verfijning nodig voor bodem applicatie. Om veilig gebruik in de landbouw te garanderen is het cruciaal om naast de wettelijke parameters ook rekening te houden met het zoutgehalte van deze producten en mogelijke aanwezigheid van microverontreinigingen, zoals microplastics. Belangrijke kanttekening hierbij is dat meststoffen afkomstig uit visserijafval en/of bijproducten (nog) niet zijn opgenomen als component materiaal categorie in Verordening (EU) 2019/1009.

**Tabel 1: Kwalificatie van BBF-producten en hun potentiële functie**

Leidende partner	BBF product	Code	Vorm	Voorgestelde functie	Aanbevolen functie
NUTRI	1) Bladbemesting	FS	vloeistof	Bladmeststof	Biostimulant voor planten
	2) Bokashi-pellet	BP	stevig	Organische meststof	Organische meststof
	3) Vermicompost en/of substraat	VER	stevig	Organische meststof	Groeimedium/bodemverbeteraar*
FERTINAGRO	1) Aminozuren, organische stof en humusextract	FER1	stevig	Biostimulant voor planten	Biostimulant voor planten
	2) Bladbemesting met N en aminozuren	FER2	vloeistof	Biostimulant voor planten	Biostimulant voor planten
	3) NFK-oplossing met aminozuren	FER3	vloeistof	Biostimulant voor planten	Organische meststof met potentieel bio stimulerend effect
	4) Bladbemesting met aminozuren, humusextract, organisch materiaal	FER4	vloeistof	Biostimulant voor planten	Biostimulant voor planten
	5) Meststof met humuszuren	FER5	vloeistof	Biostimulant voor planten	Biostimulant voor planten
UNIVPM	1) Hydrolysaten	UN1	vloeistof	Biostimulant voor planten	Organische meststof met potentieel biostimulerend effect
	2) Biochar-compostcomposiet	UN2	stevig	Groeimedium/bodemverbeteraar	Groeimedium/bodemverbeteraar
	3) Chitinerrijke meststof	UN3	vloeistof	Organische meststof	Organische meststof
	4) CaCO <sub>3</sub>	UN4	stevig	Kalkmateriaal	kalkmateriaal
NIBIO	1) Visslibpelletvormige meststof	FSP	stevig	Organische meststof	Organische meststof
	2) Vismix gepelletiseerde meststof	FMP	stevig	Organische meststof	Organische meststof
CATAR	1) Eiwitfractie	CAT1	stevig	Organische meststof	Organische meststof
	2) Aminozuren en peptiden	CAT2	vloeistof	Biostimulant voor planten	Biostimulant voor planten**
	3) Eiwitfractie opgewaardeerd	CAT3	stevig	Organische meststof	Organische meststof
UVIC	4) Aminozuren en peptiden opgewaardeerd	CAT4	vloeistof	Biostimulant voor planten	Biostimulant voor planten**
	1) Voedingsrijk concentraat	NRC1	vloeistof	Organische meststof	Niet gekwalificeerd
UVIC (zoetwater)	2) Organisch amendement	OA1	stevig	Organische meststof	Organische mest***
	1) Voedingsrijk concentraat	NRC2	vloeistof	Organische meststof	Niet gekwalificeerd
INIA	2) Organisch amendement	OA2	stevig	Organische meststof	Organische mest****
	1) Pepton	Pep	stevig	Organische meststof	Organische meststof
	2) Zalmbottenmeel	SBF	stevig	Organische meststof	Organische meststof
	3) Gedroogd visslib	DFS	stevig	Organische meststof	Niet gekwalificeerd
	4) Compost	Com	stevig	Organische meststof	Groeimedium/bodemverbeteraar

Opmerkingen: \*Hoog E. coli-gehalte. \*\*Vanwege het lage gehalte aan vrije aminozuren is verdere concentratie nodig. \*\*\*Voorbehandeling (verder drogen) nodig om Comg aan te passen. \*\*\*\* Hoog E. coli- en Zn-gehalte.

## Verdere informatie

Zhang and Akyol, 2023. D6.1 Composition & quality report of tailor-made biobased fertilisers <https://sea2landproject.eu/wp-content/uploads/2023/09/D6.1.pdf>

Zhang et al., 2023. Nutrient recovery and recycling from fishery waste and by-products. Journal of Environmental Management, 348, 119266. <https://doi.org/10.1016/j.jenvman.2023.119266>

## Over deze samenvatting

**Auteurs:** Jingsi Zhang, Çağrı Akyol and Erik Meers (Ghent University)

**Datum:** December 2023

Het **SEA2LAND**-project is een gezamenlijke innovatieactie (IA) gefinancierd door de EU in het kader van het Horizon 2020-programma. Het project heeft tot doel oplossingen te bieden om uitdagingen op het gebied van voedselproductie, klimaatverandering en hergebruik van afval te helpen overwinnen. Gebaseerd op het model van de circulaire economie bevordert SEA2LAND de productie van grootschalige meststoffen in de EU uit eigen grondstoffen. Verwacht wordt dat deze oplossing het onevenwicht aan voedingsstoffen in de bodem in Europa zal verminderen.

Het project loopt van januari 2021 tot en met december 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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# Nitrogen release dynamics of fertilising products derived from fishery waste and by-products

## Main results / outcomes

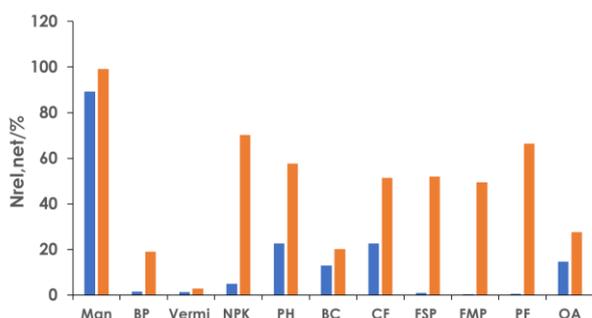
Nitrogen (N) use efficiency and the ability of bio-based fertilisers (BBFs) to substitute mineral fertilisers is dependent on the N speciation of applied N to the soil. Moreover, the environmental safety of N fertilisers depends on their risks towards losses either by leaching or volatilizing. To assess mineralisation patterns, N release dynamics of selected fishery waste-derived BBFs were assessed and compared with mineral fertilisers in soil incubation assays under controlled conditions for 120 days. The  $\text{NH}_4^+\text{-N}$  added via the BBF products was completely nitrified as was observed by the negligible concentrations of  $\text{NH}_4^+\text{-N}$  and a strong increase in the levels of  $\text{NO}_3^-\text{-N}$ .

## Practical recommendations

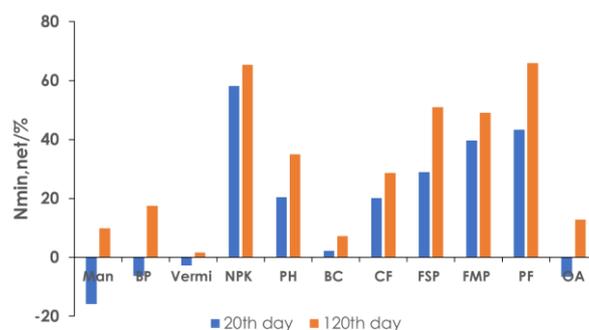
All tested fishery waste-derived fertilising products had lower mineral N content compared to that of synthetic fertiliser (Calcium Ammonium Nitrate) and liquid pig manure (Man). BBF products 'NPK', 'PH', 'FSP', 'FMP' and 'PF' had comparatively higher net N-release and N-mineralisation at the end of the incubation period. The presence of amino acids and/or other protein fractions in these fertilising products led to a higher N-release and N-mineralisation rate in the incubation tests.

Area	Country	BBF product	Abbr.	Form	Molsture, %	OM, % DM	TN, %	$\text{NH}_4^+\text{-N}$ , (g/kg)
Baltic Sea	Estonia	Bokashi pellet	BP	s	9.35	61.85	2.63	0.38
Baltic Sea	Estonia	Vermicompost and/or substrate	Vermi	s	54.46	33.17	0.89	0.11
Cantabrian Sea	Spain	NPK solution with amino acids	NPK	l	65.54	78.78	5.31	2.56
Adriatic Sea	Italy	Protein hydrolysates	PH	l	57.88	82.46	4.82	10.95
Adriatic Sea	Italy	Biochar-compost composite	BC	s	5.41	77.32	3.72	4.79
Adriatic Sea	Italy	Chitin-rich fertiliser	CF	l	57.68	82.91	4.62	10.48
North Sea	Norway	Fish sludge pelleted fertiliser	FSP	s	5.60	82.5	6.19	0.62
North Sea	Norway	Fish mix pelleted fertiliser	FMP	s	5.49	71.10	9.77	0.38
Atlantic Sea	France	Protein fraction	PF	s	1.94	83.82	7.62	0.34
Mediterranean Sea	Spain	Organic amendment	OA	s	53.97	42.30	1.89	2.77

**Table 1:** Total and mineral nitrogen contents of fishery waste-derived fertilising products selected for soil incubation



**Figure 1:** Net N-release at 20<sup>th</sup> day and 120<sup>th</sup> day



**Figure 2:** Net N-mineralization at 20<sup>th</sup> day and 120<sup>th</sup> day

## Further information

Zhang et al., 2023. Quality and safety assessment of fertilising products derived from fishery waste and by-products. Wageningen Soil Conference – Book of Abstracts, p93-94.

<https://wageningensoilconference.eu/2023/wp-content/uploads/2023/08/Book-of-abstracts-WSC2023>

## About this abstract

**Authors:** Jingsi Zhang, Çağrı Akyol and Erik Meers (Ghent University)

**Date:** December 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

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**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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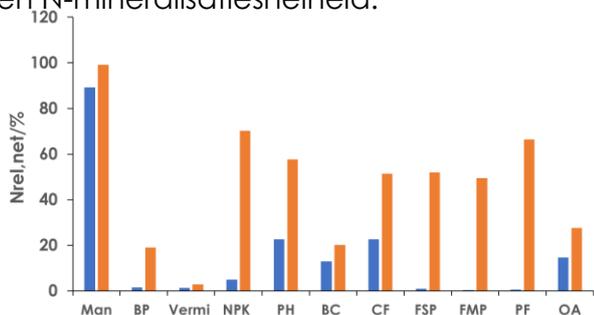
# Stikstofafgifte dynamiek van bemesting producten afkomstig van visserijafval en bijproducten

## Belangrijkste resultaten / uitkomsten

De efficiëntie van het stikstofgebruik (N) en het vermogen van biogebaseerde meststoffen (BBF's) om minerale meststoffen te vervangen, is afhankelijk van de N-speciatie van de toegepaste N in de bodem. Bovendien hangt ook de milieuveiligheid van N-meststoffen af van hun risico op verliezen door uitspoeling of vervluchtiging. Om mineralisatiepatronen te beoordelen, werd de N-afgifte dynamiek van een aantal BBF's afkomstig van visserijafval beoordeeld en vergeleken met minerale meststoffen door middel van bodemincubatietesten onder gecontroleerde omstandigheden gedurende 120 dagen. De  $\text{NH}_4^+$ -N toegevoegd door de BBF-producten werd volledig genitrificeerd, zoals werd vastgesteld door de verwaarloosbare  $\text{NH}_4^+$ -N niveau's en een sterke toename van  $\text{NO}_3^-$ -N niveaus.

## Praktische aanbevelingen

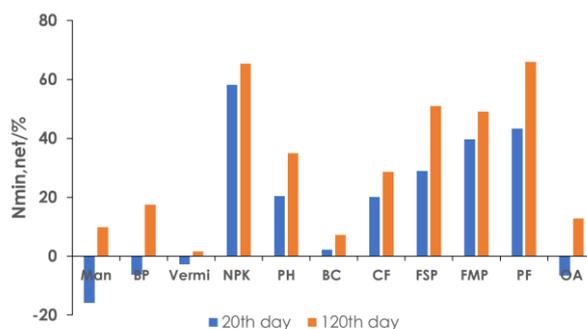
Bemestingsproducten uit visserijafval vertonen een lager gehalte aan minerale N vergeleken met kunstmest (Calcium Ammonium Nitraat) en vloeibare varkensmest. BBF-producten 'NPK', 'PH', 'FSP', 'FMP' en 'PF' hadden aan het einde van de incubatieperiode een relatief hogere netto N-afgifte en N-mineralisatie. De aanwezigheid van aminozuren en/of andere eiwitfracties in deze bemestingsproducten leidde in de incubatieproeven tot een hogere N-afgifte en N-mineralisatiesnelheid.



Figuur 1: Netto vrijgave op de 20e en 120e dag

Gebied	Land	BBF productie	Afk.	Vorm	Vocht, %	OM, % DM	TN, %	$\text{NH}_4^+$ -N, (g/kg)
Baltische Zee	Estland	Bokashi pellet	BP	s	9.35	61.85	2.63	0.38
Baltische Zee	Estland	Vermicompost en/of substraat	Vermi	s	54.46	33.17	0.89	0.11
Cantabrische Zee	Spanje	NPK-oplossing met aminozuren	NPK	l	65.54	78.78	5.31	2.56
Adriatische Zee Italië		Eiwithydrolysaten	PH	l	57.88	82.46	4.82	10.95
Adriatische Zee Italië		Biochar-compost composiet	BC	s	5.41	77.32	3.72	4.79
Adriatische Zee Italië		Chitinerijke meststof	CF	l	57.68	82.91	4.62	10.48
Noordzee	Noorwegen	Visslib gepelletiseerde meststof	FSP	s	5.60	82.5	6.19	0.62
Noordzee	Noorwegen	Vismix gepelletiseerde meststof	FMP	s	5.49	71.10	9.77	0.38
Atlantische Zee	Frankrijk	Eiwitfractie	PF	s	1.94	83.82	7.62	0.34
Middellandse Zee	Spanje	Organisch amendement	OA	s	53.97	42.30	1.89	2.77

Tabel 1: Totale en minerale stikstofgehalten van bemesting producten uit visserijafval die zijn geselecteerd voor bodem incubatie



Figuur 2: Netto mineralisatie op de 20e en 120e dag

## Verdere informatie

Zhang et al., 2023. Quality and safety assessment of fertilising products derived from fishery waste and by-products. Wageningen Soil Conference – Book of Abstracts, p93-94.

<https://wageningensoilconference.eu/2023/wp-content/uploads/2023/08/Book-of-abstracts-WSC2023.pdf>

## Over deze samenvatting

**Auteurs :** Jingsi Zhang, Çağrı Akyol and Erik Meers (Ghent University)

**Datum:** December 2023

Het **SEA2LAND**-project is een gezamenlijke innovatieactie (IA) gefinancierd door de EU in het kader van het Horizon 2020-programma. Het project heeft tot doel oplossingen te bieden om uitdagingen op het gebied van voedselproductie, klimaatverandering en hergebruik van afval te helpen overwinnen. Gebaseerd op het model van de circulaire economie bevordert SEA2LAND de productie van grootschalige meststoffen in de EU uit eigen grondstoffen. Verwacht wordt dat deze oplossing het onevenwicht aan voedingsstoffen in de bodem in Europa zal verminderen.

Het project loopt van januari 2021 tot en met december 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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# Assessing soil microbial activity in an Estonian field experiment with bio-based fertilizers using the enzyme dehydrogenase activity (DHA) method

## Main results / outcomes

It is crucial to evaluate the impact of various bio-based fertilizers derived from fish and aquaculture by-products on soil microbiological activity. Measuring soil DHA is a critical indicator of soil health and microbial activity.

## Practical recommendations



**Photo 1.** SEA2LAND field trial



**Photo 2.** Collection of soil samples



**Photo 3.** Soil DHA analyses in the laboratory

Dehydrogenase activity serves as a reliable indicator for soil microbial biomass and overall soil fertility. It demonstrates a positive correlation with organic matter content and nutrient availability. Furthermore, variations in dehydrogenase activity can indicate soil disturbance, pollution, or the effectiveness of soil management practices.

In conclusion, measuring soil dehydrogenase activity emerges as a practical and valuable tool for assessing soil health, contributing to sustainable land management and environmental conservation efforts. A comprehensive understanding of its methodologies, significance, and limitations empowers researchers, agronomists, and environmentalists to make informed decisions for the preservation and enhancement of soil quality.

## About this abstract

**Authors:** Liina Edesi and Tiina Talve, The Centre of Estonian Rural Research and Knowledge (METK)

**Date:** November 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

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# Mulla mikrobioloogilise aktiivsuse hindamine Eesti põldkatses biopõhiste väetistega ensüümi dehüdrogenaasi aktiivsuse (DHA) meetodil

## Peamised tulemused/väljund

Oluline on hinnata erinevate kalatööstuse ja vesiviljeluse kõrvalsaadustest toodetud biopõhiste väetiste mõju mulla mikrobioloogilisele aktiivsusele. Mulla DHA mõõtmine on mulla tervise ja mikroobide aktiivsuse seisukohalt üheks väga oluliseks näitajaks.

## Praktilised soovitused



Foto 1. SEA2LAND põldkatse



Foto 2. Mullaproovide kogumine



Foto 3. DHA analüüs laboris

Dehüdrogenaasi aktiivsus on usaldusväärne näitaja iseloomustamiseks mulla mikroobset biomassi ja üldist viljakust. Dehüdrogenaasi aktiivsus on positiivselt seotud orgaanilise aine sisaldusega ja toitainete kättesaadavusega. Lisaks võivad dehüdrogenaasi aktiivsuse muutused anda märku nii mulla saastatusest kui ka valedest viljelusvõtetest.

Kokkuvõtvalt võib öelda, et mulla dehüdrogenaasi määramine on praktiline ja väärtuslik meetod mulla tervise hindamiseks, mis toetab säästvat põllumajandust. Tulemused annavad teadlastele, agronoomidele ja keskkonnakaitsjatele võimaluse teha teadlikke otsuseid nii mulla viljakuse säilitamiseks kui ka parandamiseks.

## Info abstrakti kohta

**Autorid:** Liina Edesi ja Tiina Talve, Maaelu Teadmuskeskus (METK)

**Kuupäev:** November, 2023

Projekt **SEA2LAND** on koostööl põhinev innovatsioonitegevus (IA), mida EL rahastab programmi Horisont 2020 raames. Projekti eesmärk on pakkuda lahendusi, mis aitavad ületada toidutootmise, kliimamuutuste ja jäätmete taaskasutusega seotud väljakutseid. Ringmajanduse mudelist lähtuvalt edendab SEA2LAND EL-s suuremahuliste väetiste tootmist oma toorainest. Selle lahendusega loodetakse vähendada mulla toitainete tasakaalustamatust Euroopas. Projekt kestab 2021. aasta jaanuarist kuni 2024. aasta detsembrini.

**Veebileht:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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# Hormone-like activity tests to assess biostimulant effect of protein hydrolysate from shellfish waste

## Main results / outcomes

To investigate the biostimulant effect of protein hydrolysate from shellfish waste on crops, three hormone-like activity tests were performed on different formulations of shellfish protein hydrolysate: a) H100, raw hydrolysate, b) DEFAT, defatted by settling and c) F0.45, defatted and filtered at 0.45  $\mu\text{m}$ . The results gave a very weak auxin-like activity, cytokinin-like effect for H100 and DEFAT but no effect for F0.45, high gibberellin-like activity for the F0.45, negligible for H100 and DEFAT.

## Practical recommendations

The biostimulant effect of hydrolysates can be, at least in part, ascribed to hormone-like molecules (i.e. aminoacids). Plant hormones, or growth regulators, are endogenous molecules that mediate adaptations to environmental conditions. The main plant hormone classes: a) Auxins (3-indoleacetic acid [IAA] derivatives); b) Gibberellins (gibberellic acid [GA] derivatives); c) Cytokinins (kinetin-like molecules [KIN]). The use of quick-response hormone-like activity tests allows to verify if a protein hydrolysate can exert an effect similar the main plant-hormone classes on crops. This would give previous information on the possible biostimulant activity of the hydrolysate, on the most suitable formulation and on the best dilution ratio at which it can be applied. These quick response test do not replace pot and/or filed trials, but can help to address the proper dose to obtain a biostimulant effect.

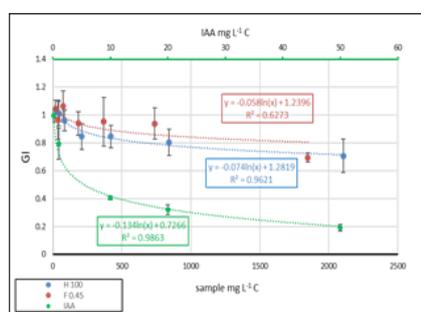


Figure 1: Auxin-like activity test

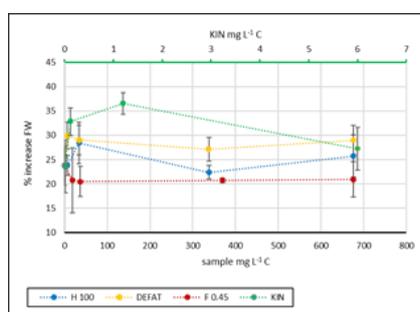


Figure 2: Cytokinin-like activity test

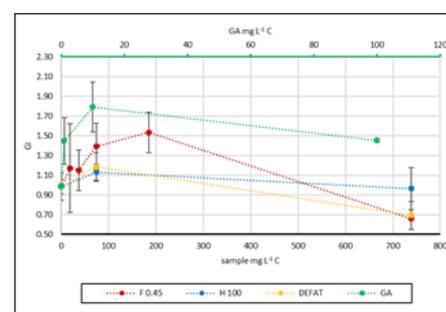


Figure 3: Gibberellin-like activity test

## Further information

Scaglia et al. (2015) *Sci. Total Environ.* 514, 314–321; Audus (1972) *Chemistry and Physiology* vol.1. Leonard Hill Books, London, UK; Pizzeghello et al. 2006 *Chemosphere*, 65, 190–200; Wang et al. 2001 *Chemosphere* 44, 1711–172; Pizzeghello et al. 2013 *J. Geochem. Explor.* 129, 70–75; Tsygankova et al. 2018 *Int. J. Chemtech Res.* 11, 10, 174–190

## About this abstract

**Authors:** Marta Dell'Orto (UMIL), Salman Nisar (UNIVPM), Josué Gonzalez-Camejo (UNIVPM), Corinne Andreola (UNIVPM), Fabrizio Adani (UMIL)

**Date:** December 2023

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## Test di attività ormono-simile per saggiare l'effetto biostimolante di idrolizzati proteici da scarti di molluschi

### Main results / outcomes

Per studiare l'effetto biostimolante sulle colture di idrolizzati proteici da scarti di molluschi marini, sono stati applicati tre test di attività ormono-simile su tre formulazioni di un idrolizzato proteico: a) H100, tal quale, b) DEFAT, degrassato per affioramento e c) F0.45, degrassato e filtrato a 0.45  $\mu\text{m}$ . I test hanno mostrato attività auxino-simile debole per tutti i formulati, moderata attività citochinino-simile per H100 e DEFAT ma non per F0.45, attività gibberellino-simile molto alta per F0.45, trascurabile per H100 e DEFAT.

### Practical recommendations

L'effetto biostimolante degli idrolizzati proteici è, almeno in parte, attribuibile a molecole ormomo-simili (i.e. aminoacidi). Gli ormoni delle piante (regolatori di crescita) sono molecole endogene che mediano l'adattamento alle condizioni ambientali. Le principali classi sono: a) Auxine (acido 3-indoloacetico [IAA] e derivati); b) Gibberelline (acido gibberellico [GA] e derivati); c) Citochinine (molecole derivate dalla Kinetina [KIN]). L'uso di test di attività ormono-simile a risposta rapida consente di verificare se un idrolizzato proteico esercita un effetto simile a quello degli ormoni delle piante. Questo fornisce informazioni preliminari sull'eventuale effetto biostimolante dell'idrolizzato, sulla formulazione e sul grado di diluizione più efficaci. Questi test a risposta rapida non sostituiscono le prove in vaso o in campo, ma possono aiutare a ottimizzarli, suggerendo le dosi e le formulazioni per ottenere l'effetto biostimolante.

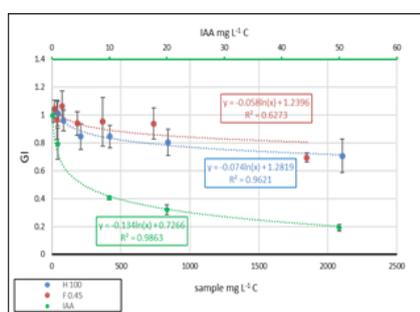


Figura 1: test auxino-simile

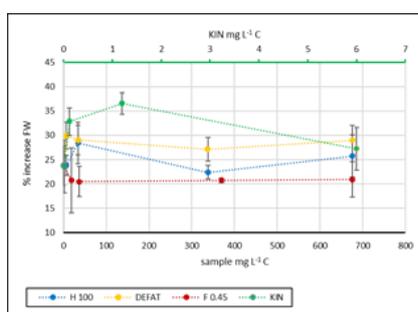


Figura 2: test citochinino-simile

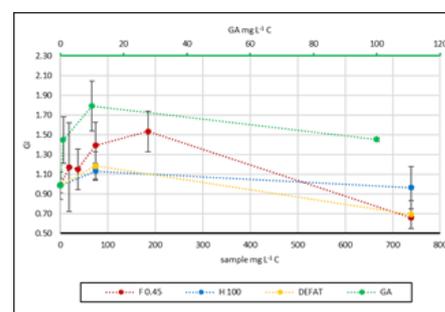


Figura 3: test gibberellino-simile

### Further information

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### About this abstract

**Autori:** Marta Dell'Orto (UMIL), Salman Nisar (UNIVPM), Josué Gonzalez-Camejo (UNIVPM), Corinne Andreola (UNIVPM), Fabrizio Adani (UMIL)

**Data:** Dicembre 2023

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# Fertilizing effect of fish farm by-products on broccoli in Pyrénées Atlantiques, France

## Main results / outcomes

Three fertilizers were tested (BBF1, BBF2, BBF3) and compared with the "farmer fertilizer" and "no fertilizer" (control) modalities. Initially, correct plant development was observed (cf. photo1).

The average biomass produced at d+30 after planting was slightly higher for the fertilizers than for the control modality (6.4 g mean dry weight), with an effect that seemed greater for BBF3 (12 g mean dry weight) (and for the farmer's fertilizer) (cf. figure 1). Nevertheless, variability is very high within the same fertilization modality and there is no significant difference. Disparities between microplots seem to have more to do with their location (see figure 2).

In addition, the climate and phytosanitary problems (diseases / physiology /...) prevented us from completing the trial and seeing the effects of fertilizers on the plant's complete cycle. Measurements (biomass, plant C/N, residues, etc.) could only be taken on young plants, and not at the decisive moment of harvest.

Future results from samples taken during the season (soil, plants) will provide an overall view of the effect of these fertilizers on the crop and the soil.



Picture 1: the trial 48 days after the plantation

- 1 : Modality 1 : BBF1
- 2 : Modality 2 : BBF2
- 3 : Modality 3 : BBF3
- 4 : Modality 4 : engrais AB
- 5 : Modality 5 : pas d'engrais

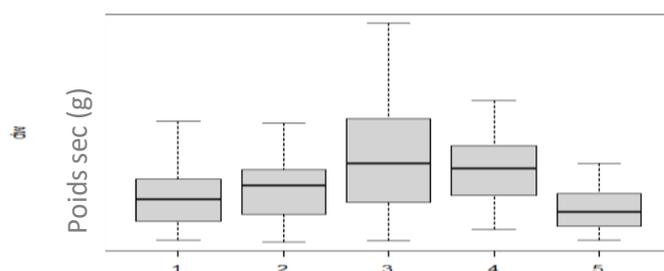


Figure 1: Broccoli weight distribution according to fertilizer (sample taken 30 days after planting)

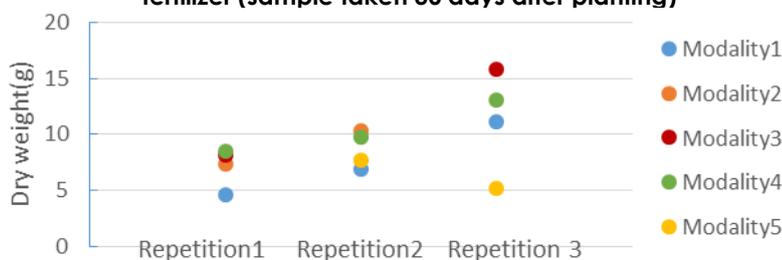


Figure 2: Average dry weight per fertilizer as a function of replication

## Practical recommendations

By supplementing with potash, these fertilizers would enable fish farm waste to be recycled for local production.

## About this abstract

**Authors:** Margot DULAIS Chambre d'Agriculture des Pyrénées Atlantiques

**Date:** December 2023

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# Effet fertilisant de co-produits issus de la pisciculture sur brocolis en Pyrénées Atlantiques

## Principaux résultats

3 fertilisants ont été testés (BBF1, BBF2, BBF3) et comparés aux modalités "engrais agriculteur" et pas "d'apport d'engrais" (témoin). Dans un premier temps, un développement correct des plants a été observé (cf. photo 1).

Les moyennes de biomasse produite à j+30 après plantation sont légèrement plus importantes pour les fertilisants que pour la modalité témoin (6,4 g poids sec moyen) avec un effet qui semble plus important pour le BBF3 (12 g poids sec moyen) (et pour l'engrais agriculteur) (cf. figure 1). Néanmoins, la variabilité est très importante au sein d'une même modalité fertilisation et il n'y a pas de différence significative. Les disparités entre micro-parcelle semblent plus tenir de leur localisation (cf. figure 2).

De plus, le climat et des problèmes phytosanitaires (maladies / physiologie / ...) ont empêché de mener l'essai à terme et de voir les effets des fertilisants sur le cycle complet de la plante. Les mesures (biomasse, C/N plant, reliquats, ...) n'ont pu être faites que sur les jeunes plantes et non au moment décisif de la récolte.

Les résultats à venir des échantillons prélevés dans la saison (sol, plantes) permettront une vision globale de l'effet de ces fertilisants sur la culture et sur le sol.



Photo 1: la plantation 48 jours après plantation

- 1 : Modalité 1 : BBF1
- 2 : Modalité 2 : BBF2
- 3 : Modalité 3 : BBF3
- 4 : Modalité 4 : engrais AB
- 5 : Modalité 5 : pas d'engrais

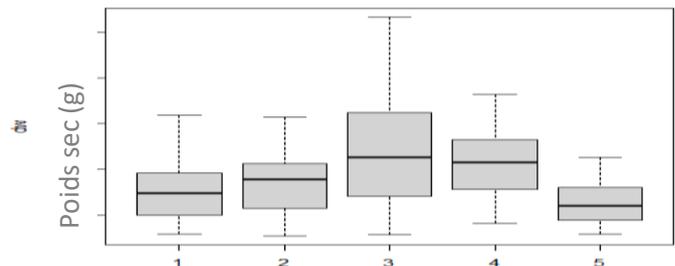


Figure 1 : Répartition du poids de brocolis en fonction du fertilisant (prélèvement 30 jours après plantation)

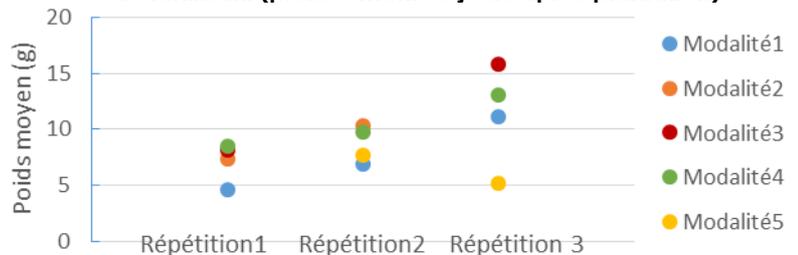


Figure 2 : Poids sec moyen par fertilisant en fonction de la répétition

## Recommandations pratiques

En complétant avec un apport de potasse, ces fertilisants permettraient une valorisation sur culture de déchets de la pisciculture avec également une dimension production locale.

## A propos de ce résumé

**Auteur :** Margot DULAIS – Chambre d'Agriculture des Pyrénées Atlantiques

**Date:** December 2023

Le projet **SEA2LAND** est une action d'innovation collaborative (IA) financée par l'UE dans le cadre du programme Horizon 2020. Le projet vise à fournir des solutions pour aider à surmonter les défis liés à la production alimentaire, au changement climatique et à la réutilisation des déchets. Basé sur le modèle de l'économie circulaire, SEA2LAND promeut la production d'engrais à grande échelle dans l'UE à partir de ses propres matières premières. Cette solution devrait réduire le déséquilibre des nutriments du sol en Europe. Le projet se déroulera de janvier 2021 à décembre 2024.

**Site web :** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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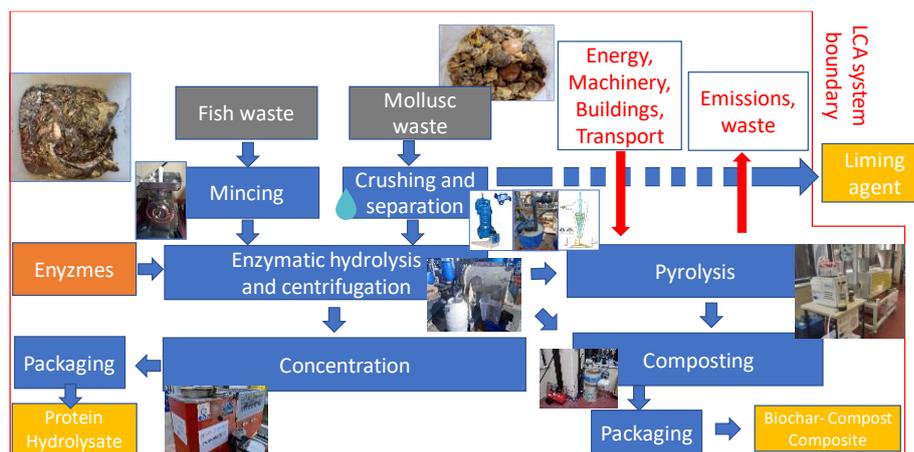
# Identifying environmental hotspots of fertilizers produced from fish and mollusc waste

## Main results / outcomes

To explore alternatives to mineral fertilizers, a pilot facility producing fertilizer from Adriatic fish and mollusc sidestreams was developed. It involves different production stages: the mechanical treatment of raw materials, a subsequent hydrolysis and a concentration step (Figure 1). A life cycle assessment (LCA) identified the main environmental hotspots of this fertilizer production regarding climate change, acidification and eutrophication: production of enzymes for hydrolysis, energy use during the concentration step and packaging.

## Practical recommendations

To reduce freshwater eutrophication, the input of enzymes should be minimized as much as possible. Greenhouse gas emissions can be lowered by using optimized concentration or drying technologies, e.g. with heat recovery. The corresponding emissions can be further lowered by the use of renewable energy sources such as biogas. In addition, the amount of packaging for the final fertilizer needs to be reduced to a minimum.



**Figure 1:** Fertilizer production scheme with sidestreams (grey), process stages (blue), co-products (yellow) and enzyme input (orange).

## Further information

Andreola et al. (2023), Techno-economic assessment of biorefinery scenarios based on mollusc and fish residuals. *Waste Management*, 166, 294-304, doi.org/10.1016/j.wasman.2023.05.014  
Landert et al. (2023), Life cycle assessment (LCA) of bio-based fertilizers from fisheries and aquaculture sidestreams. Presentation at ESPP WARM Research Meeting.

## About this abstract

**Authors:** Jan Landert (FiBL), Corinne Andreola (UNIVPM), Laura de Baan (FiBL)

**Date:** December 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

The project is running from January 2021 to December 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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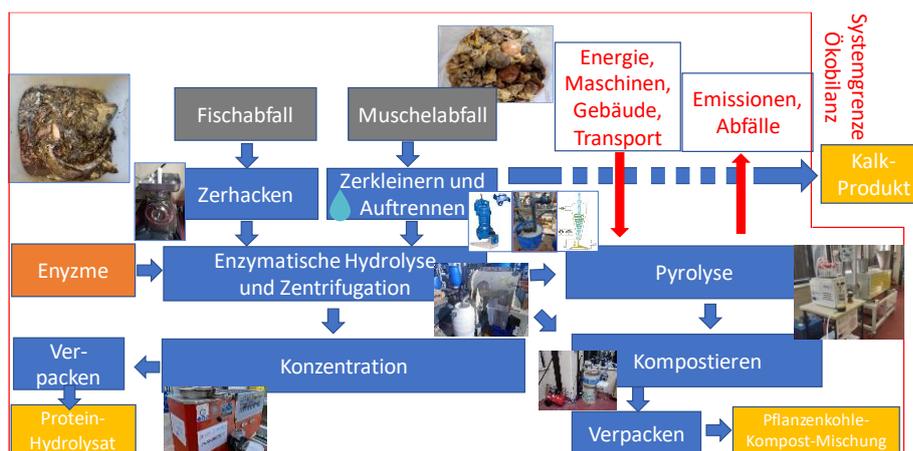
# Identifizierung von Umwelt-Hotspots bei der Herstellung von Recycling-Düngern aus Fisch- und Muschelabfällen

## Wichtigste Ergebnisse / Resultate

Um Alternativen zu Mineraldüngern zu erforschen, wurde eine Pilotanlage zur Herstellung von Düngern aus Fisch- und Muschelabfällen aus der Adria entwickelt. Sie umfasst folgende Produktionsstufen: die mechanische Behandlung der Abfälle, eine anschließende Hydrolyse und einen Konzentrationsschritt (Abbildung 1). Im Rahmen einer Ökobilanz wurden die wichtigsten ökologischen Hotspots der Recyclingdünger-Produktion im Hinblick auf den Klimawandel, die Versauerung und Eutrophierung ermittelt. Dies sind die Herstellung der Enzyme für die Hydrolyse, der Energieverbrauch während des Konzentrationsschritts und die Verpackung.

## Praktische Empfehlungen

Um die Eutrophierung von Süßwasser zu verringern, sollte der Einsatz von Enzymen so weit wie möglich minimiert werden. Die Treibhausgasemissionen können durch den Einsatz optimierter Konzentrations- oder Trocknungstechnologien, z. B. mit Wärmerückgewinnung, gesenkt werden. Die entsprechenden Emissionen können durch den Einsatz von erneuerbaren Energieträgern wie Biogas weiter gesenkt werden. Darüber hinaus sollte der Verpackungsaufwand für den Enddünger auf ein Minimum reduziert werden.



**Abbildung 1:** Schema der Recyclingdünger-Produktion mit Fisch- und Muschelabfällen (grau), Prozessstufen (blau), Nebenprodukten (gelb) und Enzym-Einsatz (orange).

## Weitere Informationen

Andreola et al. (2023), Techno-economic assessment of biorefinery scenarios based on mollusc and fish residuals. *Waste Management*, 166, 294-304, doi.org/10.1016/j.wasman.2023.05.014

Landert et al. (2023), Life cycle assessment (LCA) of bio-based fertilizers from fisheries and aquaculture sidestreams. Präsentation beim ESPP WARM Research Meeting.

## Über diese Zusammenfassung

**Die Autoren:** Jan Landert (FiBL), Corinne Andreola (UNIVPM), Laura de Baan (FiBL)

**Datum:** Dezember 2023

Das Projekt **SEA2LAND** ist eine gemeinschaftliche Innovationsmassnahme (IA), die von der EU im Rahmen des Programms Horizon 2020 finanziert wird. Das Projekt zielt darauf ab, Lösungen zur Bewältigung der Herausforderungen im Zusammenhang mit der Lebensmittelproduktion, dem Klimawandel und der Abfallwiederverwendung zu finden. Auf der Grundlage des Modells der Kreislaufwirtschaft fördert SEA2LAND die Herstellung von Düngemitteln in grossem Massstab in der EU aus eigenen Rohstoffen. Es wird erwartet, dass diese Lösung das Nährstoffungleichgewicht in den Böden Europas verringern wird. Das Projekt läuft von Januar 2021 bis Dezember 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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## Liming agent

### Main results / outcomes

The result of the liming agent meeting was to get information out to the members about why it is important to focus on liming agent

### Practical recommendations

There was various presentation given during this meeting. The main focus was on liming agent, and soil health. The various presentations was many good reasons to use liming agent that was given by: Ingvild Lauvland Høie. The focus in this presentation is: the importance of liming agent, the effect on pH and nutrient uptake, plants that are better prepared against over-winter damage, species and soil types requirements for pH.

The second presentation was held by Franzefoss (Balangen), Where they went through variable liming agents. They talked about their history on how Franzefoss was developed. They talked about different types of liming agent, how important the soil samples are, and from where the location of the soil samples are taken out, and their opportunities for use of liming agent.

When Kristin Sørensen spoke about their experiment, she talked about the results and the outcome. At the end there was a demonstration from Franzefoss of a new liming agent wagon.



### Further information

The homepage from NLR (Norsk landbruksrådgiving Nord- Norge): <https://nordnorge.nlr.no/>

### About this abstract

**Authors:** NLR Nord- Norge

**Date:** December 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

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## Kalking

### Hovedresultater / utfall

Resultatet av kalkemiddelmøtet var å få informasjon ut til medlemmene, om hvorfor det er viktig å fokusere på kalkemiddel.

### Praktiske anbefalinger

Det ble holdt ulike presentasjoner under møtene. Hovedfokus var på kalkemiddel, og jordhelse. Det ble holdt ulike presentasjoner, en av dem var: Mange gode grunner til å bruke kalkemiddel som ble holdt av: Ingvild Lauvland Høie. '

Fokus i denne presentasjonen var: betydningen av kalkemiddel, effekt på pH og næringsopptak, styrke plantene for vinteren, arter og jordtypers krav til pH.

Den andre presentasjonen ble holdt av Franzefoss (Balangen). Der de gikk gjennom variable kalkingsmidler, og snakket om Franzefoss sin historie. Videre gikk de inn på ulike kalkemidler, hvordan posisjonsbestemte jordprøver muliggjør variabel kalking. Kristin Sørensen fra NLR fortalte om forsøket, «åtekalk». På slutten var det demonstrasjon fra Franzefoss av en ny kalkingsvogn.



### Mer informasjon

Hjemmesiden til NLR (Norsk landbruksrådgiving Nord- Norge): <https://nordnorge.nlr.no/>

### Om dette abstraktet

**Forfattere:** NLR Nord- Norge

**Dato:** desember 2023

**SEA2LAND:** prosjektet er et samarbeidende Innovation Action (IA) finansiert av EU innenfor rammen av Horisont 2020-programmet. Prosjektet har som mål å gi løsninger for å hjelpe til med å overkomme utfordringer knyttet til matproduksjon, klimaendringer og gjenbruk av avfall. Basert på den sirkulære økonomimodellen fremmer SEA2LAND produksjon av storskala gjødsel i EU fra egne råvarer. Denne løsningen forventes å redusere ubalansen i jordsmonnet i Europa. Prosjektet pågår fra januar 2021 til desember 2024.

**Nettsted:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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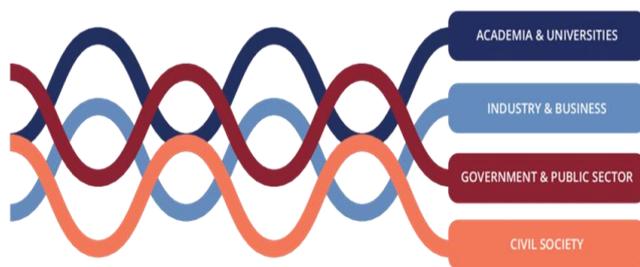
## Inventory of stakeholders

### Main results / outcomes

**Stakeholders** are persons, groups, or institutions with interests in a policy, program, or project. Their involvement may be critical for a better and more comprehensive understanding of problems and implementing solutions, they may represent a possible barrier or even a threat, or they may simply have a democratic right to be involved because project decisions will affect them.

### Practical recommendations

The identification of stakeholders establishes the base of engagement and communication strategies that is necessary for achieving greater participation and acceptance of the project. In SEA2LAND project was used a **quadruple helix model (QHM)**. The QHM advocates for a collaborative, interdisciplinary approach amongst the government, industry, academia, and civil society to establish innovative shared value opportunities in an open innovation ecosystem, benefiting all stakeholders involved. In the first step, seven main stakeholder groups were identified: **fish and aquaculture industry, agricultural producers, fertilizer producers and sellers, academia and research focused on nutrient recycling, business and financial advisors, policy makers & authorities, and public entities & general public.** The identified stakeholder groups are analysed based on their influence on the project and the impact it has on their business activities.



**Figure 1:** The quadruple helix model  
(source: [Finquelievich, 2016](#))



**Figure 2:** The stakeholder groups identified for the SEA2LAND project

### Further information

<https://innovation-entrepreneurship.springeropen.com/articles/10.1186/2192-5372-1-2>

### About this abstract

**Authors:** IPS Konzalting d.o.o. za poslovne usluge

**Date:** December 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

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## Identifikacija dionika

### Glavni rezultati / ishodi

**Dionici** su osobe, skupine ili institucije s interesima u politici, programu ili projektu. Njihovo sudjelovanje može biti ključno za bolje i sveobuhvatnije razumijevanje problema i implementaciju rješenja, mogu predstavljati moguću prepreku ili čak prijetnju, ili jednostavno imaju demokratsko pravo biti uključeni jer će odluke projekta utjecati na njih.

### Praktične preporuke

Identifikacija dionika postavlja temelj strategijama angažmana i komunikacije koje su nužne za postizanje većeg sudjelovanja i prihvaćanja projekta. U projektu SEA2LAND korišten je **model četverostruke spirale (QHM)**. QHM zagovara suradnički, interdisciplinarni pristup među vladom, industrijom, akademskom zajednicom i civilnim društvom kako bi se uspostavile inovativne prilike dijeljenja vrijednosti u otvorenom inovacijskom ekosustavu, s koristima za sve uključene dionike. U prvom koraku, identificirano je sedam glavnih skupina dionika: **ribarska industrija i akvakultura, poljoprivredni proizvođači, proizvođači i trgovci gnojiva, akademska zajednica i istraživači usmjereni na recikliranje hranjivih tvari, poslovni i financijski savjetnici, zakonodavna tijela, te javne institucije i opća javnost**. Identificirane skupine dionika analiziraju se temeljem njihovog utjecaja na projekt i utjecaja koji projekt ima na njihove poslovne aktivnosti.

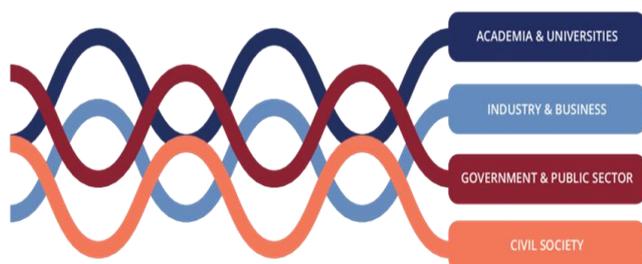


Figure 1: Model četverostruke spirale  
(izvor: [Finquellievich, 2016](#))

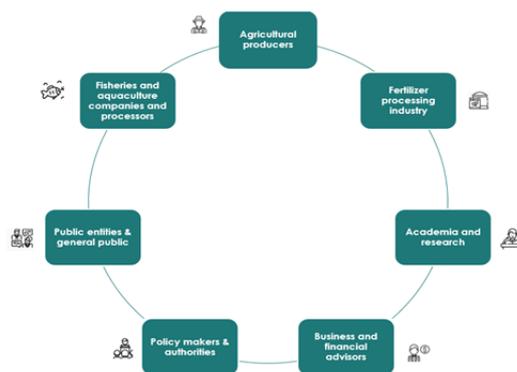


Figure 2: Grupe dionika identificirane u sklopu SEA2LAND projekta

### Dodatne informacije

<https://innovation-entrepreneurship.springeropen.com/articles/10.1186/2192-5372-1-2>

### O ovom sažetku

**Autori:** IPS Konzalting d.o.o. za poslovne usluge

**Datum:** Prosinac 2023

**SEA2LAND** je projekt u sklopu inovacijske aktivnosti (IA) financiran od strane EU u sklopu Obzor 2020 programa. Cilj projekta je pružiti rješenja koja će pomoći u savladavanju izazova povezanih s proizvodnjom hrane, klimatskim promjenama i oporabom otpada. Na temelju modela kružne ekonomije, SEA2LAND promiče proizvodnju gnojiva u EU iz vlastitih sirovina. Očekivano je da će ovo rješenje smanjiti neuravnoteženost hranjivih tvari u tlu.

Projekt traje od siječnja 2021 do prosinca 2024.

**Web stranica:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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## Conclusions of the first brainstorm session

### Main results / outcomes

Through 2 brainstorming sessions, in each of the participating countries (11 EU countries and 1 CELAC) with different stakeholders, the project will go a step further in catalysing the list of barriers and opportunities currently present in the market. Collected information will be of crucial importance for the development of strong business plans that will maximize strengths and opportunities and on the other hand, avoid threats and weaknesses that come from the competition of the bio-based/mineral fertilizer and/or within the new product development process.

### Practical recommendations

The first brainstorm sessions were held in 2023 and the total number of participants was **135**. Depending on the country, the brainstorm sessions were held online/live and the most represented stakeholder groups were agricultural producers, fisheries/aquaculture companies/processors and the fertilizer processing industry. Topics of most interest were focused on **BBF availability and future on the market, price, nutritional content, possibilities of processing the fish by-products and their advantages and disadvantages in general**. The main goal of the brainstorm sessions was to gain insight into stakeholders' views on the current state of fertilizers on the market and their opinions on new ones that will be produced as part of the project. Furthermore, the important goal was to find out how much the newly produced fertilizers would be accepted by the stakeholders regarding quality, price, organic matter. Their opinion was received **via a questionnaire on the production and market uptake of BBFs from fishing by-products and via Business Model Canvas (BMC)**. The main advantages of BBFs, from the stakeholder's point of view, are a high percentage of organic matter in the fertilizer, slow release of nutrition, followed by improved crop yields, soil fertility and decreased dependence on synthetic fertilizers. Regarding the questionnaire, most of the respondents showed a willingness to use fertilizers obtained from fish waste. The main reasons for choosing this kind of fertilizer are the content of organic matter and price. Stakeholders have shown keen interest in the project's themes and the results so far. They have indicated a preference for receiving more detailed information about the project outcomes.



Figure 1: The brainstorm session in Croatia



Figure 2: The brainstorm session in Croatia

### About this abstract

**Authors:** IPS Konzalting d.o.o. za poslovne usluge

**Date:** December 2023

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## Zaključci prve radionice

### Glavni rezultati / ishodi

Kroz 2 radionice, u svakoj od zemalja sudionica (11 zemalja EU i 1 CELAC) s različitim dionicima, SEA2LAND projekt definirat će prepreke i prilike trenutno prisutne na tržištu gnojiva. Prikupljene informacije bit će od ključne važnosti za razvoj snažnih poslovnih planova koji će maksimizirati prednosti i prilike, a s druge strane, izbjeći prijetnje i slabosti koje dolaze od konkurencije bioloških / mineralnih gnojiva i/ili unutar razvojnog procesa novih proizvoda.

### Praktične preporuke

Prve radionice održane su 2023. godine, a ukupan broj sudionika bio je **135**. Ovisno o zemlji, radionice su se održavale online/uživo, a najzastupljenije skupine dionika bili su poljoprivredni proizvođači, tvrtke za ribarstvo/akvakulturu/prerađivači te prerađivači gnojiva. Teme radionica odnosile su se na **dostupnost i budućnost bioloških gnojiva na tržištu, cijena, nutritivni sadržaj, mogućnosti prerade ribljih nusproizvoda te općenito njihove prednosti i nedostaci**. Glavni cilj bio je dobiti uvid u stavove dionika o trenutnom stanju gnojiva na tržištu te njihova mišljenja o novima koja će se proizvoditi u sklopu projekta. Nadalje, važan cilj je bio saznati koliko će novoproduzvana gnojiva biti prihvaćena s obzirom na kvalitetu, cijenu, sadržaj organske tvari. Njihovo mišljenje dobiveno je **putem upitnika o proizvodnji i tržišnoj upotrebi bioloških gnojiva dobivenih iz ribljih nusproizvoda i putem Business Model Canvas-a (BMC)**. Glavne prednosti gnojiva, sa stajališta dionika, su visok postotak organske tvari, sporo otpuštanje hranjivih tvari, praćeno poboljšanim prinosima, plodnošću tla i smanjenom ovisnošću o mineralnim gnojivima. Što se tiče upitnika, većina ispitanika je pokazala spremnost za korištenje gnojiva dobivenih iz ribljeg otpada. Glavni razlozi za odabir ove vrste gnojiva su sadržaj organske tvari te cijena. Dionici su pokazali veliko zanimanje za teme projekta i dosadašnje rezultate. Naznačili su da žele dobiti detaljnije informacije o ishodima projekta.



Figure 1: Radionica u Hrvatskoj



Figure 2: Radionica u Hrvatskoj

### O ovom sažetku

**Autori:** IPS Konzalting d.o.o. za poslovne usluge

**Datum:** Prosinac 2023

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Projekt traje od siječnja 2021 do prosinca 2024.

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## IWA Congress: Preliminary evidence of resources recovery from fishery wastes

### Main results / outcomes

UNIVPM participated in the IWA World Water Congress & Exhibition (WWCE) held in Copenhagen, Denmark, last September 2022 with around 1000 participants. The study aimed to showcase the technologies and processes implemented in the SEA2LAND project for recovery of nutrients from seafood discards.

### Practical recommendations

WWCE is a global event on water solutions organised by the International Water Association (IWA). Leaders, decision-makers, researchers and business representatives from around the world, within and outside the water sector attended this event, which provided a platform for networking and opportunities to showcase their innovative solutions to the right professionals and companies. The aim of UNIVPM, in the context of the SEA2LAND project, was to present evidence of advanced bio-based fertilisers and water reuse from fishery wastes using biorefinery scheme to recover valuable by-products such as biostimulant, soil improver, biochar and calcium carbonate, contributing to the mitigation of environmental problems associated with stabilising these discards and leading to a circular economy approach by closing nutrient loops in processing fishery and agronomic industries.



Figure 1: Introduction of the presentation

### CONCLUSION

- Combination of fish and mollusc waste to increase production capacity and reduce energy demand for heating and concentration step
- Recovered shells are promising liming agent for acidic soil
- ENZYMATIC HYDROLYSIS of PROTEIN: 1 liter of water per kg of substrate, 0.5% Alcalase at 60°C without control of pH
- ZERO-WASTE production by COMPOSTING hydrolysis leftovers.
- Adding biochar, from leftover pyrolysis or wooden biomasses, improves composting process and reduces environmental impact related

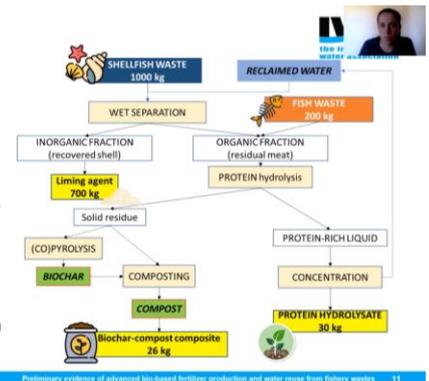


Figure 2: Conclusions of the presentation

### Further information

<https://worldwatercongress.org/exhibition/>

<https://wweelab.simau.univpm.it/>

### About this abstract

**Authors:** Università Politecnica delle Marche (UNIVPM)

**Date:** November 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

The project is running from January 2021 to December 2024.

**Website:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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## Congresso IWA: Prove preliminari di recupero delle risorse dai rifiuti della pesca

### Principali risultati/esiti

L'UNIVPM ha partecipato, lo scorso Settembre 2022, al World Water Congress & Exhibition (WWCE) dell'IWA, a Copenaghen, in Danimarca, alla presenza di circa 1000 partecipanti. Lo studio mirava a presentare le tecnologie e i processi implementati nel progetto SEA2LAND per il recupero dei nutrienti dai rifiuti di pesce.

### Raccomandazioni pratiche

WWCE è un evento globale sulle soluzioni idriche organizzato dall'International Water Association (IWA). Hanno partecipato, imprenditori, ricercatori e rappresentanti di aziende di tutto il mondo nel settore idrico, questo evento ha fornito la possibilità di presentare le loro soluzioni innovative ai professionisti e alle aziende. L'obiettivo dell'UNIVPM, nel contesto del progetto SEA2LAND, è stato quello di presentare prove di fertilizzanti avanzati a base biologica e di riutilizzo dell'acqua dagli scarti della pesca, utilizzando uno schema di bioraffineria per recuperare sottoprodotti di valore come biostimolanti, ammendanti, biochar e carbonato di calcio, contribuendo alla mitigazione dei problemi ambientali associati alla stabilizzazione di questi scarti e portando a un approccio di economia circolare chiudendo i loop dei nutrienti nella lavorazione delle industrie ittiche e agronomiche.

#### IWA World Water Congress & Exhibition

11 – 15 September 2022 | Copenhagen, Denmark



Figura 1: Slide iniziale della presentazione

#### CONCLUSION

- Combination of fish and mollusc waste to increase production capacity and reduce energy demand for heating and concentration step
- Recovered shells are promising liming agent for acidic soil
- **ENZYMATIC HYDROLYSIS of PROTEIN:** 1 liter of water per kg of substrate, 0.5% Alcalase at 60°C without control of pH
- **ZERO-WASTE production by COMPOSTING** hydrolysis leftovers.
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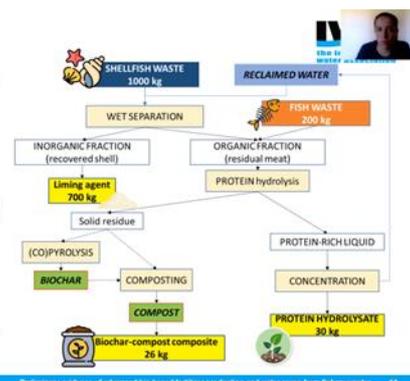


Figure 2: Slide conclusiva della presentazione

### Ulteriori informazioni

<https://worldwatercongress.org/exhibition/>

<https://wweelab.simau.univpm.it/>

### Informazioni dell'estratto

**Autori:** Università Politecnica delle Marche (UNIVPM)

**Data:** Novembre 2023

Il progetto **SEA2LAND** è un'azione collaborativa di innovazione (IA) finanziata dall'UE nell'ambito del programma Horizon 2020. Il progetto mira a fornire soluzioni per aiutare a superare le sfide legate alla produzione alimentare, al cambiamento climatico e al riutilizzo dei rifiuti. Si basa sul modello dell'economia circolare. SEA2LAND promuove la produzione di fertilizzanti su larga scala nell'UE a partire da materie prime proprie. Questa soluzione fissa come obiettivo di ridurre lo squilibrio dei nutrienti nel suolo Europeo. Il progetto è iniziato a gennaio 2021 e terminerà a dicembre 2024.

**Sito Web:** [www.sea2landproject.eu](http://www.sea2landproject.eu)



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# Impact of SEA2LAND fertilizers on Broccoli production under Belgian organic conditions

## Main results / outcomes

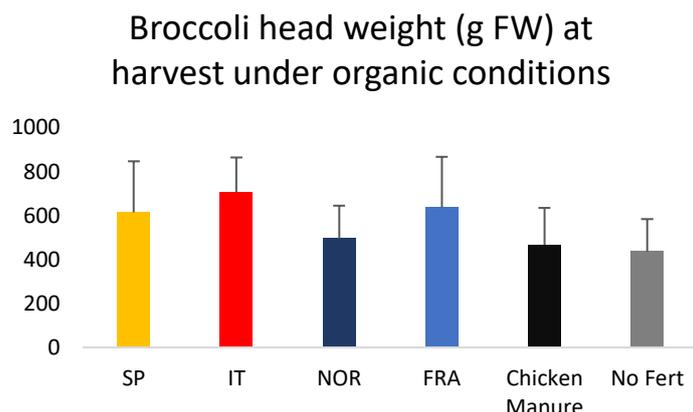
In 2023, 4 bio-based fertilizers from the SEA2LAND project were tested under organic conditions on Broccoli production. The results were compared to a commonly used fertilizer in organic farming (chicken manure) and to no addition of fertilizer. In total, all the plots received the equivalent of 120 kg N/ha (except for the “No Fert” treatment). The results at harvest (fresh weight (grams) of broccoli heads with commercialized standards) indicate a good performance of all tested fertilizers with the best results obtained with the hydrolysate of liquid formulation (Italy). Although spring and summer conditions were extremely difficult in Belgium for the year 2023, these results are encouraging and show the potential of these bio-based fertilizers, in particular for this crop and under organic conditions.

## Practical recommendations

For liquid formulations such as hydrolysate from UNIVPM (Italy) and liquid fertilizer from FERTINAGRO (Spain), it is recommended to apply the product diluted 5 times in water and to avoid a post-planting application of the product (pre-planting application of the product is favorable). For solid formulations such as dried fish sludge from Grønn Gjødsel (Norway) and organic fertilizer from CATAR (France), both pre and post-planting applications are possible.



**Fig. 1:** Field trial in Upigny (Belgium) where broccoli (var: Parthenon) was grown under organic conditions with 6 different treatments (see Figure 2 for treatment details)



**Fig. 2:** Fresh weight (grams) of broccoli heads (size > 8 cm) as influenced by Sea2Land Fertilizers under organic conditions in Upigny (Belgium) in 2023 (SP:liquid fertilizer, IT:hydrolysate, NOR:dried fish sludge, FRA:organic fertilizer, Chicken Manure : common organic fertilizer used under Belgian conditions; No Fert: no fertilizer added)

## Further information

Full details of this field trial can be obtained by contacting Cécile Thonar ([cecile.thonar@ulb.be](mailto:cecile.thonar@ulb.be)), Nicolas Luburić ([nicolas.luburic@brioaa.bio](mailto:nicolas.luburic@brioaa.bio)) or Eddy Montigny ([eddy-montigny@brioaa.bio](mailto:eddy-montigny@brioaa.bio)).

A publication will also be elaborated and link will be given on the SEA2LAND website once it is released.

## About this abstract

**Authors:** Eddy Montignies, Nicolas Luburić, Cécile Thonar (BRIOAA (Belgian Research Institute of Organic Agriculture and Agroecology) and ULB (Université Libre de Bruxelles, Belgium).

**Date:** December 2023

**SEA2LAND** project is a collaborative Innovation Action (IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe.

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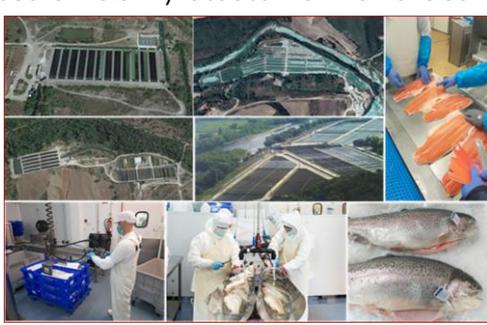
# Understanding the value of freshwater aquaculture and fish processing byproducts through agro-innovative approach & technological solutions

## Main results / outcomes

CAVIAR PIRINEA and some research partners are making available an extended catalogue of side streams characterization, which are routinely sold to waste managing companies with no valorisation income derived. The technological approaches developed herein by BETA are revealing that within a private aquaculture production scenario of 3.100T fish/year (i.e., rainbow trout (*O. mykiss*) and sturgeon (*Arcipenser sp.*)) and 1.902T of fresh processed products/year (i.e., fish, roe and caviar) => 69m<sup>3</sup> fish sludge, 96T fish viscera and 200T of non-conforming fish/year could respectively be evaluated through some of the current research techniques in progress. Likewise, the project could show that every increased productivity derived from intensification in aquaculture and/or fish processing practices will not only lead to a subsequent huge but also economically recoverable production of agro-innovative byproducts. The solutions developed are expected to reduce the soil nutrient imbalance in Europe.

## Practical recommendations

Sludge produced from freshwater aquaculture systems can be successfully valorized by a portfolio of technologies to recover nutrients on a dry basis, as follows for example: (i.) Solid fraction of freshwater sludge: 7.0% TKN, 0.4% TP, and 0.1% K. and (ii.) Liquid fraction of freshwater sludge: 0.33 g N/L, 0.02 g TP/L, and 0.02 g K/L. Dead fish is being valorized as a co-substrate during the treatment of the solid fraction from freshwater aquaculture sludge. The specific use of trout as a co-substrate is showing to be very potential because it presents high organic matter content and valuable and recoverable nutrients as N (4.4% TKN) and P (0.4% TP) on a dry basis. Likewise, 26 private and public stakeholders involved in 8 technical work-packages and with expertise in the fields of agriculture, aquaculture, fisheries and fish processing from all over Europe, will continue developing through the end of 2024, comprehensive data sets relating to (i.) agriculture and fertilization; (ii.) side-streams characterization and technology development; (iii.) food waste and circular economy; (iv.) environmental performances and constraints; (v.) sustainability assessment and business models.



**Fig. 1:** Facilities and activity of Caviar Pirinea SLU.



**Fig. 2:** A. Rainbow Trout from Caviar Pirinea SLU; B. Biodrying pilot unit for the valorization of fish sludge and dead fish set in BETA. C. Fish Sludge from the processing plant. D. Dead fish as co-substrate. E. Mechanical process and osmosis. and F. Freeze concentrator

## Further information

The physicochemical characterizations herein are making evident the **feasibility of recovering nutrients from dead fish and sludge produced in aquaculture companies** and it could represent a promising option for the production of bio-based fertilizers (BBF) from aquaculture by-products (further details on freshwater vs. marine, in progress). Furthermore, the potential application of **these BBF could reduce the costs associated with sludge management**, bringing both cost reduction a new market opportunity, for the aquaculture sector.

## About this abstract

**Authors:** Mendiola, Diego (CAVIAR), Lidia Paredes, Tiago Akaboci, Laia Llenas and Sergi Ponsa (BETA-UVIC).  
**Date:** December 2023  
**SEA2LAND** project is a collaborative Innovation Action(IA) funded by the EU in the frame of the Horizon 2020 programme. The project aims to provide solutions to help overcome challenges related to food production, climate change and waste reuse. Based on the circular economy model, SEA2LAND promotes the production of large-scale fertilisers in the EU from own raw materials. This solution is expected to reduce the soil nutrient imbalance in Europe. The project is running from January 2021 to December 2024.  
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# SEALAND



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