Country specific requirements for transfrontier transport and use of recycling-derived fertilisers in NW Europe

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Summary and conclusions

The objective of the NWE-Interreg project ReNu2Farm is to increase the use and production of recycled nitrogen (N), phosphorus (P) and potassium (K) for fertilisers in Northwest Europe (NWE).

The proper development of the market for biobased, recycling-derived fertilisers is hampered among others by the legal status of the fertilisers. Because the products are often produced from waste or from animal by-products, the end products are considered as waste or animal by-products as well. For that reason, it is not allowed or difficult to trade these products between member states within EU as fertiliser. In an adjacent report that has been written within the scope of the ReNu2Farm project the legislative framework at EU level for the trade and use of recycling derived fertilisers has been described. An important development has been the publication of the EU Fertilising Product Regulation 2019/1009 in June 2019, which will replace the current Fertiliser Regulation EC 2003/2003 from July 2022 onwards. EU regulation 2019/1009 aims at 'facilitating the recognition of organic and waste-based fertilisers in the single market and thus encourage the recycling of bio-nutrients as fertilising products in the circular economy'. However, EU Regulation 2019/1009 is facultative, which means that it exists next to the continuing national legislations for the trade of fertilisers. In the present report, we describe national legislations for the trade and use of fertiliser products in countries in North West Europe (NWE). Based on that overview, we identified legal barriers for the trade of fertiliser products.

The countries in the NWE area have their own national legislations:

- The Netherlands: Fertiliser Act (Meststoffenwet) and the accompanying Implementation Decree (Uitvoeringsbesluit Meststoffenwet) and Implementation Regulation (Uitvoeringsregeling Meststoffenwet).
- Belgium: Royal Decree on the marketing and use of fertilisers, soil improvers and culture substrates (Koninklijk besluit betreffende het in de handel brengen en het gebruiken van meststoffen, bodemverbeterende middelen en teeltsubstraten).
- France: The marketing of national fertilisers in France is regulated by the Rural code (Code Rural, Livre II, Chapitre V : Mise sur le marché et utilisation des matières fertilisantes, des adjuvants pour matières fertilisantes et des supports de culture L.255-1 à L.255-18), the Decree of 21 December 1998 concerning the authorisation of fertilisers and cultivation materials (Arrêté du 21 décembre 1998 relatif à l'homologation des matières fertilisantes et des supports de culture) and the Decree of September 2003 on the mandatory implementation of standards. (Arrêté du 5 septembre 2003 portant mise en application obligatoire de normes).

- Germany: The manufacture, placing on the market and use of fertilisers, soil improvers, culture media and plant aids are governed by the Fertiliser Act (DüG) and its regulations. The requirements for placing fertilisers on the market are laid down in the Düngemittelverordnung (DüMV) (Fertiliser Regulation). It covers the requirements on the origin of the products, appearance, nutrient contents, maximum levels of contaminants and tolerance levels.
- Ireland: The marketing of national fertilisers in Ireland is regulated by the Fertilisers, Feeding stuff and Mineral Mixtures Act 1955 and the Statutory Instrument SI 248/1978 Marketing of non-EEC fertilisers regulations 1978.
- United Kingdom: For (mineral) EC Fertilisers, England and Wales has developed the EC Fertilisers Regulation 2006. In addition, national fertilisers are regulated via the Fertiliser Regulations 1991 and 1998. Because UK has left the EU (Brexit), things have been changed from 1 January 2021, fertilisers are marketed under either the domestic framework or the new 'UK fertiliser' label, which have replaced the EC Fertiliser label.

With respect to the consequences of national legislations for the possibilities for recycling derived fertilisers (RDF's), it is concluded that:

- RDF's are treated differently in the national legislations of member states within NW Europe, amongst others in the following ways:
    - Procedures for the authorisation of waste or by-products as fertiliser are often not clear and strongly differ between countries.
    - In some countries, recycling derived fertilisers are authorised by a category with minimum criteria, while in other countries the same products undergoes a case-by-case authorisation, that is applicable only to the specific product from a specific waste stream / site / process and/or a specific producer.
    - Criteria for contaminants like heavy metals are different between countries, so that a specific RDF may meet the criteria for heavy metals in one country and not in another country;
    - The fertiliser status and end-of-waste status are of relevance. In some countries, the end-of-waste status is supplied as soon as a product receives a fertiliser status, but in other countries that is not the case.
- As a result of the first conclusion, a specific RDF (this is for example the case with poultry litter ash and struvite) may have a fertiliser status in one country and a waste status in another country. This hampers the recycling of nutrients from waste, because it hinders:
    - cross-border transport,
    - to use it as raw material in fertiliser production,
    - to use it as a component for blending,

    - to market and use it directly as a fertiliser in different countries.
- Mutual recognition is interpreted differently by the member countries within NW Europe, and in practice most countries prescribe the regular procedure for the authorisation of fertilisers, even if a fertiliser product has a fertiliser status in another member state.
- It requires a lot of administrative work and good knowledge of the authorisation procedures for getting a fertiliser or end-of-waste status in the different countries.

1 Introduction

The objective of the NWE-Interreg project ReNu2Farm is to increase the use and production of recycled nitrogen (N), phosphorus (P) and potassium (K) for fertilisers in Northwest Europe (NWE).

Within the scope of sustainable agriculture and a circular, biobased economy, it is crucial to find ways to reduce quantities of non-recycled nutrients like N, P and K and to decrease the dependency on nutrient import. In the NWE Interreg project ReNu2Farm opportunities for the replacement of nutrients from traditional mineral fertilisers by recycling derived fertilisers are explored. Within the NWE territory, regional differences can be identified with respect to nutrient supply and demand. Hot spots with a surplus of N and P from animal manure are identified in the NWE and at the same time, there are regions with a shortage of nutrients from animal manure. Opportunities for the replacement of nutrients from traditional mineral fertilisers by recycling-derived fertilisers from regions with a nutrient surplus are explored within the scope of the current project.

The proper development of the market for bio based, recycling derived fertilisers is hampered among others by the legal status of the fertilisers. Because the products are often produced from waste or from animal by-products (e.g., sewage sludge, food waste and animal manure), the end products are considered as waste or animal by-products as well. For that reason, it is not allowed or difficult to trade these products between member states within EU as fertiliser.

In another report that has been written within the scope of the ReNu2Farm project (Van Schöll & Postma, 2022) the legislative framework at EU level for the trade and use of recycling-derived fertilisers has been described. An important development is the publication of the EU Fertilising Product Regulation 2019/1009 in June 2019, which replaces the Fertiliser Regulation EC 2003/2003 from July 2022 onwards. EU regulation 2019/1009 aims at 'facilitating the recognition of organic and waste-based fertilisers in the single market and thus encourage the recycling of bio-nutrients as fertilising products in the circular economy'. When strict rules for the safe recovery of nutrients into secondary raw materials are fulfilled, those raw materials may be used as a component of CE-marked fertilising products, which are classified in Product Function Categories (PFC's). The consequence is that RDF's may become an EU fertiliser product, provided that they meet the requirements for raw materials (classified in component material categories, or CMC's), production and contaminants. In order to verify that EU fertilising products comply with the requirements of this FPR, conformity assessment procedures have been defined. The procedures differ in dependence of the PFC's that are produced and the CMC's that are used.

EU Regulation 2019/1009 is facultative, which means that it exists next to the continuing national legislations for the trade of fertilisers. If a CE mark is used for a fertiliser, the product should comply with EU Regulation 2019/1009. However, it is also possible to choose for national legislations and regulations, which is especially of interest for products that are meant for use in the region or country and/or for products that are exported from one country to another.

In the present report, we describe national legislations for the trade and use of fertiliser products in countries in Northwest Europe (NWE). Based on that overview, we identified legal barriers for the trade of fertiliser products.

2 National legislations

2.1 General

Every member state has its' own national legislation for the trade and use of fertilisers, which will still exist after the new EU Fertiliser regulation 2019/1009 is in place. After publication of EU 2019/1009 in July 2019 the member states started to implement that in national legislations. This process should be finished in July 2022, because EC Fertiliser regulation 2003/2003 will be withdrawn then. In general, it is expected that most member states will leave their national legislations unchanged.

The countries in the NWE area have their own national legislations:

- The Netherlands: Fertiliser Act (Meststoffenwet) and the accompanying Implementation Decree (Uitvoeringsbesluit Meststoffenwet) and Implementation Regulation (Uitvoeringsregeling Meststoffenwet).
- Belgium: Royal Decree on the marketing and use of fertilisers, soil improvers and culture substrates (Koninklijk besluit betreffende het in de handel brengen en het gebruiken van meststoffen, bodemverbeterende middelen en teeltsubstraten).
- France: The marketing of national fertilisers in France is regulated by the Rural code (*Code Rural, Livre II, Chapitre V : Mise sur le marché et utilisation des matières fertilisantes, des adjuvants pour matières fertilisantes et des supports de culture L.255-1 à L.255-18*), the Decree of 21 December 1998 concerning the authorisation of fertilisers and cultivation materials *(Arrêté du 21 décembre 1998 relatif à l'homologation des matières fertilisantes et des supports de culture*) and the Decree of September 2003 on the mandatory implementation of standards. (*Arrêté du 5 septembre 2003 portant mise en application obligatoire de normes*).
- Germany: The manufacture, placing on the market and use of fertilisers, soil improvers, culture media and plant aids are governed by the Fertiliser Act (DüG) and its regulations. The requirements for placing fertilisers on the market are laid down in the Düngemittelverordnung (DüMV) (Fertiliser Regulation). It covers the requirements on the origin of the products, appearance, nutrient contents, maximum levels of contaminants and tolerance levels.
- Ireland: The marketing of national fertilisers in Ireland is regulated by the Fertilisers, Feeding stuff and Mineral Mixtures Act 1955 and the Statutory Instrument SI 248/1978 Marketing of non-EEC fertilisers regulations 1978.
- United Kingdom: For (mineral) EC Fertilisers, England and Wales has developed the EC Fertilisers Regulation 2006. In addition, national fertilisers are regulated via the Fertiliser Regulations 1991 and 1998. Because UK will leave the EU (Brexit), things

will change and from 1 January 2021, fertilisers will have to be marketed under either the domestic framework or the new 'UK fertiliser' label, which will replace the EC Fertiliser label.

In the following paragraphs, the national legislations and regulations are described per country, with special emphasis on the legislation with regard to recycling derived fertilisers.

2.2 The Netherlands

2.2.1 Regulation of National Fertilisers

The marketing of fertilisers in the Netherlands is regulated by the Fertiliser Act (Meststoffenwet) and the accompanying Implementation Decree (Uitvoeringsbesluit Meststoffenwet) and Implementation Regulation (Uitvoeringsregeling Meststoffenwet). The Fertiliser Act defines the general requirements and criteria for fertiliser categories. Fertiliser categories are EC-Fertilisers, regained phosphates, sewage sludge, compost, animal manure, liming materials, other organic fertilisers and other inorganic fertilisers. The Fertiliser Act of the Netherlands designates nutrients, acid neutralising value and organic matter as agronomic valuable components of fertilisers. For the protection of the health of the environment, plants, animals and human the contents of heavy metals, arsenic and organic micro-contaminants are limited. The specific criteria for the different fertiliser categories are defined in the 'Implementation Decree' and 'Implementation Regulation'. Thresholds for contaminants are expressed on nutrient content and are roughly based on a maximum amount that may be brought to the soil. It is the responsibility of the producer that the fertiliser product complies to the requirements of the Fertiliser Act. Any product that complies to the requirements and criteria for a fertiliser category can be marketed without registration or authorisation, with the exception of fertiliser products that are produced from waste or residue products.

2.2.2 Regulation of recycling-derived fertiliser products

The handling and management of waste and residue products is regulated by the Environmental Act (Wet Milieubeheer). When waste products are authorised for use as a fertiliser according to provisions in the Fertiliser Act these are exempted from waste management requirements on handling, management and transport.

Compost, sewage sludge and regained phosphates (amongst which struvite) are defined as fertiliser categories in the Fertiliser Act. All other waste and residue products have to be registered on a positive list (Fertiliser Act Implementation Regulation, Annex Aa, Bijlage Aa Uitvoeringsregeling Meststoffenwet) to be authorised as a fertiliser product or component for the production of fertiliser products. Authorisation is given to specifically defined substances but is not limited to a specific producer or trademark. The time frame for registration of a waste or residue product as fertiliser is at least 6 months (but often

longer) and is free of charge. No end-of-waste status is given to products that are authorised as fertiliser!

A list of substances that may be used as a fertiliser or for the production of fertilisers can be found at the website of the national government (Fertiliser Act Implementation Regulation, Annex Aa) https://wetten.overheid.nl/BWBR0018989/2020-04-16/#BijlageAa.

A summary of the legal status of recycling-derived fertilisers in the Netherlands is as follows:

- Ashes: waste; not authorised as fertiliser (generally too high contents heavy metals, especially Cu);
- Struvite: fertiliser category. Still waste, exempted from waste management regulations if used as fertiliser;
- Compost: fertiliser category. Still waste, but exempted from requirements on waste management regulations;
- Digestate: animal manure, fertiliser category. Digestion of manure with co-materials is only allowed if these co-materials are authorised for such use by registration on the Annex Aa of the Implementation Regulation Fertiliser Act.
- Ammonium sulphate from air scrubbing (biological or chemical): authorisation is considered as an inorganic fertiliser if recovered from authorised sources. Only few products are authorised as far as they originate from air from stables, composting of sewage sludge with green cuttings or poultry manure, drying facilities. Ammonium sulphate from other sources is not allowed to be used as a fertiliser. Mixing with other fertilisers is not allowed.
- Ammonium salts from stripping and scrubbing of manure or derived products are regarded as animal manure, following the definition in the Nitrate directive.
- Pig urine: animal manure, fertiliser category.

2.2.3 Mutual recognition of fertiliser products

Mutual recognition applies to fertilisers that are lawfully produced or put on the market in another EU member state or another state with which agreements have been made. However, these products are required to comply with the same or higher level of environmental safety as set in the Fertiliser Act. So, mutual recognition applies, but only when the requirements for the protection of the health of humans, animals or environment are equivalent to those for the Dutch national fertilisers. In practice this will mean that registration on the positive list will be required for recycling derived fertilisers.

2.3 Belgium

2.3.1 Regulation of national fertilisers

The marketing of fertilisers in Belgium is regulated by the Royal Decree on the marketing and use of fertilisers, soil improvers and culture substrates (28 JANUARI 2013-Koninklijk besluit betreffende het in de handel brengen en het gebruiken van meststoffen, bodemverbeterende middelen en teeltsubstraten). The Royal Decree contains general requirements on quality and labelling of fertiliser products, and a positive list of fertiliser types (as Annex 1). Each fertiliser type is defined by a specific type designation, a description, quality requirements (amongst others criteria on nutrient content), comparable to the Annex I of the Fertiliser Regulation EG 2003/2003. Except for sewage sludge, no criteria for contents of heavy metals or other contaminants in fertiliser types are defined. Fertiliser products that do not comply with one of the fertiliser types may only be brought to the market by derogation.

2.3.2 Regulation of recycling-derived fertiliser products

For waste products, derogation can only be granted if the product is authorised for use as fertiliser or soil improver by the regional authorities. The waste management in Belgium is regulated at the regional level (Flanders, Wallonia and Brussels region). Products are authorised if they are registered on a positive list (Flanders: VLAREMA annex 2) or have obtained a resource certificate (Grondstoffenverklaring) or -for organic waste streams- an inspection certificate (VLACO Keuringsattest). Products with a resource certificate or inspection certificate are considered as end-of-waste in Belgium.

Resource and inspection certificates are specific for a certain product and production location and for specific use. Products have to be safe to use for human health and environment within the good agricultural practice, for which thresholds for contents of heavy metals and organic contaminants are defined (Flanders: VLAREMA annex 2).

A list of derogations and authorisations is publicly available (www.fytoweb.fgov.be). A summary of the legal status of recycling-derived fertilisers in Belgium / Flanders is as follows:

- Ashes: if derogated, only with resource certification for product and producer.
- Struvite: if derogated, only with resource certification for product and producer.
- Compost: authorised, only with inspection certification. Considered end-of-waste.
- Ammonium sulphate from air stripping with acid: authorised, on list of fertiliser types KB.
- Ammonium sulphate from biological air treatment: not on positive list, only with resource certificate for product and producer.
- Ammonium salts from stripping and scrubbing of manure or derived products are regarded as animal manure, following the definition in the Nitrate directive.

- Pig urine: animal manure, fertiliser category.

2.3.3 Mutual recognition:

Products that are authorised for marketing as a fertiliser product in another member state may be marketed as a fertiliser product in Belgium if they comply with one of the fertiliser types of the Royal Decision. Products that do not comply with a fertiliser type of the Royal Decision have to obtain derogation. For such products, the mutual recognition procedure corresponds to a derogation application. The time frame for processing the application is four months from receipt of the complete dossier. The cost of processing the application is € 1500. The following information is required:

- Product-related technical rules (legislation), certified by the Member State and upon which the application for mutual recognition is based (in French, Dutch or English)
- The raw materials used and their origin
- A short description of the manufacturing process
- A *recent* product analysis carried out by an approved laboratory (in case of a non-Belgian laboratory, a copy of the approval issued by the competent authority should be enclosed, accompanied by the analysis method if appropriate)
- A label or accompanying document (in French or Dutch) as an example
- The purpose(s), dose(s) and instructions for use
- As the case may be, all documents proving that the product meets the requirements of Regulation 1069/2009 or any other EU food safety and environment protection legislation.

2.4 France

2.4.1 Regulation of national fertilisers

The marketing of national fertilisers in France is regulated by the Rural code (*Code Rural, Livre II, Chapitre V : Mise sur le marché et utilisation des matières fertilisantes, des adjuvants pour matières fertilisantes et des supports de culture L.255-1 à L.255-18*), the Decree of 21 December 1998 concerning the authorisation of fertilisers and cultivation materials *(Arrêté du 21 décembre 1998 relatif à l'homologation des matières fertilisantes et des supports de culture*) and the Decree of September 2003 on the mandatory implementation of standards. (*Arrêté du 5 septembre 2003 portant mise en application obligatoire de normes*). The Rural code gives the general definitions and conditions for the marketing of fertiliser products.

All non-EC-fertilisers have to meet the requirements of obligatory standard norms (NFU) of fertilisers or soil improvers, or they have to obtain an authorisation *(homologation*) to be marketed as a national fertiliser product. The French Agency for Food, Environmental and Occupational Health & Safety (ANSES) can authorise products following an

assessment which, under the prescribed conditions of use, reveals its absence of harmful effect on human health, animal health and the environment and its effectiveness, according to cases, in respect of plants and plant products or soils.

Fertiliser products that meet the obligatory standard norm (NFU) do not have to get an authorization and can be marketed in France. The Decree of September 2003 (with amendments) lists the titles of the standard norms that apply to fertiliser products. The list includes organic fertilisers and soil improvers derived from organic waste products (compost). Descriptions include origin, nutrient contents, thresholds for contaminations and pathogens, sanitation. Fertiliser type descriptions with criteria are not freely publicly available but have to be bought from the normalisation institute ANSES.

Most relevant standard NF U-norms are:

- NF U 42-001 (1981) for Fertilisers: contains various classes of mineral and organic fertilisers. The required minimum nutrient contents have been formulated for the different classes and types that have been defined. One of the classes is class VI, consisting of organic fertilisers that originates from animals or plants.
    - A fertiliser type within this category is animal manure, which should contain at least 3% N and 5% P_2O_5, while the sum of N, P_2O_5 and K_2O should be 10% at least.
    - Another class is poultry manure, which should contain at least 3% N and 3% P_2O_5, while the sum of N, P_2O_5 and K_2O should be 7% at least.
- NF U 44-051 for Organic Soil Improvers: Minimum limits for dry matter and organic matter contents have been formulated, while maximum limits have been formulated for the nutrient contents. The dry matter content should be 30% at least and the organic matter should be 20% at least. Maximum limits for nutrient contents are 3% for N, P_2O_5 and/or K_2O, while the sum of N, P_2O_5 and K_2O should not exceed 7% (VCM, 2014). Various fertiliser types are distinguished within this category, like compost of animal manure, green waste compost or compost from the residues of fungi growers (Ollivier, 2015)
- NF U 44-095 for Organic Soil Improvers: Composts composed from materials that are of use for agriculture and from materials from water treatment. Minimum limits for dry matter and organic matter contents have been formulated and maximum limits have been formulated for heavy metal contents, organic micropollutants and the number of pathogenic microorganisms. The dry matter content should be 50% at least and the organic matter should be 20% at least. As for NFU 44-051, the maximum limits for nutrient contents are 3% for N, P_2O_5 and/or K_2O, while the sum of N, P_2O_5 and K_2O should not exceed 7%.

2.4.2 Regulation on recycling -derived fertiliser products

Products that meet the standard NFU-norms do not have to be registered. The producer is responsible for the compliance of the product with the limits. The organisation that puts the product on the market has to have a seat in France.

On the other hand, products that do not meet one of the NFU norms have to be authorised (obtain 'homologation') and registered. Therefore, a detailed dossier (administrative and technical file) has to be submitted and approved. Derogation is given specifically to a producer and production site.

A list of products with a derogation for use as a fertiliser product or cultivation material is available at ephy.anses.fr.

A summary of the legal status of recycling-derived fertilisers in France is as follows:

- Ashes: not conform NFU. Ash with homologation can be brought to the market.
- Struvite: no NFU standard or homologation. Subject of green deal north west resources roundabout.
- Compost: if conforming to the NFU norm NFU044-051 or -095 Product.
- Ammonium sulphate from air scrubbing with acid: if conforming to the NFU norm NFU-042, criterium for N%>20%. For most ammonium salts the N content will be 8%, so the NFU-042 is not feasible. A request for a homologation could be send in.
- Product Ammonium sulphate from biological air treatment: unknown.
- Pig urine: animal by-product.

2.4.3 Mutual recognition of fertiliser products

Products either have to meet the NFU norms or apply for the homologation.

2.5 Germany

2.5.1 Regulation of national fertilisers

The production, placing on the market and use of fertilisers, soil improvers, culture media and plant aids are governed by the Fertiliser Act (DüG) and its ordinances. Different types of fertilisers are distinguished: solid animal manure, fluid animal manure, mineral fertilisers, etc.

The requirements for placing fertilisers on the market are laid down in the Düngemittelverordnung (DüMV) (Fertiliser Ordinance). It covers the requirements on the origin of the products, appearance, minimum nutrient contents, maximum contents of contaminants.

Fertilisers have to comply to one of the fertiliser types described in annex 1 of DüMV. Fertiliser types are classified in five categories:

1. Single mineral fertilisers
2. Compound mineral fertilisers
3. Organic and organo-mineral fertilisers
4. Micronutrient fertilisers
5. Fertilisers for ornamental horticulture.

2.5.2 Regulation of recycling-derived fertiliser products

The DüMV contains a positive list (annex 2 of DüMV) of products -including waste and residue products- that may be used as a component material for the production of fertilisers or soil improvers. It also defines levels of nutrients, contaminants and tolerance levels. Limits for heavy metals and organic contaminants are expressed on a dry weight base, except for Cd in P-fertilisers that are expressed per kg P2O5.

The use of organic waste and residue products is regulated by the Bio-Waste Regulation (Bioabfallverordnung or BioAbfV). This describes the required treatment of the products, a positive list of input materials and gives threshold values for contaminants and pathogens and all administrative requirements on handling, transport, and use of compost and digestates. For sewage sludge the maximum limits for contaminants are included in the Sewage Sludge Ordinance (Klärschlammverordnung or AbfKlärV), but biowastes and sewage sludges that are used in fertilisers should also comply with the limits in the Fertiliser Ordinance (DüMV).

The Verbringungsverordnung (marketing regulation) governs placing on the market, transport and taking possession of manure, as well as the related commercial substance streams.

The German fertiliser legislation does not provide for a formal "request procedure". Those wishing to produce or place on the market "new" fertiliser products (fertilisers, soil improvers, growing media or plant strengtheners) must however informally request the BMELV (Bundesministerium für Ernährung und Landwirtschaft; Federal Ministry of Food and Agricluture) to amend/alter the existing rules. These requests will be evaluated by members of the Scientific Advisory Board on Fertiliser Issues. (BMEL, 2020 https://www.bmel.de/DE/themen/landwirtschaft/pflanzenbau/ackerbau/duengung.html) .

The following information is necessary in order to be able to evaluate a new type of fertiliser sufficiently (BMEL):

1. Purpose of the material (fertiliser, soil improver, growing medium or plant strengthener)

2. Description of the material (including composition, production method, quantities produced, validation procedures, etc.)
3. Material safety in accordance with the Fertiliser Act (DüG)
4. Mode of action and effectiveness
5. Distinguishing features relating to comparable materials
6. Confirmation of the responsible federal state authority that the material has not been registered previously under the Fertiliser Ordinance;
7. Suggestion of a change of type, for a new fertiliser type
8. Intended classification / labelling.

A summary of the legal status of recycling derived fertilisers in Germany is as follows:

- Ashes: only from certain sources, like organic fertilisers that are clean. Fly ashes are excluded. The requirements are specified in Annex 2 of the DüMV.
- Struvite: yes
- Compost: yes, but under strict control
- Ammonium sulphate from air scrubbing with acid: defined as input source for fertiliser production. Includes the ammonium sulphate derived from stripping and scrubbing during manure treatment.
- Product Ammonium sulphate from biological air treatment: unknown.
- Pig urine: animal by-product.

2.5.3 Mutual recognition of fertiliser products

The DüMV also gives the condition for mutual recognition of fertiliser products. In principle, this is possible, but only when the requirements for the protection of the health of humans, animals or environment are equivalent to those for the German national Fertilisers.

2.6 Ireland

2.6.1 Regulation of national fertilisers

The marketing of national fertilisers in Ireland is regulated by the Fertilisers, Feeding stuff and Mineral Mixtures Act 1955 (FFMMA) and the Statutory Instrument SI 248/1978 Marketing of non-EEC fertilisers regulations 1978.

The FFMMA sets the general conditions for the regulation and control of the manufacturing and placing on the market of fertilisers and sampling thereof. SI 248/1978 sets the requirements and criteria for fertilisers and liming materials in a structure comparable to annex I of the EC regulation 2003/2003. Thresholds for minimum nutrient

(NPK) contents are given, but criteria for heavy metals or other contaminants are not included.

It is differentiated between:

1. straight and compound N, P and/or K mineral fertilisers,
2. compound N, P and/or K fertilisers containing organic matter, and
3. low nutrient fertilisers (no criteria on nutrient contents).

Requirements on labelling and packaging are defined.

2.6.2 Regulation on fertiliser products

Fertiliser products that do not comply with one of the fertiliser types in SI 248/1978 have to get authorised by the Ministry of Agriculture. There is no protocol for the authorisation, but there is a Guide for the registration of a new type of fertiliser for registration in Ireland.

The information submitted to the Ministry of Agriculture must show that the fertiliser:

- provides nutrients in an effective manner;
- does not adversely affect human, animal, or plant health, or the environment.

No list of fertiliser products that are authorised to be brought on the market and used as a fertiliser is publicly available.

The handling and use of waste products is regulated by the Waste Management Act, S.I. No. 821/2007, the Waste Management (Facility Permit and Registration) Regulations and Environmental Protection Agency Acts. Moreover, regulations on Food Waste. S.I. No. 71 of 2013 EU Household Food Waste And Bio-Waste) and Regulations 2013 and S.I. No. 508 of 2009 Waste Management (Food Waste) Regulations 2009 are of relevance.

2.6.3 Mutual recognition of fertiliser products

Ireland does not have an official protocol of the mutual recognition or fertiliser products. Recycling-derived fertiliser products will have to submit a request for registration as a fertiliser, following the Guide to the registration of a new type of fertiliser for registration in Ireland.

2.7 United Kingdom

2.7.1 Regulation of national fertilisers

EC-Fertilisers have been regulated in England and Wales by the EC Fertilisers Regulation 2006. After Brexit, producers have been able to continue selling EC fertiliser, replacing the CE label with mention of 'UK fertilisers'.

In addition, national fertilisers are regulated via the Fertiliser Regulations 1991 and 1998. Fertilisers that meet the requirements of one of the fertiliser categories, don't have to be registered. Within FR 1991 the following categories of fertilisers are distinguished:

A. Straight Fertilisers
B. Compound Fertilisers
C. Fluid Fertilisers
D. Fertilisers containing Boron, Cobalt, Copper, Iron, Manganese, Molybdenum or Zinc as trace Elements
E. Fertilisers containing mainly Calcium, Magnesium or Sulphur as Nutrients

Most fertilisers that are classified in one of the fertiliser categories mentioned above, are mineral fertilisers. However, in group A, organic products like dried blood, horn meal, meat and bone meal, hoof meal and rape meal and oilseed fertiliser are included.

2.7.2 Regulation on recycling-derived fertilisers

There is a possibility in the UK to use waste materials as fertiliser or soil improver. This is regulated by the Environment Agency, which has developed the U10 waste exemption for this purpose: 'the U10 exemption allows you to spread specific waste on agricultural land to replace manufactured fertilisers or virgin materials (such as lime) to improve or maintain soil.' https://www.gov.uk/guidance/waste-exemption-u10-spreading-waste-to-benefit-agricultural-land#types-of-activity-you-cannot-carry-out.

Types of waste that are allowed are specified by name and waste codes that are defined in the List of Wastes (LoW) Regulations. One needs to make sure that the waste fits within the waste code and the description. Moreover, maximum amounts of the waste products that may be stored and applied to the agricultural land are defined per waste type. Examples of some categories are as follows:

- Chalk;
- Ash from wood chips.

In addition, requirements about the way of storage and application have been formulated in dependence of the risks that are associated with the various waste products. Those conditions should be respected when the products are applied.

Moreover, it is indicated that it is not allowed to use waste materials that are not mentioned in the list, even if those products have a beneficial effect to soil quality and/or plant growth. Maximum levels of contaminants, like heavy metals, are not given.

A summary of the legal status of recycling derived fertilisers in the UK is as follows:

- Ashes: ash from incineration of clean plant material or untreated wood (special waste code 100101) and Poultry litter ash (PLA) that meets the end-of-waste criteria
- Struvite: with authorisation, product and producer specific

- Compost: only compost with an end-of waste certificate
- Ammonium sulphate from air scrubbing with acid or biological treatment: unknown.
- Pig urine: animal by-product (note: the regulation EC/2099/1069 on Animal by-products no longer applies in the UK after Brexit)

2.7.3 Mutual recognition of fertiliser products

Due to the leaving of UK from the EU, the UK will no longer fall within the scope of the mutual recognition principle from 1 January 2021 onwards. Fertilisers will have to be marketed under either the domestic framework or the new 'UK fertiliser' label, which will replace the EC Fertiliser label. See https://www.gov.uk/guidance/manufacturing-and-marketing-fertilisers-if-there-is-no-brexit-deal.

3 Consequences for RDF products

3.1 Evaluation of RDF's according to national legislations

In the foregoing chapter, the national legislations with respect to recycling-derived fertilisers of most countries in NWE region have been shortly summarised. In the description of each country, the consequences of the national legislations for the legal status of selected RDF's in that country are given. But what are the differences between countries in the way they treat RDF's? And what is the consequence of those differences? Those questions will be treated in this chapter. A summary of the differences of the way the selected RDF's are evaluated in Europe and the various partner countries, is given by Van Schöll (2019; table 3.1). The evaluation at the basis of the European legislation is discussed elsewhere (Van Schöll & Postma, 2022), and the situation based on national legislations is discussed per product below table 3.1.

Table 3.1. Overview of the evaluation of selected RDF's according to the national legislations in countries in NW Europe (Van Schöll, 2019).

	Compost	Ashes	Struvite	Ammonium sulphate	Ammonium nitrate
EC FR2003/2003	not included	not included	only 1 product	N% too low	If N% >15%, or manure?
EC FR revision	CMC compost	CMC Strubias	CMC Strubias	SafeManure	SafeManure
Netherlands	yes	no	yes	yes (some)	manure?
Belgium	certification	derogation	derogation	yes	manure?
Germany	yes	yes (limited)	yes	yes	manure?
France	yes (NFU)	derogation	no	??	manure?
Ireland	yes	no	no	??	manure?

Ashes are evaluated as follows in the various NWE countries:

- In The Netherlands ashes are not authorised as fertiliser, because they generally contain too high contents of heavy metals, especially Cu and Zn (see further under 3.2). However, for the export of poultry litter ash to an fertiliser production location, an end-of-waste status has been obtained in 2015 (see 3.2);
- In Belgium / Flanders, ashes are only authorised with a resource certification for product and producer.
- In France, ashes do not fall under one of the NFU, but poultry litter ash from BMC is authorised at the basis of a 'homologation' under the name 'Agriphos'.

- In Germany, only ashes from certain sources are authorised. Examples of those sources are sludges, materials of plant or animal origin. Fly ashes are not allowed. The requirements are specified in Annex 2, table 6 and 7 of the DüMV. The status of ashes in Ireland is waste. Use as fertiliser should be regulated under the environmental permit of production facility.
- In the United Kingdom (UK), ash that is produced by burning clean plant material or untreated wood, has a special waste code 100101. This ash is included in the U10 exemption, that 'allows you to spread specific waste on agricultural land to replace manufactured fertilisers or virgin materials (e.g. lime) to improve or maintain soil' (https://www.gov.uk/guidance/waste-exemption-u10-spreading-waste-to-benefit-agricultural-land). Moreover, end-of-waste criteria for poultry litter ash (PLA) has been defined (Environmental Agency, 2012a). If the criteria are met, the end-of-waste status is obtained and the ash may be applied as fertiliser. See further under 4.2 for additional information.

Struvites are evaluated as follows in the various NWE countries:

- The Netherlands: certain recovered phosphates (struvite, magnesium phosphate, dicalcium phosphate) are authorised as fertilisers by national regulation. However, struvite from municipal wastewater treatment plants is still considered waste, and it is only exempted from waste management regulations if it is used as a fertiliser.
- Belgium / Flanders: struvite is only authorised with resource certification for product and producer.
- France: for struvite no NFU standard or homologation exists and it has a waste status. It is subject of the Green deal North West Resources Roundabout (https://www.wastematters.eu/news-from-europe/news-from-europe/struvite-to-be-included-into-the-international-green-deal-north-sea-resources-roundabout.html).
- Germany: struvite is authorised by a special category in the DüMV (category 6.2.4 Phosphatfällung), which includes precipitates of phosphate that are obtained with calcium chloride, magnesium chloride, magnesium oxide etc.
- Ireland: unknown, no application done.
- United Kingdom: specific struvite products, like the one from Slough sewage works (Ostara process), have an authorisation, but that is restricted to one product from one producer. See further under 3.3.

Composts are evaluated as follows in the various NWE countries:

- In the Netherlands: compost is regulated as fertiliser category. Still waste, exempted from waste management regulations. Composted animal manure is regarded as animal manure.

- Belgium / Flanders: derogation and with inspection certification are required. Derogated composts are considered end-of-waste.
- France: yes, if conform the NFU norm NFU044-051 or -095 Product.
- Germany: yes, but under strict control.
- Ireland: regulated at the level of environmental permission production site.
- United Kingdom: A quality protocol is available for the end-of-waste status of compost from source-separated biowaste (Environmental Agency, 2012b; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/297215/geho0812bwpl-e-e.pdf). Criteria are formulated for the allowed input materials, for the processing and for the properties of the end product. If these criteria are met, the resulting outputs will normally be regarded as having been fully recovered and to have ceased to be waste. Only certified composts can be marketed and used as fertiliser or soil improver.

Ammonium sulphates are evaluated as follows in the various NWE countries:

- In the Netherlands, ammonium sulphate from air scrubbing (biological or chemical) has received an authorisation in dependence of origin and way of production. Only a few products (recovered from stables, composting of sewage sludge with green cuttings or poultry manure, drying facilities) have received authorisation, from other sources it is not allowed to be used as a fertiliser. Mixing with other fertilisers is not allowed. Ammonium salts from stripping and scrubbing of manure is still considered manure, in line with the definition of manure in the Nitrate directive.
- Belgium: Ammonium sulphate from air stripping with acid: yes, on list of fertiliser types KB. Ammonium sulphate from biological air treatment: not on positive list, only with resource certificate for product and producer. Ammonium salts from stripping and scrubbing of manure is still considered manure, in line with the definition of manure in the Nitrate directive.
- France: Ammonium sulphate from air stripping with acid: yes if conform the NFU norm NFU-042, amongst others N%>20%. Because that will not be possible (N content will be 8% at maximum), so it will keep the status of waste or animal manure? A request for a homologation could be send in.
- Germany: Ammonium sulphate from air stripping with acid: yes defined as input source for fertiliser production. Ammonium salts from stripping and scrubbing of manure is considered inorganic waste product, and as such allowed to be used for production of N-fertilisers.
- Ireland: unknown
- United Kingdom: unknown

3.2 Consequences for practice: the poultry litter ash case

BMC Moerdijk in the Netherlands is incinerating 430,000 tonnes of poultry manure a year which represents one-third of the total production of poultry manure in the Netherlands. Products are electricity and poultry litter ash (PLA). The yearly production of PLA is about 60,000 tonnes (containing 6,600 tonnes P2O5 and 7,200 tonnes K2O), which is sold as PK fertiliser and fertiliser component (figure 3.1). Because the 'production' of phosphate in animal manure in the Netherlands (169,000 tonnes P2O5 in 2019) is higher than the phosphate requirement (or potential 'consumption') by agricultural production (139,000 tonnes P2O5 in 2019), the P surplus on national scale is 30,000 tonnes P2O5 and a significant amount of phosphate from animal manure should be exported to other countries where input of phosphate is required for sufficiently high P doses to agricultural land, thus enabling good production levels.

Figure 3.1. Pictures of the production plant of poultry litter ash (PLA) of BMC in Moerdijk (left) and close up of the end product, PLA (right).

The PLA is a hydrated ash since water is added to the ash at the end of the process. This reduces the dust formation when the ash fertiliser is stored, transported, and applied to soil. This ash is used as a PK fertiliser and consists of the ash of poultry manure (75%), sand (12.5%), water (10%), a boiler additive (1.25%), and lime (1.25%). In terms of nutrients, it contains about 11% P_2O_5, 12% K_2O as well as 20% CaO, 5% MgO, and 7% SO_3. The sodium content is with 3% Na_2O low.

In addition to the nutrient contents, the heavy metal contents are of importance for the evaluation of the product as a fertiliser within the scope of the national legislations in the various countries. The Cu and Zn contents were 380 and 1900 mg per kg, respectively, which is rather high, and which is a bottleneck for getting the status of a fertiliser in some countries (see further).

The PLA is marketed directly as a fertiliser (30% of the produced ash) or as a component in bulk blending of the fertiliser industry (70%). The ash is blended into compost but also into mineral fertilisers. The current destination countries are France, Belgium, and the United Kingdom. In these countries, the ash has a national authorization to be sold as a fertiliser (see further).

The status of the PLA depends on the perspective (Waste Framework Directive, Animal By-Product Regulation, Nitrate Directive, national legislation). As the product is not regulated by the current EU Fertiliser Regulation BMC Moerdijk and its' customers had to prepare a lot of documents and go through long processes to have the ash registered as a fertiliser in France, Belgium, and England (De Leeuw, 2019).

Attempts has been done in several countries to get an authorisation for the status as fertiliser:

- In the Netherlands, the first letter about the legal status of the PLA was send to the Dutch government and many conversations have followed after that. The end-of-waste status was obtained in 2015, but the product is not authorised as fertiliser, because Cu and Zn levels were higher than the maximum allowed limits according to the Dutch legislation (Uitvoeringsbesluit Meststoffenwet Annex II, table 1https://wetten.overheid.nl/BWBR0019031/2020-01-01#BijlageII; CDM, 2016; both Cu and Zn contents in PLA are about two times as high as the maximum limits). The lack of a fertiliser status of PLA hampers its' export.
- In France, PLA is authorised to be used as a fertiliser since 2001, based on the imported product from the United Kingdom ('homologation'). At https://ephy.anses.fr/mfsc/agriphos the information about the fertiliser status of the product can be seen under the name 'Agriphos'. The first registration under this name was in 2014. The authorisation is owned by the applicant, so new applications for the same product by other organisations have to follow the same extensive and costly procedure.
- In England, Wales and Northern Ireland, end-of-waste criteria for PLA has been derived and described in a 'Quality Protocol Poultry Litter Ash' (Environmental Agency, 2012a). Criteria about input materials, sampling, storage, use, nutrient requirements and maximum limits for heavy metals have been formulated. If the criteria are met, the end-of-waste status is obtained and the product may be applied as fertiliser. The upper limits for Cu and Zn are relatively high in the UK (596 and 2063 mg per kg respectively), so that the actual Cu and Zn contents (380 and 1900 mg per kg dm respectively) just meet these limits.
- In Belgium, PLA has a derogation since June 2006, which is renewed in 2011 and 2016. An additional requirement since 2016 is that for the use in Flanders a valid 'raw material certificate' (a so called 'grondstofverklaring') delivered by OVAM is obligated.

In addition, the product should meet the criteria of VLAREMA 6 for its' use in Flanders. Within that scope, maximum levels for i) heavy metal contents in the product and ii) heavy metal dosage to agricultural land should be met. The maximum limits for the heavy metal contents are based on the assumption that 2 tonnes per hectare per year of the product is applied. However, because of relatively high P and K contents, a dosage of 2 tonnes per hectare per year is too high from a viewpoint of 'good agricultural practice'. With a 'normal' dose of 1 tonnes per hectare, the maximum dosage level is met. In spite of the fact that the upper limit for the Zn content in the product is exceeded, a 'raw material certificate', and the resulting end-of-waste status, was obtained in 2018.

From the example of the PLA it can be concluded that it is possible to export a fertilising product to other countries within NW Europe, also without a CE Fertiliser status. However, this requires a lot of administrative work and good knowledge of the authorisation procedures for getting a fertiliser or end-of-waste status in the different countries.

3.3 Consequences in practice: the struvite case

In several wastewater treatment plants in The Netherlands, phosphorus is gained during the water treatment via precipitation of struvite ($MgNH_4PO_4 . 6H_2O$). The total production of struvite at 7 locations distributed over The Netherlands is about 3500 tonnes struvite per year, which contains about 1000 tonnes of P_2O_5 (Schemen, 2017). Other European countries where struvite is produced are Germany, Belgium / Flanders, UK, Denmark, France and Spain (Thornton, 2016; figure 3.2).

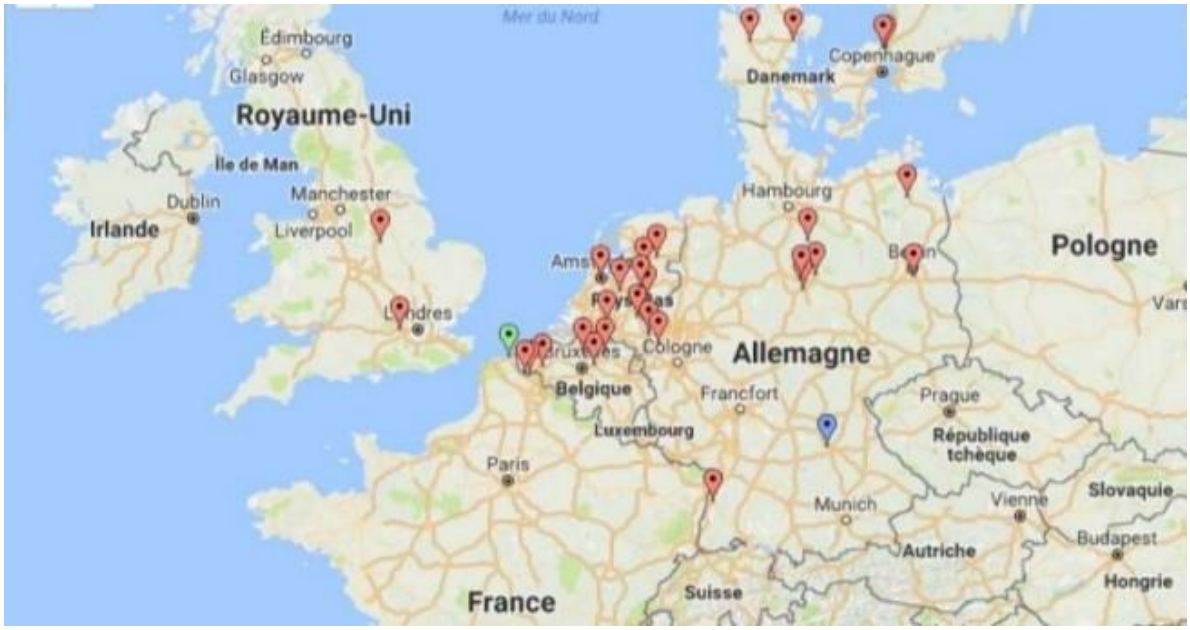

Figure 3.2. Locations of struvite production across Northwest Europe (source: Thornton, 2016; https://de.batchgeo.com/map/f4c921a4573967d7e18aa0e651cc3264).

Struvite might be used directly as a fertiliser, but it can also be used as a raw material for fertiliser production. The amount of P from mineral fertilisers used in the Netherlands is relatively low and amounts up to only 6,000 tonnes of P2O5, which is less than 5% of the total P use by (mineral ánd organic) fertilisers in the Netherlands.

One of the associated partners in the ReNu2Farm project is the Waterboard Vallei & Veluwe, which produces 1,800 tonnes of struvite per year at locations in Amersfoort and Apeldoorn. Different technologies are used for the struvite production, i.e. the Pearl- and the NuReSys-technology, resulting in slightly different products. Both products are relatively pure, and only contain very low amounts of organic matter and other impurities.

The product from Apeldoorn contains 1.8% N, 25.5% P2O5, 15.1% MgO and < 0.5% organic matter (De Vries et al., 2017; figure 3.3). Moreover, an extensive investigation of possible contaminants, like heavy metals, organic micropollutants and pathogens has been performed in struvite samples originating from various production locations (Morgenschweiss et al., 2016). It was concluded that the products met the requirements with respect to the contents of heavy metals and micropollutants in the Dutch Fertiliser Act, but that pathogens are present in amounts that require special attention.

The struvite that is produced at the location in Apeldoorn is used for the production of a P-containing mineral fertiliser (which is called Physiostart P Plus with 6% NH4-N and 27% P2O5; see https://aquaminerals.com/struvite-in-fertiliser-for-maize/; Figure 3.3) by Timac Agro, which is part of the Groupe Roullier in France.

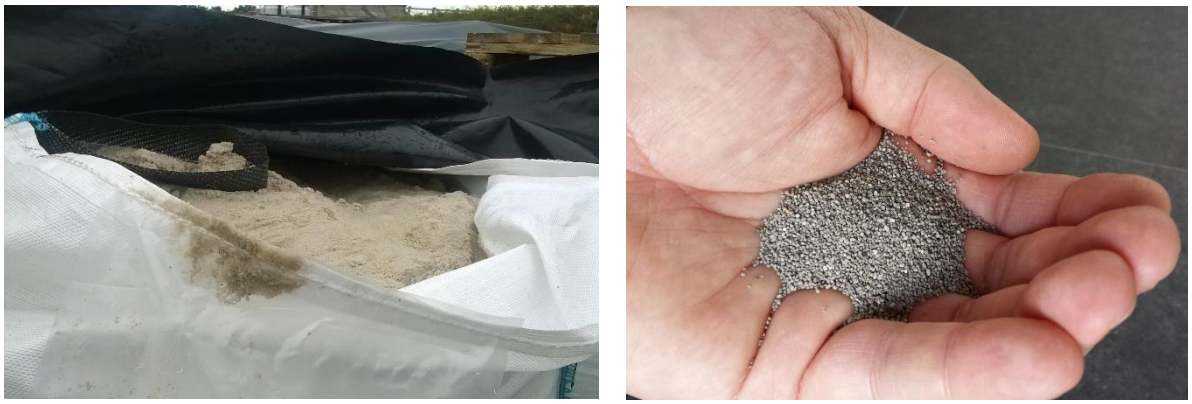

Figure 3.3. Pictures of struvite from the WWTP in Apeldoorn (left), which is used as raw material for the production of the fertiliser Physiostart P Plus bij Timac Agro (right).

Struvite has a fertiliser status in The Netherlands, but it is still considered as waste. The consequence is that, if the struvite is not directly used as fertiliser, but as a raw material for fertiliser production, it is still waste. Because Timac Agro is producing the fertiliser in France, the struvite should be transported to France, where it is still waste. So, the waste status is complicating the use of struvite as a secondary raw material for P fertiliser production. In some countries, struvite is not considered as waste, because it is considered a "by-product", in others it is resolved by company self-declaration of End-of-Waste status validated by the regulatory authorities, in others it is not resolved to date.

Timac Agro has put a lot of efforts in making it possible to transport struvite to France and to use it there as a raw material for fertiliser production. In 2019, a permission is obtained in France for the transport and use of 100 times a certain amount of struvite from the Netherlands to the fertiliser plant in France (pers. communication E. van Delden, 2020). Timac Agro considers this as sub-optimal, because relatively small amounts should be treated each time separately, which is not efficient.

The situation with regard to the legal situation of struvite in different European countries is summarised by ESPP (Scope Newsletter 124, 2017) as follows (only relevant countries mentioned):

- Certain recovered phosphates (struvite, magnesium phosphate, dicalcium phosphate) are authorised as fertilisers by national regulation in the Netherlands as of 29/3/16. However, this regulation does not ensure End-of-Waste status. Waste status does not prevent application as fertiliser but is a procedural obstacle to cross border trade and to use as a raw material for fertiliser production. Clarification on the conditions for End-of-Waste status is still ongoing. Also, this regulation states that

these phosphates must be treated by a "suitable process" to eliminate "the majority of pathogens" and definition of such processes is also ongoing.

- Case-by-case authorisations have been accorded for recovered struvite by national/regional authorities. These are applicable only to the specific product from a specific waste stream / site / process:
- Agristo and Clarebout, both from potato processing (both NuReSys process) in Flanders,
- Slough sewage works (Ostara process) in the UK,
- Berlin Wasser sewage works in Brandenburg, Germany.

It is mentioned that '*these case-by-case authorisations depend on the specific quality of the authorised product and so do not constitute a 'blanket' authorisation for struvite in the relevant country. However, these case-by-case authorisations can provide a precedent for future authorisation for other production sites, subject to their also proving product quality and safety. In some cases, they are supported by a clause in national legislation, e.g. "recovered precipitated phosphates" in German fertiliser legislation*.'

Within the scope of the North Sea Resources Roundabout (NSRR), which is an initiative of The Netherlands, Belgium, France and UK, it is tried to tackle barriers to cross-border trade in secondary raw materials, like struvite (https://aquaminerals.com/aquaminerals-signs-international-green-deal-on-struvite/).

It can be concluded that the current lack of clarity and disparities between Member States with respect to the legal status of struvite poses a significant obstacle to P recovery via struvite. It poses further obstacles to transport, to sale as fertiliser, but also to use in fertiliser blending or in its' use as a raw material in fertiliser production. It is not impossible to use struvite as a raw material for fertiliser production, but especially because of the waste status of struvite in many countries, it is complicated, it needs a lot of administrative efforts, and the final result is often not optimal.

4 Conclusions

From the information described in the foregoing chapter, the following conclusions can be drawn:

- Recycling derived fertilisers (RDF's) are treated differently in the national legislations of member states within NW Europe, a.o. in the following ways:
    - Procedures for the authorisation of waste or by-products as fertiliser are often not clear and strongly differ between countries.
    - In some countries, recycling derived fertilisers are authorised by a category with minimum criteria, while in other countries the same products undergoes a case-by-case authorisation, that is applicable only to the specific product from a specific waste stream / site / process and/or a specific producer.
    - Criteria for contaminants like heavy metals are different between countries, so that a specific RDF may meet the criteria for heavy metals in one country and not in another country;
    - The fertiliser status and end-of-waste status are of relevance. In some countries, the end-of-waste status is supplied as soon as a product receives a fertiliser status, but in other countries that is not the case.
- As a result of the first conclusion, a specific RDF (this is for example the case with poultry litter ash and struvite) may have a fertiliser status in one country and a waste status in another country. This hampers the recycling of nutrients from waste, because it hinders:
    - Cross-border transport,
    - to use it as raw material in fertiliser production,
    - to use it as a component for blending,
    - to market and use it directly as a fertiliser in different countries.

Mutual recognition is interpreted differently by the member countries within NW Europe, and in practice most countries prescribe the regular procedure for the authorisation of fertilisers, even if a fertiliser product has a fertiliser status in another member state.

It requires a lot of administrative work and good knowledge of the authorisation procedures for getting a fertiliser or end-of-waste status in the different countries.

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Additional prerequisites for fertiliser management

Consequences for the use of recycling-derived fertilisers

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Deliverable 1.2-II (WP T3)

Partners:

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Summary and conclusions

The objective of the NWE-Interreg project ReNu2Farm is to increase the use and production of recycled nitrogen (N), phosphorus (P) and potassium (K) for fertilizers in Northwest Europe (NWE). The proper development of the market for biobased, recycling-derived fertilisers (RDF's) is hampered among others by the legal status of the fertilisers. Because the products are often produced from waste or from animal by-products (e.g. sewage sludge, food waste and animal manure), the end products are considered as waste or animal by-products as well. For that reason, it is not allowed or difficult to trade these products between member states within EU as fertiliser. In two other reports that have been produced within the scope of ReNu2Farm, the legislative framework at EU and national level for the trade and use of RDF's has been described. In addition to the consequences of the legal status of fertiliser products for the possibilities for the trade and use of the products as fertiliser, the legislation for the application limits is also of relevance for the potential use of recycling-derived fertilisers (RDF's). That is the reason that we describe the legislation for the application limits at European and national level and the consequences for the use and application of RDF's in this report.

For the use of recycling-derived fertilisers (RDF's) application limits for animal manure and other organic and mineral fertilisers are of relevance. Within the scope of the Nitrate directive most countries in NW Europe have formulated application standards for animal manure (170 kg total N per ha and 230-250 kg total N per ha for grassland on dairy farms in some countries), but there are differences in the way countries have implemented additional application standards in their national legislations. Some countries have formulated application standards for the summed application of N with animal manure ánd other fertilisers, which are sometimes based on total N (which is the case for UK, Ireland, France and Belgium / Flanders (optional)) and sometimes on effective N (which is the case for Belgium / Flanders (optional) and the Netherlands). Germany is using the N balance in the legislation with respect to the allowed N application, and has formulated maximum amounts for the allowed N surplus. In addition, some countries have formulated application standards for phosphate (e.g. Belgium / Flanders and the Netherlands).

Next to the application limits, countries have also formulated the allowed application periods for various fertilising products. These periods vary between countries, regions, soil types, crop types and fertiliser types. When using RDF's, the application standards for animal manure and/or for the summed N input with animal manures and other fertilisers and additional regulations for application periods and/or prescribed ways of storage and application (e.g. ammonia emission should be prevented during storage and application of animal manure and Renure products) should be respected.

The main conclusions per fertiliser type are as follows:

For composts it is of importance whether they are produced from animal manure or from other sources, like green waste or household waste. Composts produced from animal manure have the legal status of animal manure and for that reason the application standard of 170 kg total N per ha is of relevance for that product. That is not the case for composts produced from green waste and household waste. As of 16 July 2022, some of the composts could be used as a component for the production of EU fertilisers with CE marking. In some countries (e.g. Flanders and the Netherlands) the *effective* N applied with compost should be taken into account for the N application standard, while in other countries (e.g. France, UK and Ireland) the *total* N applied with compost should be taken into account.

Ashes from the incineration or gasification of biowaste, sewage or manure are considered waste and can only be used as a fertiliser if authorised as such. Germany and the UK have a limited authorisation of ashes as a fertiliser whereas Flanders and France have given derogations for the ashes from specific producers. As of 16 July 2022, some of the ashes could be used as a component for the production of EU fertilisers with CE marking. The Nitrate Directive does not pose any restrictions on the use of ashes as a fertiliser. Ashes are mostly used as a PK-fertiliser and/or for their neutralising value. In countries where the ashes are authorised ánd where application standards for phosphate are in place (e.g. in Flanders), the allowed doses of ashes are limited by the P application standards.

Struvite derived from sludge treatment (sewage or biowaste) is a biowaste and can only be used as a fertiliser if authorised as such. This is of relevance for the struvites considered in this project. Only Germany and the Netherlands have a limited authorisation of struvite as a fertiliser whereas Flanders and the UK have given derogations for the struvite from specific producers. As of 16 July 2022, some of the struvites could be used as a component for the production of EU fertilisers with CE marking. The fertiliser application is generally limited by application standards for total P and N (total or effective).

Ammonium sulphate and ammonium nitrate can be produced directly from liquid animal manure through a stripping-scrubbing process. Following the strict interpretation of livestock manure in the Nitrate directive, the ammonium sulphate would be considered a manure product, and the application limit of 170 kg N per hectare applies. However, for the use of ammonium salts as a component for EU fertilisers with CE marketing, the ammonium sulphate is regarded as a waste product that does not fall under the scope of the Animal by-product regulations. Countries seem to differ in the definition of the ammonium salt products, with some countries (Belgium, the Netherlands) following the definition of the Nitrate directive, while other countries follow the definition of the Fertilising product regulation. This will also impact the transport and handling of the

product as either an ABP or a product. In dependence of the composition in relationship with the criteria for SafeManure, the ammonium sulphate could get the Renure status. In that case, the same provisions apply to the ammonium sulphate as to N containing chemical fertilisers and it can be applied on top of the application limit of 170 kg N per hectare. However, because the S content in ammonium sulphate is relatively high in comparison with N, high N doses with ammonium sulphate are not possible within the limits of the Good Agricultural Practices. Because the ammonium nitrate does not contain S, it can be applied in larger amounts than the ammonium sulphate.

1 Introduction

The objective of the NWE-Interreg project ReNu2Farm is to increase the use and production of recycled nitrogen (N), phosphorus (P) and potassium (K) for fertilizers in Northwest Europe (NWE).

Within the scope of sustainable agriculture and a circular, biobased economy, it is crucial to find ways to reduce quantities of non-recycled nutrients like N, P and K and to decrease the dependency on nutrient import. In the NWE Interreg project ReNu2Farm opportunities for the replacement of nutrients from traditional mineral fertilisers by recycling-derived fertilisers are explored. Within the NWE territory, regional differences can be identified with respect to nutrient supply and demand. Hot spots with a surplus of N and P from animal manure are identified in the NWE territory and compared to regions with a shortage of nutrients from animal manure. Opportunities for the replacement of nutrients from traditional mineral fertilizers by recycled fertilizers from regions with a nutrient surplus are explored within the scope of the current project.

The proper development of the market for biobased, recycling-derived fertilisers (RDF's) is hampered among others by the legal status of the fertilisers. Because the products are often produced from waste or from animal by-products (e.g. sewage sludge, food waste and animal manure), the end products are considered as waste or animal by-products as well. For that reason, it is not allowed or difficult to trade these products between member states within EU as fertiliser.

In another report that has been written within the scope of the ReNu2Farm project (Van Schöll & Postma 2022-I) the legislative framework at EU level for the trade and use of recycling-derived fertilisers has been described. An important development was the adoption of the EU Fertiliser Product Regulation 2019/1009 in June 2019, which aims at 'facilitating the recognition of organic and waste-based fertilisers in the single market and thus encourage the recycling of bio-nutrients as fertilising products in the circular economy'. When strict rules for the safe recovery of nutrients into secondary raw materials are fulfilled, those raw materials may be used as a component of CE-marked fertilising products, which are classified in Product Function Categories (PFC's). The consequence is that RDF's may become an EU fertiliser product, provided that they meet the requirements for raw materials (classified in component material categories, or CMC's), production and contaminants.

EU Regulation 2019/1009 is facultative, which means that it exists next to the continuing national legislations for the trade of fertilisers. National legislations and regulations are

especially of interest for products that are meant for use in the region or country where they are produced and/or for products that are exported from one country to another.

In a second report, national legislations for the trade and use of fertiliser products in countries in North West Europe (NWE) are described (Van Schöll & Postma, 2022-II). With respect to the consequences of national legislations for the possibilities for recycling-derived fertilisers (RDF's), we concluded that

i) RDF's are treated differently in the national legislations of member states within NW Europe,
ii) a specific RDF may have a fertiliser status in one country and a waste status in another country,
iii) mutual recognition is interpreted differently by the member countries within NW Europe and
iv) it requires a lot of administrative work and good knowledge of the authorisation procedures for getting a fertiliser or end-of-waste status in the various EU countries.
v) the differences in national legislations between countries are undesirable and hampers the creation of a level playing field.
vi) the implementation of the regulation EU/2019/1009 on fertilising products is a breakthrough for the recognition of recycling-derived fertiliser products.

In addition to the consequences of the legal status of fertiliser products for the possibilities for the trade and use of the products as fertiliser, the legislation for the application limits is also of relevance for the potential use of recycling-derived fertilisers (RDF's). That is the reason that we describe the legislation for the application limits at European and national level and the consequences for the use and application of RDF's in this report.

2 EU legislation on use of fertilisers

2.1 Introduction

At the European level there is no legislation directly aiming to regulate the application of fertilisers. There is however legislation aiming to protect the quality of the ground and surface waters throughout the European Union that strongly impacts the application of fertilisers. Most relevant are the Water Framework directive and the Nitrate directive.

This legislation sets goals and targets for the chemical and ecological status of surface and ground water and quality standards. Nitrogen and phosphorus are amongst the elements that strongly affect the chemical and ecological status of waters. Regulation of the flow of nitrogen and phosphorus from agricultural areas to ground and surface water is therefore seen as key issue. This can be achieved by measures on the application of fertilisers and manures.

2.2 Water Framework Directive (WFD 2008/98/EC)

The Water Framework Directive (WFD 2008/98/EC) aims to establish a framework for the protection of all waters including rivers, lakes, estuaries, coastal waters and groundwater, and their dependent wildlife/habitats under one piece of environmental legislation. It sets out rules to halt deterioration in the status of European Union (EU) water bodies and achieve 'good status' for Europe's rivers, lakes and groundwater. (Source: https://eur-lex.europa.eu/browse/summaries.html).

Specifically the WFD aims to:

- protect/enhance all waters (surface, ground and coastal waters)
- achieve "good status" for all waters
- restoring the ecosystems in and around these bodies of water;
- reducing pollution in water bodies;
- manage water bodies based on river basins or catchments
- guaranteeing sustainable water usage by individuals and businesses.
- involve the public.

The Water Framework Directive is linked to a number of other EU directives, (https://www.epa.ie/water/watmg/wfd/), illustrated in Figure 2 1. These include Directives relating to the protection of biodiversity (Birds and Habitats Directives), directives related to specific uses of waters (drinking water, bathing waters and urban wastewater directives) and to directives concerned with the regulation of activities undertaken in the environment (Industrial Emissions and Environmental Impact Assessment directives. Directives on topics such as Floods and the Marine Strategy Framework have significant

linkages with the WFD which is also supplemented by the Priority Substances Directive and the Groundwater Directive. The Sustainable Use of Pesticides and the Sewage Sludge Directives provide for the control of materials applied to land. The Nitrates Directive forms an integral part of the Water Framework Directive and is one of the key instruments in the protection of waters against agricultural pressures.

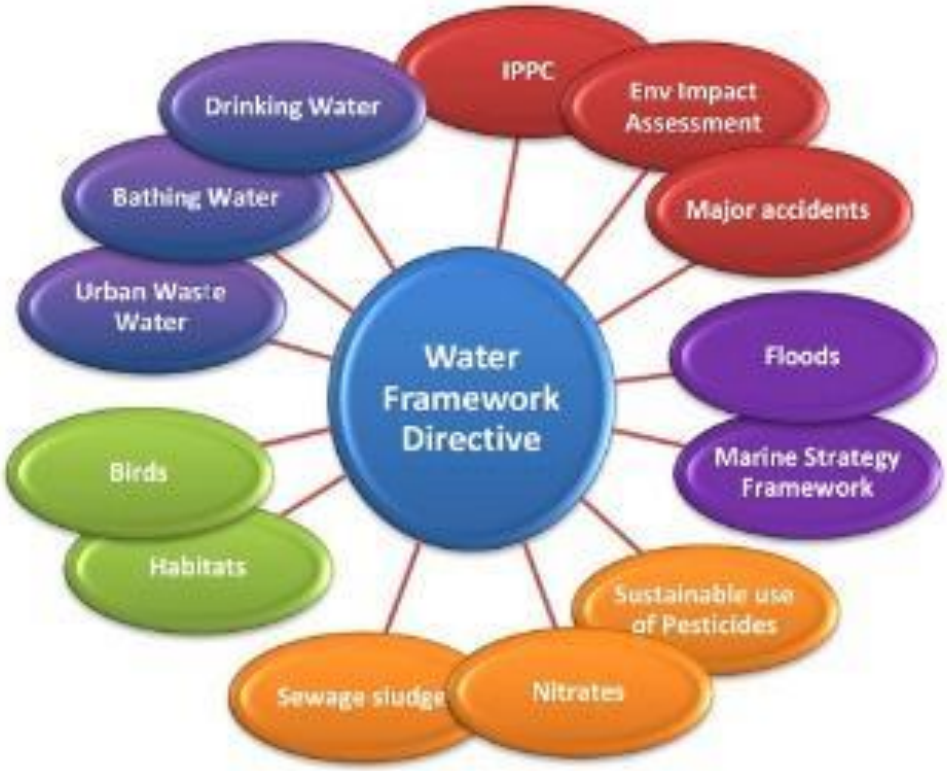

Figure 1 WFD Interaction with other EU Legislation (Source: SWMI, 2015 on https://www.epa.ie/water/watmg/wfd/)

The WFD places clear responsibilities on national authorities of the member states (Source: https://eur-lex.europa.eu/browse/summaries.html). They have to:

- identify the individual river basins on their territory — that is, the surrounding land areas that drain into particular river systems;
- designate authorities to manage these basins in line with the EU rules;
- analyse the features of each river basin, including the impact of human activity and an economic assessment of water use;
- monitor the status of the water in each basin;
- register protected areas, such as those used for drinking water, which require special attention;

- produce and implement 'river-basin management plans' to prevent deterioration of surface water, protect and enhance groundwater and preserve protected areas;
- ensure the cost of water services is recovered so that the resources are used efficiently and polluters pay;
- provide public information and consultation on their river-basin management plans.

The approach to protect and improve the quality of water differs between surface waters and groundwater (Source: https://ec.europa.eu/environment/water/water-framework/info/intro_en.htm).

For **surface water**, both the ecological and chemical quality have to be protected and improved. Good ecological status is defined in terms of the quality of the biological community, the hydrological characteristics and the chemical characteristics. As no absolute standards for biological quality can be set which apply across the Community, because of ecological variability, the controls are specified as allowing only a slight departure from the biological community which would be expected in conditions of minimal anthropogenic impact.

Good chemical status is defined in terms of compliance with all the quality standards established for chemical substances at European level. These include standards for nitrogen and phosphorus.

For **groundwater** the presumption has been that it should not be polluted at all. For this reason, setting chemical quality standards may not be the best approach, as it gives the impression of an allowed level of pollution to which Member States can fill up. Few such standards have been established at European level for particular issues (nitrates, pesticides and biocides), and these must always be adhered to. But for general protection, the approach comprises a prohibition on direct discharges to groundwater, and (to cover indirect discharges) a requirement to monitor groundwater bodies so as to detect changes in chemical composition, and to reverse any anthropogenically induced upward pollution trend.

Agriculture is a substantial source of N and P in surface and ground water. Therefore, the 'river-basin management plans' need to include measures to reduce the flow of nitrogen and phosphorus from agriculture, i.e. by controlling the fertiliser application. In addition, the Nitrate Directive specifically aims to reduce the flow of nitrates from agricultural sources.

2.3 Nitrate directive (91/676/EEC)

The Nitrates Directive (Council Directive 91/676/EEC) aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. Farming is responsible for

over 50 % of total nitrogen discharges into surface waters. The Nitrates Directive forms an integral part of the Water Framework Directive and is one of the key instruments in the protection of waters against agricultural pressures. (Source https://eur-lex.europa.eu/browse/summaries.html).

Implementation measures of the Nitrates Directive that countries have to take are ((https://ec.europa.eu/environment/water/water-nitrates/index_en.html)):

- designate as vulnerable zones all those draining into waters which are or could be affected by high nitrate levels and eutrophication, the so-called nitrate vulnerable zones (NVZ's)
- draw up a code of Good Agricultural Practices. Codes should include:
    - measures limiting the periods when nitrogen fertilizers can be applied on land in order to target application to periods when crops require nitrogen and prevent nutrient losses to waters;
    - measures limiting the conditions for fertilizer application (on steeply sloping ground, frozen or snow covered ground, near water courses, etc.) to prevent nitrate losses from leaching and run-off;
    - requirement for a minimum storage capacity for livestock manure; and
    - crop rotations, soil winter cover, and catch crops to prevent nitrate leaching and run-off during wet seasons
- establish action programmes for the NVZ areas to reduce nitrate pollution of waters; taking into account available scientific and technical data and overall environmental conditions. These programmes must include:
    - measures already included in Codes of Good Agricultural Practice, which become mandatory in NVZs; and
    - other measures, such as limitation of fertilizer application (mineral and organic), taking into account crop needs, all nitrogen inputs and soil nitrogen supply, maximum amount of livestock manure to be applied (corresponding to 170 kg nitrogen /hectare/year).
- limits the application of nitrogen from manure: in areas covered by Action Programmes, the Directive prescribes that the highest amount of nitrogen from manure that can be applied annually is 170 kg/ha
- monitor the effectiveness of the action programmes;
- provide training and information for farmers, where appropriate.
- carry out a comprehensive monitoring programme and submit every 4 years, a comprehensive report on the implementation of the Directive. The report includes information on nitrate-vulnerable zones, results of water monitoring, and a summary of the relevant aspects of codes of good agricultural practices and action programmes.

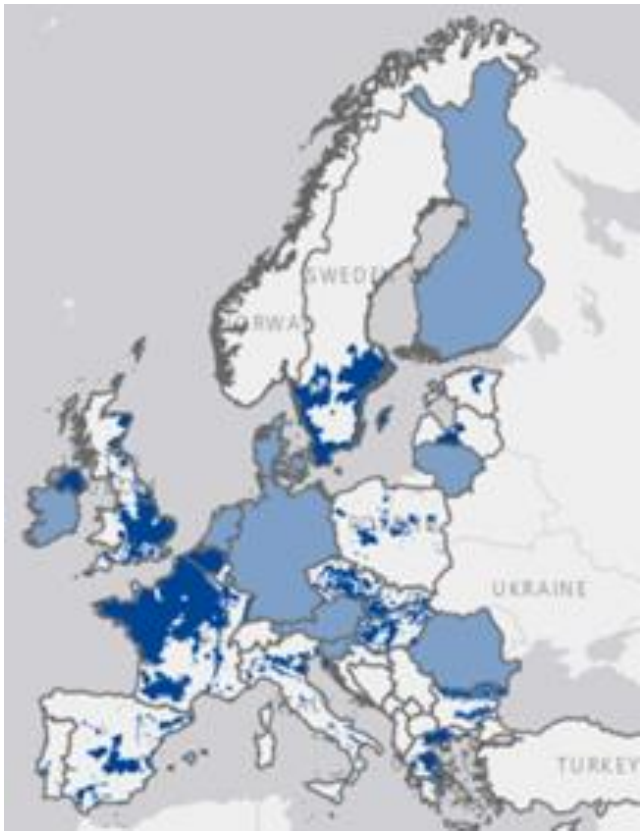

Figure 2 Nitrates vulnerable zones. Countries in blue have designated the whole territory as NVZ (art.3.5) (https://water.jrc.ec.europa.eu/ 01/09/2020)

All member states have implemented the mandatory action programmes, taking into account the specific pedo-ecological conditions in their territory. All action programmes use the maximum limit of 170 kg nitrogen (total N) per hectare per year in NVZ for the application of animal manure. In some countries, all agricultural land is declared as NVZ (f.i. in the Netherlands, Germany), other member states have designated specified areas as NVZ (e.g. France) (Figure 2 2).

Higher applications of animal manure than the 170 kg N per hectare are allowed in certain situations, provided that nitrate concentrations in groundwater will not exceed 50 mg per litre, e.g. because of high N uptake by crops. These exceptions are called 'derogations', which have been granted to the Netherlands, Belgium (only in Flanders), Ireland and UK (Northern Ireland, England, Scotland and Wales) and Italy (regions of Lombardia and Piemonte) (https://ec.europa.eu/environment/water/water-nitrates/index_en.html). Germany had a derogation until 2013, but has lost it in 2014 (Van Gruisen, 2017).

Chemical fertilisers are not bound to the limit of 170 kg N/ha, but should be used in accordance with Good Agricultural Practice. Application rates may be higher provided that the fertilisation standards of Good Agricultural Practices are met and groundwater and surface water are not polluted by nitrates. In some EU countries, application limits for N take into account N fertiliser replacement values (NFRV's) of organic fertilisers, because not all N is available for crop uptake and will cause a risk for NO3 leaching. This is for example the case in the Netherlands and Denmark (Van Dijk & Ten Berge, 2009), where the N application limits are based on effective N. However, in other countries, like Belgium (Flanders) and France, the legislation is based on the total N application. This will be described more extensively in the next chapter.

In addition to maximum application limits, the action programmes also include application measures to increase the effectiveness of the fertilisers and limit emissions, such as timing of application (e.g. applying manure outside the growing season is not allowed) and application modes (e.g. insert animal manures into the soil), and storage conditions (e.g. by covering manure and thus preventing N losses by NH3 volatilisation).

2.4 Safemanure / ReNure

Within the Nitrate Directive livestock manure is defined as: *'livestock manure': means waste products excreted by livestock or a mixture of litter and waste products excreted by livestock, even in processed form* (article 2g of Nitrate directive). This definition is to be interpreted very strictly.

The implication of the strict interpretation of the definition of livestock manure, means that recycling-derived fertiliser products which are derived from animal manure will remain to be regarded as animal manure by definition, even if they have similar properties as chemical fertilisers. This will be the case for e.g. composts and digestates based on animal manure, but also for liquid products like mineral concentrates, ammonium nitrate and ammonium sulphate. For that reason, they also remain subject to the maximum application limit of 170 kg N per hectare from the Nitrate directive, limiting their marketability.

The production of high quality recycling-derived fertilisers (such as ammonium nitrate, ammonium sulphate) that cannot be distinguished from chemical fertilisers had not been foreseen. The rationale behind the application standard for animal manure is that because of the inherent properties of the livestock manure an application above 170 kg N would result in an undesirable losses by leaching to the water system. The high quality ammonium salts do not have the same properties as manure. Therefore it would not be necessary to impose the application measures for manure on these products. The legal status of animal manure of those products, will also limit possibilities for transport, etc.

because they remain animal manure in case the end point in the manufacturing chain has not been declared.

The consequence is that there is no fair level playing field for fertilisers recovered from animal manure, even if the final properties and purity are similar to chemical fertilisers. Therefore, the EC has launched a study to evaluate the effectiveness and environmental safety of manure-derived fertilisers, the Safemanure project.

The results of the Safemanure project have been published by the Joint Research Centre (Huygens et al., 2020). Within that scope, the authors explored which criteria could allow nitrogen (N) fertilisers that are partially or entirely derived from manure, to be used in areas with water pollution by N following the same provisions applied to N containing chemical fertilisers in the Nitrates Directive (91/676/EEC), while ensuring adequate agronomic benefits.

Fertilising products that meet the criteria are referred to as "REcovered Nitrogen from manURE (RENURE)". In the final report the following criteria for RENURE were formulated:

(i.) RENURE is obtained through a process where the handling chain for the manure(s) applied as input material involves a physical, chemical, or biological process step for the treatment of manure other than solely mixing, blending, drying, rewetting, granulation and/or storage, that increases the concentration of mineral N, urea N and/or crystal-bound N (% relative to total N) compared to the input material(s). The production process results in materials of a consistent quality that is in compliance with all other criteria.

(ii.) RENURE materials have a mineral N:TN ratio ≥ 90% or a TOC:TN ratio ≤ 3. This criterion is evaluated by correcting for any N derived from concentrated N materials (>3% N, dry matter basis) that classify as products or by-products and not originating from manure.

(iii.) RENURE materials do not exceed the following limit values:
- Cu: 300 mg kg-1 dry matter; and
- Zn: 800 mg kg-1 dry matter.

(iv.) Member States should ensure that the timing and application rates of RENURE and other fertilising materials are synchronised with plant NPK requirements to minimise nutrient leaching and run-off losses. In accordance with the application of good agro-environmental practices, this involves in particular:
- the specification of information on the content of N, P2O5, and K2O in RENURE materials for any of these elements where the concentration exceeds 1% of dry matter, with a maximum deviation of 25% from the actual value, in order to monitor and record the field nutrient budget;
- unless inappropriate, maintaining a living plant cover on the land for as much of the year as possible or equivalent measures.

(v.) Member States should prevent and minimise NH3 emissions during RENURE application on field (by injection, immediate incorporation of surface-applied materials or equivalent measures), especially for RENURE N fertilisers that have
- > 60% of the N present in N forms other than NO3--N, and
- a pHH2O > 5.5.

(vi.) Member States should prevent and minimise emissions to air resulting from storage through enforcing appropriate storage conditions of RENURE.

Thereby it was noted that the RENURE involves the processing of livestock manure, an animal by-product. RENURE materials will remain subject to the controls of Regulation EC/1069/2009 and Regulation EU/142/2011 on animal by-products (ABP), until the end point in the manufacturing chain, as defined in these Regulations, is reached. Similarly, the RENURE proposals have been developed taking into account the provisions of the National Emissions Reduction Commitments (NEC) Directive (Directive (EU) 2016/2284) that control the emissions of air pollutants, including ammonia.

For ammonium salts that are recovered from manure or processed manure through a process of stripping and scrubbing this end point in the manufacturing chain under the ABP regulations does not apply: the ammonium salts are not considered as an animal by-product but as a residue product of air purification. Ammonium salts may be used as a component for EU fertilising products, provided that they meet the criteria for the CMC 15 that is in preparation.

The criteria for RENURE products have not been implemented yet. It is still under discussion whether this will be implemented by an amendment of the Nitrate Directive, via the country specific Nitrate programmes or by derogation measures.

3 National legislation on fertiliser use

3.1 Introduction

The Nitrate directive has to be implemented in all EU member states and within that scope all member states are obliged to make Action programmes for Nitrate Vulnerable Zones (NVZ) in which they describe how the Nitrate directive is implemented in their country. These action plans also take into account measures for the Water Framework directive.

Several overviews have been given, in which action programmes of EU member states have been compared (e.g. Van Grinsven et al., 2012; Ten Berge & Van Dijk, 2009, Gault et al., 2016). In this chapter, we will give a short overview of the headlines of the national legislations in which the Nitrate directive has been implemented in the relevant countries within NW Europe.

In the former chapter, it has already been described that the following elements are part of the action plans:

- Derogation: a maximum application limit of 170 kg N per ha in animal manure is prescribed for NVZ, but exceptions (so called derogations) are supplied for several countries. Within these countries it is allowed to apply higher amounts of N with animal manure in the NVZ, provided that this will not lead to an increase of the risk for exceeding the critical nitrate limit of 50 mg NO3 per litre. Van Grinsven et al. (2012) gave an overview of the derogations for grassland (mostly dairy farms) in nitrate vulnerable zones of several countries that were of relevance in 2009 (Table 3.1).
- Derogations are granted at farm level, except in Flanders (Belgium), and mostly apply to farms with at least 70-80% of farm land in use for grassland. Flanders has a derogation at field level and includes some arable crops.
- N application standards: the action programmes in Flanders and the Netherlands contain crop specific N application standards for the combined input with manures, mineral fertilisers and other sources (Ten Berge & Van Dijk, 2009). The application standards apply to fertiliser equivalent (FE) N, being the sum of N in mineral fertilisers plus N fertiliser equivalents given as manures and other sources. In 2011 a new system has been introduced in Flanders, in which farmers can choose between a fixed total nitrogen amount of FE N values for organic fertilisers per crop.

Table 3.1. Area of nitrate vulnerable zones per country and application limits for manure (in kg N/ha) in 2009 within the scope of the obtained derogation (European Commission, 2011, cited by Van Grinsven et al., 2012).

	Nitrate Vulnerable Zones area (%)	Application limit for manure (kg N ha^{-1})	Share of Agricultural land (%)	Share of farms (%)
Belgium	68			
Flemish Region	100	250/200[1]	12	10
Walloon Region	42[2]			
Denmark	100	230	4	3.2
France	45	170	0	0
Germany	100	230	< 1	< 1
Ireland	100	250	8	8
Netherlands	100	250	45	32
United Kingdom	39	250	1.5	1.3

[1] Also a derogation for some arable crops. [2] Situation in 2007 (Anonymous, 2008b).

- In Ireland, the Netherlands and UK, standards are differentiated for some crops with actual yield level and target and in Ireland and the UK the standards also depend on the soil N status and cropping history.
- In Germany there are no legal N application limits for total or FE nitrogen. Instead, there is a restriction on net N surplus at farm level in combination with statutory FE values. The N surplus should not exceed 60 kg N per ha.
- France did not negotiate with the EU Commission about a derogation with respect to the application limit of 170 kg N/ha with animal manure. It does not prescribe application standards in its' action programme for nitrate vulnerable zones. Fertiliser equivalents vary with crops and application period but have no legal status. Total N inputs are limited only in areas where nitrate concentrations in ground or surface water are high. This limit is 210 kg N/ha in so called complementary action areas (Zones d'Actions Complémentaires), which are used for drinking water and face at the same time high nitrate values. In some watersheds with nitrate in surface water exceeding 50 mg N/l total N inputs are restricted to values as low as 140 kg N/ha.
- Fertiliser equivalents of manure: because not all N in manure is available for plant uptake in the year of application, most countries work with the concept of Fertiliser Replacement Values or Fertiliser Equivalents (FE's) in the application standards for N. FE's for a certain type of manure are rather similar in different countries, but differences are there (table 3.2). For cattle and pig slurry the FE's are relatively high in Denmark and low in United Kingdom and Ireland. In France, the FE's have no legal status.

Table 3.2. Statutory N fertiliser equivalents (in %) for application of several manure types per country (Webb et al., 2013; cited by Van Grinsven et al., 2012).

	Cattle slurry	Pig slurry	Layer solid manure	Broiler solid manure
Netherlands	60	60–70	55	55
Flemish Region	60	60	30	30
Denmark	70	75	65	65
France*	50–60	50–75	45–65	45–65
Germany	50	60	30	30
United Kingdom	20/35	25/50	20/35	20/30
Ireland	40	50	50	50

* No legal status.

3.2 The Netherlands

In the Netherlands, fertiliser application is regulated by the Fertiliser Act (Meststoffenwet) and the accompanying Implementation Decree (Uitvoeringsbesluit Meststoffenwet) and Implementation Regulation (Uitvoeringsregeling Meststoffenwet).

The allowed fertiliser application at farm level is regulated via a set of application standards:

1. The first one is an application standard for manure, based on total N. This is the implementation of the prescribed standard of 170 kg N/ha for N in the Nitrate directive. Derogations are available for dairy farms with >80% grassland (in March 2022 not yet for 2022 and following). They are allowed to apply 230-250 kg N/ha via animal manure, in dependence of soil type.
2. The second application standard is for the sum of N applied with animal manure (for which fertiliser equivalents are used), mineral fertilisers and other fertilisers (including compost; also based on fertiliser equivalents). This group of application standards is highly differentiated at the basis of the crop and soil type. A long list with N application standards per crop and soil type is available. A short extract for major crops is shown in table 3.3.
3. The third application standard applies to P_2O_5. These standards differ at the basis of the P status of the soil and the crop type (grassland versus arable and/or horticultural crops; table 3.4 and 3.5).

Soil analysis is only required for the use of sewage sludge

Table 3.3. Application standards for N (based on effective N) in the Netherlands for some major crops per soil type (situation 2019-2021; www.rvo.nl).

Crop	Sand	Clay	Peat
Grassland			
• Grazing & mowing	250	345	265
• Mowing	320	385	300
Maize	112-140	160-185	150
Potatoes			
• Ware	184-235	250	245
• Starch	184-230	240	230
Sugar beets	116-145	150	145
Winter wheat	160-190	245	160
Spring barley	80	80	80
Onions	120	120	120

Table 3.4. Phosphate application standards for grassland in 2020 (www.rvo.nl).

P-class	P-AL-value	Amount of P2O5 (per ha)	Protocol for sampling
High	> 50	75 kg	No
Rather high	41 t/m 50	90 kg	Phosphate differentiation and Derogation, or Phosphate poor and Phosphate fixing
Neutral	27 t/m 40	95 kg	Phosphate differentiation and Derogation, or Phosphate poor and Phosphate fixing
Low	16 t/m 26	105 kg	Phosphate differentiation and Derogation, or Phosphate poor and Phosphate fixing
Poor	< 16	120 kg	Phosphate poor and Phosphate fixing

Table 3.5. Phosphate application standards for arable land in 2020 (www.rvo.nl).

P-class	Pw-value	Amount of P2O5 (per ha)	Protocol for sampling
High	> 55	40 kg	no
Rather high	46 t/m 55	60 kg	Phosphate differentiation and Derogation, or Phosphate poor and Phosphate fixing
Neutral	36 t/m 45	70 kg	Phosphate differentiation and Derogation, or Phosphate poor and Phosphate fixing
Low	25 t/m 35	80 kg	Phosphate differentiation and Derogation, or Phosphate poor and Phosphate fixing
Poor	< 25	120 kg	Phosphate poor and Phosphate fixing

3.3 Belgium

Fertiliser application in Belgium (Flanders) is regulated via the Manure Decree (Mestdecreet) that contains application standards based on

- total N in manure (125 kg N for crops with low N demand, other crops 170 kg per hectare),
- the FE of N from manure, other fertilisers (like compost) and mineral fertilisers. A distinction is made for soil type (sand or no-sand) and crop groups. Eighteen crop groups and eleven crop combinations are distinguished.
- Total P in fertilisers. Eighteen crop groups are distinguished, and a distinction is made in classes of soils, depending on the P-status.

The total amount of allowed N is mostly higher than the maximum allowed amount of N applied with manure. This means that, if the maximum allowed amount of N with manure is applied, additional N may be given with mineral fertiliser or other fertilisers, like compost.

3.4 France

Fertiliser application in France is regulated only by the application standard of 170 kg total N per ha for manure. There is no general N standard for the total N input with animal manures and other (mineral) fertilisers at national scale or in Nitrate vulnerable zones (NVZ's). Total N inputs are limited only in areas where nitrate concentrations in ground or surface water are high. This limit is 210 kg N/ha in so called complementary action areas ('Zones d'Actions Complémentaires'), which are used for drinking water and face at the same time high nitrate values. In some watersheds with nitrate in surface water exceeding 50 mg N/l total N inputs are restricted to values as low as 140 kg N per ha for arable, pig

and poultry farms (maximum 40 kg N per ha as mineral fertilisers) and 170 kg N per ha (including excretions on pastures) for cattle farms (maximum 70 kg N per ha as mineral fertilisers) (Van Dijk & Ten Berge, 2009).

The nitrogen balance is used as a basis for N fertiliser recommendations and is calculated from (i) the foreseeable nitrogen requirements of the crops, and (ii) the nitrogen supply to the crops from the soil and from fertilisation (organic and mineral) (Hermann & Hermann 2019). Fertiliser equivalences are used for organic manures and vary per crop, but have no legal status (Comifer, 2011 cited by Van Grinsven et al., 2012).

3.5 Germany

At national scale the Fertilisation Ordinance (Düngeverordnung, or DüV) is in force, but the States (Länder) have their own regulations. The DüV does not regulate the use of total N with fertilisers by fixed application standards. Instead, the basis of the DüV is good agricultural practice aiming at:

1. Yield stability and product quality
2. Conservation of environmental values and
3. Maintenance of soil fertility (Van Dijk & Ten Berge, 2009).

According to Van Dijk & Ten Berge (2009) the state or regional authorities need to publish fertilisation recommendations based on the DüV and are responsible to implement measures enforcing compliance with regulations. At the basis of these fertiliser recommendations, farmers have to make a fertilisation plan or nutrient management plan.

In addition, farmers have to make a nutrient balance at field level every year, in which they include inputs with fertilisers (organic and mineral) and legume crops and outputs with harvested products. Calculated N surpluses are averaged over the three most recent years and may not exceed a threshold of 60 kg N per ha (situation 2009-2011). On the N balance of vegetable crops a loss term of 50-120 kg N per ha (annual basis) is subtracted to account for the inevitable losses associated with vegetable crops.

No penalties are given when the threshold level is exceeded.

Soil analysis is required for the use of biowaste (including compost).

3.6 Ireland

Ireland has also a derogation of 250 kg N per ha for grassland on dairy farms, which is only of relevance for 8% of the agricultural area in the country (situation of 2009; EC, 2011 cited by Van Grinsven et al., 2012).

In addition, N application standards are included in the action programmes for the Nitrate directive. These standards are based on total N and are relatively low, if compared with other countries in NW Europe (table 3.7).

Table 3.7. Nitrogen application standards (kg N per ha per year) for some major crops in the 4th action programmes for the Nitrate directive expressed either as fertiliser equivalent (FE) or total N (after Van Grinsven et al., 2012).

		Soil	Grass: graze and cut	Forage maize	Winter wheat	Potato (ware)	Sugar beet
Netherlands	FE	sand	260	150	160	245	145
	FE	clay	310	185	220	250	150
Denmark[1,2]	FE	sand	310[5]	150	[3]150	140	110
	FE	clay	330[5]	155	[4]180	140	120
Flemish Region	FE[8]	sand	235	135	160	190	135
	FE[8]	clay	245	150	175	210	150
	total	sand	350	205	200	260	205
	total	clay	360	220	215	280	220
United Kingdom	total	all	330	150	220	270	120
Ireland[6]	total	all	[7]306	140	180	145	155

[1] 0–5 % clay, not irrigated, [2] > 15 clay, not irrigated, [3] fodder quality, [4] baking quality, [5] for grass with clover 62–227 kg N ha^{-1}, depending on % clover, [6] soil nitrogen index 2 for arable crops, [7] for stocking rate between 170 and 210 kg ha^{-1} N per year, [8] valid from 2011 and without catch crop.

3.7 UK

The derogation in the UK was also 250 kg N per ha for grassland on dairy farms, but that represents only 1.5% of the agricultural land in the country (situation of 2009; EC, 2011 cited by Van Grinsven et al., 2012).

As in Ireland, these standards are based on total N. However, the allowed N applications for some crops are significantly higher than in Ireland. This is for example the case for winter wheat and ware potatoes. The application standards are 220 and 270 kg N per ha respectively in the UK and are relatively high, if compared with other countries in NW Europe (table 3.7). It should be noted that after the Brexit the Waste Framework directive and the Nitrate Directive do no longer apply to the UK.

4 Consequences for the use of RDF's

4.1 Composts

For the use of compost, a distinction has to be made between composted manures and composted biowaste (i.e. household and green waste). If we have a look at the composts that are used in the ReNu2Farm project (table 4.1), the composts 2-3-4 are based on manure and the compost 1 is based on household waste.

Table 4.1 Average contents (in % of fresh matter) of dry matter (DM), C organic and macronutrients in the composts 1 (household waste),and compost 2,3,4 (composted animal manure), analysed by laboratories of University of Ghent and/or Limerick and of Arvalis (source: Saju et al., 2021).

Product	laboratory	DM	Corg	N	P_2O_5,	K2O	SO3	CaO	MgO	Na2O
Compost 1	UGhent	65	19	2.6	1.9	1.8	1.7	3.2	0.3	0.3
Compost 2	UGhent	33	12	1.4	1.6	0.8	1.1	1.3	1.0	0.1
	Arvalis	33	12-13	1.6-1.8	1.8	1.1	0.6	1.7	0.9	0.2
Compost 3	UGhent	56	21	2.2	1.5	0.9	1.2	0.0	0.8	0.3
	Arvalis	33	11-21	1.3-2.8	1.6-3.2	1.1-1.4	1.9	1.7	0.8	0.4
Compost 4	UGhent	50	16	1.7	1.5	1.9	1.3	1.0	0.6	0.4
	Arvalis	32-63	11-14	0.9-1.7	1.6-3.2	0.8	1.7	1.1	0.9-1.4	0.9

Composted manure is regarded as manure from a legal point of view. The application and handling of composted manure should be in accordance with the animal by-product legislation. The amount of composted manure that may be applied is regulated by the application rate of 170 kg N per hectare from the Nitrate Directive.

In some countries, the use of composted manure is also regulated by application standards for P. In the Netherlands, the P application standard on soils with a high P status is only 40 kg P2O5 per ha for arable crops. If the application of compost from animal manure is limited to a dose of 40 kg P2O5 per ha, the N application is only 35 kg N per ha. This 35 kg N has to be subtracted from the application standard of 170 kg N per ha, which means that in addition 135 kg N per ha may be applied via animal manure in addition to the composted manure.

The application of household and green waste compost in agriculture is regulated at the national level and differs between the member states. In some countries compost is considered waste and application is under strict control. The use of compost is in practice limited to the country where it is produced because of differences between member

states in standards and regulations (input sources, criteria on heavy metals and organic microcontaminants, process requirements), logistic and administrative barriers for the export of a waste product, and the voluminous nature of the product.

Third party certification of compost is necessary in some countries (Be-Flanders, UK) or beneficial (Germany: no soil analysis required for RAL compost). In the Netherlands compost has to comply to the Fertiliser Act. In France, compost has to comply to NFU norms or have obtained homologation. In Ireland, standards and norms are part of waste management certificate of producer.

The volume of compost applied is limited by application rates for N and/or P in some countries (Netherlands, Belgium-Flanders), or by a total amount limitation (UK, Germany).

Nitrogen (and phosphorus) fertiliser equivalent values apply, but these differ between member states (For N: 10% in the Netherlands, 15% in Flanders, and 0-5% UK; For P 50% in the Netherlands, Flanders and the UK).

The consequence of the last remark is that a certain application with compost (e.g. 20 tonnes per ha) leads to different amounts of the so-called 'effective N' applied with that compost in the various countries. If 20 tonnes of household waste compost is applied, this results in an application of 52 kg total-N (of relevance for France), 5.2 kg effective N for the Netherlands and 7.8 kg effective N for Flanders.

As of 16 July 2022, compost that complies with the prerequisites of the regulation EU/2019/1009 on EU fertilising products can be used for the production of soil improvers and organic fertilisers with CE marking, which will automatically have an end-of-waste status. It is not yet clear how the different member states will regulate the **application** of EU fertilising products that are produced from compost.

4.2 Ashes

Ashes from the incineration or gasification of biowaste, sewage or manure are considered waste and can only be used as a fertiliser if authorised as such. Germany and the UK have a limited authorisation of ashes as a fertiliser whereas Flanders and France have given derogations the ashes from specific producers (De Leeuw, 2019; Van Schöll & Postma 2022-II). As of 16 July 2022, ashes that comply with the prerequisites of the regulation EU/2019/1009 on EU fertilising products can be used for the production of soil improvers and organic fertilisers with CE marking, which will automatically have an end-of-waste status.

The Nitrate Directive does not pose any restrictions on the use of ashes as a fertiliser. Ashes are mostly used as a PK-fertiliser and/or for their neutralising value. In countries where the ashes are authorised ánd where application standards for phosphate are in place (e.g. in Flanders), the allowed doses of ashes are limited by the P application standards. This is for example the case for poultry litter ash in Belgium-Flanders (Van Schöll & Postma 2022-II).). For the use in Belgium-Flanders a valid 'raw material certificate' (a so called 'grondstofverklaring') delivered by OVAM is obligated, and in addition, the product should meet the criteria of VLAREMA 6. Within that scope, maximum levels for i) heavy metal contents in the product and ii) heavy metal dosage to agricultural land should be met. The maximum limits for the heavy metal contents are based on the assumption that 2 tonnes per hectare per year of the product is applied. However, because of relatively high P and K contents, a dosage of 2 tonnes per hectare per year is too high from a viewpoint of 'good agricultural practice', because the P and K dose would have been 178 kg P_2O_5 and 168 kg K_2O per ha (table 4.2). With a 'normal' dose of 1 tonnes per hectare, the maximum dosage level is met (89 kg P_2O_5 and 84 kg K_2O per ha). In spite of the fact that the upper limit for the Zn content in the product is exceeded, a 'raw material certificate', and the resulting end-of-waste status, was obtained for Poultry Litter Ash in 2018 (De Leeuw, 2019).

Table 4.2. Average contents (in % of fresh matter) of dry matter (DM), organic matter (OM) and macronutrients in the ashes the incineration of sewage sludge (ash 1) poultry manure (ash 2) gasification of sewage sludge with green waste (bed ash 3 and fly ash 4) or sewage sludge (ash 5), analysed by laboratories of University of Ghent and/or Limerick and of Arvalis (source: Saju et al., 2021).

Product	laboratory	DM, %	OM, %DM	Corg	N, %	P2O5, %	K2O, %	SO3, %	CaO, %	MgO, %	Na2O, %
Ash 1	UGhent	100	0,01	0	0,0	14,9	0,8	12,5	8,8	1,8	15,9
	ULimerick	100	n.d.	n.d.	0,0	19,2	1,6	7,5	14,4	2,5	13,5
Ash 2	UGhent	94	3,8	0,64	0,0	12,1	8,4	6,5	23,2	4,8	1,8
	Arvalis	94	2,6	0,17	0,0	12,6	16,1	0,0	21,4	5,5	0,0
	ULimerick	100	n.d.	n.d.	0,0	12,6	12,8	7,8	21,8	5,8	1,9
Ash 3	UGhent	100	0,3	0,02	0,0	1,2	1,0	1,7	0,6	0,1	0,1
Ash 4	UGhent	89	12	5,2	0,0	0,7	1,9	2,8	9,4	0,7	5,3
Ash 5	UGhent	100	5,5	14	0,2	15,3	0,6	6,0	18,9	1,6	0,4

4.3 Struvite

A distinction should be made between struvite derived from animal manure and struvite derived from sludge treatment (table 4.3). Struvite from the treatment of manure is legally still regarded as manure, following the definition of manure in the Nitrate Direction. The application volume of manure derived struvite is regulated by the application rate of 170 kg N per hectare from the Nitrate Directive. The application and handling of manure derived struvite should be in accordance with the animal by-product legislation.

Struvite derived from sludge treatment (sewage or biowaste) is a biowaste and can only be used as a fertiliser if authorised as such. This is of relevance for the struvites considered in ReNu2Farm (table 4.3). As of 16 July 2022, struvites that comply with the prerequisites of the regulation EU/2019/1009 on EU fertilising products can be used for the production of soil improvers and organic fertilisers with CE marking, which will automatically have an end-of-waste status. When transported as a component for fertiliser production, the struvites will still be regarded as a waste product.

Table 4.3 Average contents (in % of fresh matter) of dry matter (DM), organic matter (OM) and macronutrients in the struvites derived from municipal waste water (struvite 1) and food waste processing (struvite 2) , analysed by laboratories of University of Ghent and/or Limerick and or Arvalis (source: Saju et al., 2021).

Product	**laboratory**	***DM, %***	***OM %DM***	**Corg %DM**	**N, %**	**P2O5, %**	**K2O, %**	**SO3, %**	**CaO, %**	**MgO, %**	**Na2O, %**
Struvite 1	UGhent	*61*	*27*	0,11	5.5	33.9	0.1	0.0	0.0	17.4	0,0
	Arvalis	*55*	*0.84*	0.42	5.7	28.4	0.1	0.0	0.5	14.9	0,0
	ULimerick	*51*	*18*	n.d.	5.1	6.0	0.1	0.0	0.0	15.6	0,0
Struvite 2	UGhent	*56*	*16*	0.08	5.1	35.0	2.3	0.0	0.0	17.1	0,0
	ULimerick	*58*	*20*	n.d.	5.1	6.9	1.4	0.0	0.1	16.4	0,0

Not all struvites will meet the criteria of the EU regulation. In that case they should be authorised at the national level. Only Germany and the Netherlands have a (limited) authorisation of struvite as a fertiliser whereas Flanders and the UK have given derogations the struvite from specific producers (Van Schöll & Postma 2022-II).). Struvite is generally considered as a P-fertiliser. In The Netherlands, fertiliser application is limited by application rates for animal manure, effective N and P-total. Because of the market surplus of animal manure and low to negative pricing of animal manure, most farmers prefer to use animal manure as a P-source for the required P fertilisation. In addition, farms that have a derogation for the 170 kg N per hectare from the Nitrate Directive are not allowed to use inorganic P-fertilisers, including struvite. As a result, even though the

use of struvite is allowed, there is no market demand for struvite in The Netherlands. Export of struvite is hampered by the waste status of the struvite.

4.4 Ammonium sulphate

Ammonium sulphate from air treatment installations is considered a waste product and can only be used as a fertiliser if authorised as such. Germany, Belgium and The Netherlands have a (limited) authorisation of ammonium sulphate as a fertiliser (Van Schöll & Postma 2022-II).). This includes ammonium sulphate that is derived from air treatment installations in stables. The Nitrate Directive does not pose any restrictions on the use of ammonium sulphate from airscrubbing as a fertiliser.

Ammonium sulphate can also be produced directly from liquid animal manure through a stripping-scrubbing process (Table 4.4). This product is considered in ReNu2Farm (Saju et al., 2021; Van Schöll & Postma 2022-II).).

As of 16 July 2022, ammonium salts that comply with the prerequisites of the regulation EU/2019/1009 on EU fertilising products can be used for the production of EU inorganic fertilisers with CE marking, which will automatically have an end-of-waste status. It is not yet clear how the different member states will regulate the application of EU fertilising products that are produced from ammonium sulphate that is derived from animal manure. Ammonium slats that are derived from treatment of air resulting from stripping and scrubbing of manure are not considered an animal by-product under the scope of the regulations EC/2009/1069 and EU/142/2011 on ABP. As a discrepancy, these salts are considered as animal manure following the strict interpretation of the definition of livestock manure in the Nitrate Directive. In Germany, the ammonium salts are regarded as inorganic fertiliser components, whereas in the Netherlands and Belgium the definition of the Nitrate directive is followed. In that case, the application limit of 170 kg N per hectare applies.

Table 4.4. Average contents (in % of fresh matter) of dry matter (DM), organic matter (OM) and macronutrients in ammonium sulphate that was stripped/scrubbed from animal manure, analysed by laboratory of University of Ghent (source: Saju et al., 2021).

Product	DM,	OM, %DM	N	P2O5,	K2O,	SO3,	CaO	MgO	Na2O
AS	25	n.d	3,9	0,0	0,0	7,1	0,0	0,0	0,0

In dependence of the composition in relationship with the criteria for SafeManure (paragraph 2.3; mineral N > 90% of total N; Cu and Zn contents should not exceed maximum limits; Huygens et al., 2020), the ammonium sulphate could get the Renure status. In that case, the same provisions apply to the ammonium sulphate as to N

containing chemical fertilisers and it can be applied on top of the application limit of 170 kg N per hectare. In addition, NH3 emissions during application of Renure-products on field should be prevented by injection, immediate incorporation of surface-applied materials or equivalent measures. During storage NH3 emissions from Renure products should also prevented by enforcing appropriate storage conditions (see chapter 2.4). However, because the S content in ammonium sulphate is relatively high in comparison with N, high N doses with ammonium sulphate are not possible because of Good Agricultural Practices.

4.5 Ammonium nitrate

Ammonium nitrate is produced directly from liquid animal manure through a stripping-scrubbing process (Table 4.5). This product is considered in ReNu2Farm (Saju et al., 2021; Van Schöll & Postma 2022-II).)

As of 16 July 2022, ammonium salts that comply with the prerequisites of the regulation EU/2019/1009 on EU fertilising products can be used for the production of EU inorganic fertilisers with CE marking, which will automatically have an end-of-waste status. It is not yet clear how the different member states will regulate the application of EU fertilising products that are produced from ammonium sulphate that is derived from animal manure. Ammonium slats that are derived from treatment of air resulting from stripping and scrubbing of manure are not considered an animal by-product under the scope of the regulations EC/2009/1069 and EU/142/2011 on ABP. As a discrepancy, these salts are considered as animal manure following the strict interpretation of the definition of livestock manure in the Nitrate Directive. In Germany, the ammonium salts are regarded as inorganic fertiliser components, whereas in the Netherlands and Belgium the definition of the Nitrate directive is followed.

The Renure status could also be obtained for ammonium nitrate, provided that it meets the criteria. In dependence of the national / regional application standards for manure and other fertilisers, it could be an advantage that the product is no longer considered as animal manure, because the N could be applied on top of the 170 kg N per ha that may be applied with manure. Because the ammonium nitrate does not contain S, it can be applied in larger amounts than the ammonium sulphate within the recommendations of Good agricultural practice.

Table 4.5. Average contents (in % of fresh matter) of dry matter (DM), organic matter (OM) and macronutrients in ammonium nitrate that was stripped/scrubbed from animal manure, analysed by laboratory of University of Ghent (source: Saju et al., 2021).

Product	DM,	OM, %DM	N	P2O5,	K2O,	SO3,	CaO	MgO	Na2O
AN	23	n.d	8.2	0,0	0,0	0,0	0,0	0,0	0,0

5 Conclusions and recommendations

For the use of recycling-derived fertilisers (RDF's) application limits for animal manure and other organic and mineral fertilisers are of relevance. Within the scope of the Nitrate directive most countries in NW Europe have formulated application standards for animal manure (170 kg total N per ha and 230-250 kg total N per ha for grassland on dairy farms in some countries), but there are differences in the way countries have implemented additional application standards in their national legislations. Some countries have formulated application standards for the summed application of N with animal manure ánd other fertilisers, which are sometimes based on total N (which is the case for UK, Ireland, France and Belgium / Flanders (optional)) and sometimes on effective N (which is the case for Belgium / Flanders (optional) and the Netherlands). Germany is using the N balance in the legislation with respect to the allowed N application, and has formulated maximum amounts for the allowed N surplus. In addition, some countries have formulated application standards for phosphate (e.g. Belgium / Flanders and the Netherlands).

Next to the application limits, countries have also formulated the allowed application periods for various fertilising products. These periods vary between countries, regions, soil types, crop types and fertiliser types (Gault et al., 2016).

When using recycling-derived fertilisers, the application standards for animal manure (based on total N) and/or for the summed N input with animal manures and other fertilisers (based on total or effective N; varies per country) and additional regulations for application periods and/or prescribed ways of storage and application (e.g. ammonia emission should be prevented during storage and application of animal manure and Renure products) should be respected.

The main conclusions per fertiliser type are as follows:

For composts it is of importance whether they are produced from animal manure or from other sources, like green waste or household waste. Composts produced from animal manure have the legal status of animal manure and for that reason the application standard of 170 kg total N per ha is of relevance for that product. That is not the case for composts produced from green waste and household waste. As of 16 July 2022, some of the composts could be used as a component for the production of EU fertilisers with CE marking. In some countries (e.g. Flanders and the Netherlands) the *effective* N applied with compost should be taken into account for the N application standard, while in other

countries (e.g. France, UK and Ireland) the *total* N applied with compost should be taken into account.

Ashes from the incineration or gasification of biowaste, sewage or manure are considered waste and can only be used as a fertiliser if authorised as such. Germany and the UK have a limited authorisation of ashes as a fertiliser whereas Flanders and France have given derogations for the ashes from specific producers. As of 16 July 2022, some of the ashes could be used as a component for the production of EU fertilisers with CE marking. The Nitrate Directive does not pose any restrictions on the use of ashes as a fertiliser. Ashes are mostly used as a PK-fertiliser and/or for their neutralising value. In countries where the ashes are authorised ánd where application standards for phosphate are in place (e.g. in Flanders), the allowed doses of ashes are limited by the P application standards.

Struvite derived from sludge treatment (sewage or biowaste) is a biowaste and can only be used as a fertiliser if authorised as such. This is of relevance for the struvites considered in this project. Only Germany and the Netherlands have a limited authorisation of struvite as a fertiliser whereas Flanders and the UK have given derogations the struvite from specific producers. As of 16 July 2022, some of the struvites could be used as a component for the production of EU fertilisers with CE marking. The fertiliser application is generally limited by application standards for total P and N (total or effective).

Ammonium sulphate and ammonium nitrate can be produced directly from liquid animal manure through a stripping-scrubbing process. Following the strict interpretation of livestock manure in the Nitrate directive, the ammonium sulphate would be considered a manure product, and the application limit of 170 kg N per hectare applies. However, for the use of ammonium salts as a component for EU fertilisers with CE marketing, the ammonium sulphate is regarded as a waste product that does not fall under the scope of the Animal by-product regulations. Countries seem to differ in the definition of the ammonium salt products, with some countries (Belgium, the Netherlands) following the definition of the Nitrate directive, while other countries follow the definition of the Fertilising product regulation. This will also impact the transport and handling of the product as either an ABP or a product. In dependence of the composition in relationship with the criteria for SafeManure, the ammonium sulphate could get the Renure status. In that case, the same provisions apply to the ammonium sulphate as to N containing chemical fertilisers and it can be applied on top of the application limit of 170 kg N per hectare. However, because the S content in ammonium sulphate is relatively high in comparison with N, high N doses with ammonium sulphate are not possible within the limits of the Good Agricultural Practices. Because the ammonium nitrate does not contain S, it can be applied in larger amounts than the ammonium sulphate.

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