Legal framework for recycling-derived fertilising products in the EU

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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 North-West Europe (NWE). The trade and use of recycling-derived fertilisers (RDF's) from various waste streams (such as sewage sludge, food waste and animal manure) is limited for several reasons. This hampers the proper development of the market for bio-based fertilisers. An important aspect is 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-product as well. For that reason, it is not allowed or difficult to trade these products between member states within EU as fertilisers. The legislative framework at EU level for the trade and use of recycling-derived fertilisers within NWE and the existing legal barriers are described in this report.

The 'EC fertilisers' are regulated by Regulation (EC) No 2003/2003 on mineral fertilisers and may circulate freely within the EU single market. EC fertilisers comply with fertiliser type designations in the annexes to the regulation. They also guarantee farmers a minimum nutrient content. From an evaluation of EC 2003/2003 carried out in 2010 it was recommended to include criteria for contaminants and to expand the list with mineral fertilisers with other fertilising products of plant and animal origin. Based on that evaluation, a revision of EC 2003/2003 started.

EC regulation 2003/2003 will be withdrawn in July 2022 and replaced by EU regulation 2019/1009. In June 2019 the new EU regulation 2019/1009 on fertilising products has been published after a long period of preparation. 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. The consequence is that RDF's may become (a component for) EU fertilising products, provided that they meet the requirements for raw materials, production and contaminants.

The new EU regulation 2019/1009 distinguishes seven product function categories (PFC's), which replace the extensive detailed list with EC-fertiliser types in the outgoing EC regulation 2033/2003. EU Fertilising products from these PFC's have to be produced exclusively from clean raw materials, which have been defined in component material categories (CMC's).

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 fertilising product, the product should comply with all provisions of the EU Regulation 2019/1009. However, producers may also choose for compliance with national legislations and regulations, which is especially of interest for products that are meant for use in the country in which they are brought to the market and that are not exported. These national fertilising products cannot be labelled with the CE marking. Trade of these fertilisers between different countries of the EU can be done according to the Mutual regulation principle.

Depending on the nature of the RDF other relevant EU Regulations and Directives should be taken into account. The most relevant ones are:

- EC Regulation 2019/51508 on Mutual recognition: for the trade of fertilising products without a CE-status between EU countries;
- EC Regulations 1069/2009 and 142/2011 on Animal By-Products: for fertilisers derived from animal by-products, like animal manure;
- The Waste Framework Directive (2008/98/EC) and the EC Regulation 1013/2006 on shipment of Waste: for recycling-derived fertilisers derived from waste;
- The Nitrate Directive (91/676/EEC): relevant for recycling-derived fertilisers that are rich in nitrogen (N), especially if those fertilisers have been derived from animal manure;
- The Sewage Sludge Directive 86/278/EEC: for recycling-derived fertilisers derived from sewage sludge;

Moreover, for all fertilising products, REACH (1907/2006) and EC/1272/2008 on classification, labelling and packaging of substances and mixtures (CLP) should be taken into account.

Most RDF's which are considered within the ReNu2Farm project could belong to one of the component material categories (CMC's) as defined in the FPR. Those RDF's that also comply to the requirements of one of the defined product function categories (PFC's) can be traded with a CE marking within the scope of the revised Fertilising Product Regulation (EU 2019/1009) from July 2022 onwards, when it will replace EC 2003/2003. Once RDF's use a CE marking, the free trade between member states within the European Union is possible.
With respect to the investigated RDF's, the following opportunities and bottlenecks are foreseen:

- The investigated ashes from incineration or gasification of sewage sludge and/or animal manure have macronutrient contents that are sufficiently high, but for the ashes from the gasification of a mixture of sewage sludge with green cuttings the macronutrient contents are too low to be classified as a Solid inorganic macronutrient

fertiliser (Product Function Category (PFC) 1 C I) a)) within the scope of EU 2019/1009. Moreover, the heavy metal contents in all ashes except from the incineration of poultry manure exceeded the threshold levels for Inorganic macronutrient fertilisers. However, the ashes could meet the criteria for CMC 13 and/or 14 and could be used as a component for a fertiliser. It depends on the properties (amongst others heavy metal contents) of the other components and the mass ratio between components, whether a PFC could be produced that meets the criteria for heavy metals, or not.

- The investigated struvites show good possibilities to get a CE mark within the scope of EU 2019/1009 and could be classified as PFC 1 C) I) a) Solid inorganic macronutrient fertiliser. However, also struvites with a higher organic matter content are brought at the market. In the case the organic C content is higher than 3% on dry matter basis, the product can not be classified as CMC 12 material and may thus not be used as a component material.
- The investigated compost from household waste has a good possibilities to get a CE mark within the scope of EU 2019/1009 and could be classified as PFC 1 A) I) Solid, organic fertiliser or PFC 3 A) Organic soil improver. Hygienisation will be a prerequisite in all cases. A prerequisite for composts derived from materials that fall under the scope of the Animal By-products Regulation is that an End point in manufacturing chain will have to be defined in the Animal By-Products (ABP) regulation, so that it can be classified in CMC 3 or CMC10 in the FPR. It is still unsure if composted manure will be considered as an end point product. Heavy metal contents of the investigated products remain below the maximum limits.
- Some of the investigated liquid N products have relatively low nutrient contents, which makes it difficult to be classified as a CE marked Fertilising product. The nutrient contents of 5 of the 9 investigated products are too low to meet the criteria of the regulation EU/2019/1009. Moreover, some liquid products have very low dry matter contents, which resulted in relatively high heavy metal contents expressed at the basis of dry matter. This could also be a limitation for getting a CE mark. For liquid products derived from Animal By-products an End point in manufacturing chain will have to be defined in the Animal By-Products (ABP) regulation, so that it can be classified in CMC 10 in the FPR. If the liquid products are classified as a CMC material they could be used as a component for a EU fertilising product. It depends on the properties (a.o. nutrient and heavy metal contents) of the other components and the mass ratio between components, whether a PFC could be produced that meets the criteria for nutrients and heavy metals, or not.
- If ashes and struvite meet the criteria for CMC's, they could be used in principle as a component for an EU Fertilising Product. However, the CMC's will still have the legal status of waste, with all the associated administrative and logistic requirements. This will hamper the production of an EU Fertilising product from these components,

especially if the Fertilising products are produced in a different country than the country where the ash and struvite are produced.

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). The main essential plant nutrients are N, P and K which are mostly combined in mineral NPK-fertilisers. Currently, in the NWE countries together there are still 5,400,000 t of N, 400,000 t of P and 6,000,000 t K as mineral fertiliser used. Fertiliser production in the EU is dependent on imported raw materials (P, K) and energy (N). Each year about 2,392 Gg of P is imported into EU-27, mostly in the form of mined rock phosphate or animal feed. Most of it ends as sewage sludge being landfilled or incinerated without further valorisation of the ashes. This is a waste of a valuable resource because rock phosphate is a limited and finite resource.

Within the scope of sustainable agriculture and a circular, bio-based economy, it is crucial to find ways to reduce quantities of non-recycled nutrients like N, P and K and to decrease the EU-dependency on nutrient import. In the NWE Interreg project ReNu2Farm we consider sewage sludge, food waste and animal manure as potential sources of recovered nutrients. The recycling-derived fertilisers considered are struvite, ashes, compost, digestates and liquid-N products from processing of manure.

Within the NWE territory, regional differences can be identified with respect to nutrient supply and demand. Hotspots with a surplus of N and P in the NWE territory are the Netherlands, Flanders in Belgium, Brittany in France and Ireland. At the same time, there are regions with potential to replace mineral N and P fertilisers: the use of mineral fertilisers is highest in Northern France, Wallonia in Belgium, East-England and Ireland. Opportunities for the replacement of nutrients from traditional mineral fertilisers by recycled fertilisers from regions with a nutrient surplus are explored within the scope of the current project.

The trade and use of recycling-derived fertilisers that are derived from various waste and (animal) by-product streams (e.g. sewage sludge, food waste) and animal manure is limited for several reasons. This hampers the proper development of the market for bio-based fertilisers. An important barrier is the legal status of the fertilisers. Because the products are often produced from waste or from animal by-products, the end products are legally 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 the EU as a fertilising product.

Within this project, we have identified the legal barriers for the trade of fertilising products. The analysis was focused on the outgoing EC 2003/2003 for fertilisers, the new

EU 2019/1009 for fertilising products, the Animal By-Product Regulations, Waste Framework Directive, Waste shipment regulation and Nitrate Directive to identify:

- differences in legal standards,
- criteria for (trans frontier) trade,
- application standards.

The legislative framework at the EU level for the trade and use of recycled fertilisers within NWE and existing legal barriers are described in the present report.

Within the scope of this project, we consider several recycling-derived fertilising products derived from the waste streams sewage sludge, food waste and animal manure. We focus on products which have been produced at least on a pilot scale and sometimes are already used in practice. A number of products has been analysed for its' composition (nutrients and heavy metals) within Work Package T1 (Saju et al., 2021). A summary of the products we consider is given in table 1.1.

Table 1.1. Classification of products considered in this study (After Saju et al., 2021).

Source material	**Treatment**	**Recovered products**
Sewage sludge	Incineration	Ash 1
	Gasification with green cuttings	Ash 3 (bed ash) Ash 4 (fly ash)
	Gasification	Ash 5
	P precipitation	Struvite 1
Food waste / household waste	Composting	Compost 1
	P-precipitation	Struvite 2
	Digestion+separation+evaporation	Mineral concentrate
	Stripping/scrubbing	Ammonia water 2
Manure	Incineration of poultry manure	Ash 2
	Blending & composting	Compost 3
	Digestion	Digestate
	Digestion + separation	P-poor solid fraction digestate
	Separation	Liquid fraction manure
	Stripping/scrubbing	Ammonium Sulphate
	Stripping/scrubbing	Ammonium nitrate
	Stripping/scrubbing	Ammoniawater 1
	Separate collection	Pig urine

Within the next chapters we are describing the legal framework that is of relevance for the trade and use of fertilising products summarized in table 1.1.

2 Legal framework overview

2.1 European Union

Marketing of fertilisers in the European Union is currently (till 15 July 2022) governed by the outgoing EC regulation 2003/2003 regarding fertilisers and by national fertilisers regulations of the member states. Depending on the nature of the recycling-derived fertilisers, also regulations on animal by-products (Regulation (EC) No 1069/2009 and 142/2011 on Animal By-products), sewage sludge (Sewage Sludge Directive 86/278/EEC) and wastes (Waste Framework Directive 2008/98/EC and Waste Shipments Regulation (EC No 1013/2006)) apply on the trade, handling and use as a fertiliser.

Most recycling-derived fertilisers (RDF's) cannot be classified as EC fertiliser within the scope of EC 2003/2003. The EC regulation 2003/2003 only deals with inorganic fertilisers. 'Inorganic fertiliser' is defined as: a fertiliser in which the declared nutrients are in the form of minerals obtained by extraction or by physical and/or chemical industrial processes.

In 2010 the EC regulation 2003/2003 has been evaluated (CSES, 2010). The evaluation resulted in several recommendations. One of the recommendations was to include criteria for contaminants. Another recommendation was to expand the list of EC fertiliser types with fertilising products from animal and plant origin.

In addition, the evaluation showed that member states used very different national legislations and standards for trade and use of fertilisers. Moreover, the rules for mutual recognition as laid down in the Regulation (EC) No 764/2008 (replaced by Regulation (EU) 2019/515) were not followed by all member states. Trade of non-EC fertilisers between countries also led to a high administrative and logistic burden because of the lack of transparancy on the legal structures in the member states, with language barriers adding to the burden. Because of these differences between member states, there was no fair level playing field for producers of similar products based in the different countries of the |EU. Because this goes against the principle of free and fair trade within the EU, the outcome of the evaluation was a direct reason to revise EC 2003/2003.

In July 2019 the Commission adopted the new Regulation (EU) 2019/1009 on Fertilising products, aiming to simplify the existing legislation, to improve the way the EU's fertiliser market works and to extend the rules to non-harmonised products, in effect those fertilisers governed by EU countries' national laws. EC regulation 2003/2003 is withdrawn in effect on 15 July 2022. The EU regulation 2019/1009 will apply from July 16 2022, giving the national authorities and producers three years to prepare for the requirements of the new regulation.

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. The consequence is that RDF's can become an EU fertilising product, provided that they meet the criteria for raw materials, production, agricultural effectivity and contaminants.

In addition to the EU fertilising product regulation, the following legislations / regulations are of relevance:

- National legislations on fertilisers (see paragraph 2.2)
- EU Regulation 2019/515 on Mutual recognition. (Regulation (EU) 2019/515 of the European Parliament and of the Council of 19 March 2019 on the mutual recognition of goods lawfully marketed in another Member State and repealing Regulation (EC) No 764/2008)

and, for recycling-derived fertilising products

- EC regulations 1069/2009 and 142/2011 on Animal By-Products
- Waste Framework Directive 2008/98/EC
- EC regulation 1013/2006 on Shipment of Waste
- Nitrate directive
- Sewage Sludge Directive 86/278/EEC.

In addition, products have to comply with the following regulations:

- EC regulation 1907/2006 (REACH) on registration, evaluation, authorisation and restriction of chemicals
- EC regulation 1272/2008 (CLP) on classification, labelling and packaging of substances and mixtures

2.2 National legislation in EU member states

The EC regulation 2003/2003 and EU Regulation 2019/1009 are facultative regulations that exist next to the continuing national legislations for the trade of fertilisers. Facultative means that a producer may choose to use a CE mark or not. If a CE mark is used, the fertilising 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 that are not exported.

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 the member states started to implement that in national legislations. This process will be finished in July 2022, because EC Fertiliser regulation 2003/2003 will be withdrawn then. In general, member states will leave their national legislations unchanged as much as possible.

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

- Belgium: Royal Decision 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.
- The Netherlands: Fertiliser Act (Meststoffenwet) and the accompanying Implementation Decree (Uitvoeringsbesluit Meststoffenwet) and Implementation Regulation (Uitvoeringsregeling Meststoffenwet).

The national legislations and their impact on the possibilities for recycling-derived fertilisers are described in more detail in another report (Van Schöll & Postma 2022).

3 EU fertiliser regulations

3.1 EC regulation 2003/2003 (applies till 15 July 2022)

EC fertilisers are regulated by outgoing Regulation (EC) No 2003/2003 on mineral fertilisers and may circulate freely within the EU single market. EC fertilisers comply with EC fertiliser type designations in the annex 1 to the regulation. They also guarantee farmers a minimum nutrient content of mineral fertilisers and overall safety, in particular for high nitrogen content ammonium nitrate fertilisers. It is the responsibility of the manufacturer to make sure that a fertiliser labelled as an 'EC Fertiliser' meets the technical and labelling requirements of the Regulation.

The key points are summarized as[1]:

- The regulation only applies to mineral fertilisers consisting of one or more plant nutrients. Other fertilisers are governed by EU countries' national legislation.
- In its Annex I, the regulation lists fertiliser types according to their specific characteristics. Once a fertiliser meets this type designation it may bear the letters 'EC'. The fertiliser may then be sold and used throughout the EU. This EC designation guarantees farmers that the fertilisers contain a minimum nutrient content and are safe to use.
- For a new type designation to be listed in the Annex I to the regulation, the manufacturer of a fertiliser corresponding to that type designation must lodge a request with a national competent authority. This request is forwarded to the European Commission, which consults the other EU countries and decides to accept or reject the application based on the advice of a committee set up by the The regulation only applies to mineral fertilisers consisting of one or more plant regulation.
- To achieve the EC status, a fertiliser must provide nutrients effectively, not harm human, animal or plant health or the environment and demonstrate it has been subject to the relevant sampling, analysis and test methods.
- Manufacturers must keep records that make it possible to trace a fertiliser while it is on the market and for a further 2 years thereafter.
- Certain basic information, such as the manufacturer's contact details and the fertiliser's main properties, must appear on packages, labelling and accompanying documents.

[1] Safe and effective fertilisers on the EU market. SUMMARY OF: Regulation (EC) No 2003/2003 relating to fertilisers (last visited 20/12/2021)
https://eur-lex.europa.eu/legal-content/EN/LSU/?uri=CELEX:32003R2003&qid=1640019462315 (

- Specific rules apply to primary and secondary inorganic nutrient fertilisers, to inorganic micro-nutrient fertilisers and to ammonium nitrate fertilisers of high nitrogen content.
- Certain product types have been added for liming materials (materials that neutralise acid soils) and agronomic fertiliser additives, as well as inhibitors (such as nitrogen inhibitors — materials that slow down or prevent nitrification).'

The quality of these EC fertilising products is regulated by criteria about:

- A description of the types of fertilisers;
- A description of the production process with most important substances;
- Requirements for minimum contents of fertilising constituents and their solubility and designated analysis methods;
- Requirements for the information about the properties of the fertiliser that should appear on packages and labels.

In the EC regulation 2003/2003 no specific criteria have however been formulated for contaminants in EC fertilisers and no maximum levels for heavy metals and organic micro pollutants exist. A number of member states has a derogation for the regulation of cadmium levels in phosphate fertilisers.

The list of fertilisers in Annex 1 of EC regulation 2003/2003 distinguishes the following categories:

1. Inorganic straight primary nutrient fertilisers (N, P and K fertilisers);
2. Inorganic compound primary nutrient fertilisers (NPK, NP, NK and PK fertilisers);
3. Inorganic fluid fertilisers;
4. Inorganic secondary nutrient fertilisers;
5. Inorganic micro-nutrient fertilisers;
6. Nitrification and urease inhibitors;
7. Liming materials.

EC regulation 2003/2003 only deals with inorganic fertilisers. 'Inorganic fertiliser' is defined as: a fertiliser in which the declared nutrients are in the form of minerals obtained by extraction or by physical and/or chemical industrial processes. Calcium cyanamide, urea and its condensation and association products, and fertilisers containing chelated or complexed micro-nutrients may, by convention, be classed as inorganic fertilisers.

EC regulation 2003/2003 does not apply to fertiliser products of biological origin and or containing nutrients of plant and/or animal origin (including animal manure). Thereby it excludes most recycling-derived fertilising products (RDF's). This exclusion complicates and hampers the free trade of RDF's. In addition, the following thresholds are also making it difficult for RDF's to become an EC fertiliser:

- The requirements for the minimum contents of fertilising constituents are quite high, which is often difficult to meet for RDF's;
- The composition of RDF's is often more variable than that of traditional mineral fertilisers and it is often difficult to meet strict requirements for the maximally allowed tolerances in fluctuations of the composition.

3.2 EU regulation 2019/1009 (applies from 16 July 2022)

3.2.1 General

The EU regulation 2019/1009 on Fertilising Products (shortened to FPR) has been adopted in June 2019 and will apply from 16 july 2022. The setup of FPR differs from the former EC Fertiliser Regulation 2003/2003. The basis is European horizontal legislation, which implies that there are obligations for the supply of information and there is a connection with other regulations about the control of environmental risks, like the Regulation on Animal By-Products (EC 1069/2009 and 142/2011) the Waste Framework Directive 2008/98/EC and EC Regulation 1907/2006 (REACH) on registration, evaluation, authorisation and restriction on chemicals.

The FPR is facultative (as was the regulation EC 2002/2003). Producers of fertilisers may choose to market their products as EU fertilising product with CE marking. If the CE marking is used, the prerequisites of EU Fertilising product Regulation 2019/1009 apply. If not, producers may still produce and trade fertilisers if those fertilisers meet criteria of national legislation. That may be of use for fertilisers that are only used within a country and that are not exported and/or for fertilisers that are exported only to one or several specific countries. For products without the CE mark the rules of EU regulation on Mutual recognition apply when they are exported within the EU.

The setup of the new EU Fertilising product Regulation 2019/1009 distinguishes the following chapters and annexes:

I. General provisions
II. Obligations of economic operators
III. Conformity of EU fertilising products
IV. Notification of conformity assessment bodies
V. Union market surveillance, control of EU fertilising products entering the union market and union safeguard procedure
VI. Delegated powers and committee procedures
VII. Amendments
VIII. Transition and final provisions

Annex 1. Product function categories (PFC's) of EU fertilising products

Annex 2. Component Material Categories (CMC's)
Annex 3. Labelling requirements
Annex 4. Conformity assessment procedures
Annex 5. EU declaration of conformity

3.2.2 Product Function Categories (PFC's)

The extensive list of mineral fertilisers and liming fertilising products in EC Regulation 2003/2003 is not maintained as such in the EU Fertilising Products Regulation 2019/1009. Instead of that list, seven product function categories (PFC's) are distinguished.

In Annex 1 of the EU Fertilising Products Regulation 2019/1009 the following PFC's are designated:

1. Fertiliser
    - A. Organic fertiliser
        - I. Solid organic fertiliser
        - II. Liquid organic fertiliser
    - B. Organo-mineral fertiliser
        - I. Solid organo-mineral fertiliser
        - II. Liquid organo-mineral fertiliser
    - C. Inorganic fertiliser
        - I. Inorganic macronutrient fertiliser including sub-categories
        - II. Inorganic micronutrient fertiliser including sub-categories
2. Liming material
3. Soil improver
    - A. Organic soil improver
    - B. Inorganic soil improver
4. Growing medium
5. Agronomic additive
    - A. Inhibitor
        - I. Nitrification inhibitor
        - II. Urease inhibitor
    - B. Chelating agent
    - C. Complexing agent
6. Plant biostimulant
    - A. Microbial plant biostimulant
    - B. Non-microbial plant biostimulant
7. Fertilising product blend

In the second part of Annex 1 of the EU Fertilising Products Regulation 2019/1009, the requirements with respect to the PFC's have been formulated. These includes minimum contents for fertilising products (e.g. nutrients, organic matter, neutralising value).

A new aspect in comparison with the outgoing EC regulation 2003/2003 is that, in addition to criteria for minimal contents of fertilising substances, criteria have been formulated for maximum allowed contents of heavy metals, organo-micropollutants, pathogens, undesired substances (e.g. plastic, glass) and decomposability of polymers. The requirements differ between the PFC's.

Fertilising products from this PFC's have to be produced exclusively from materials as defined in component material categories (CMC's;

Fertilising products defined by the PFC's shall consist exclusively of component materials complying with the requirements of one or more of the component material categories (CMC's) defined in annex II of the FPR (see paragraph 3.2.3).

If a fertilising product with CE marking is produced from a waste material complying to requirements of one or more of the CMCs, if it meets all the requirements with respect to a PFC the product will automatically have reached an end-of-waste status (Article 19). The waste-derived fertilising product will therefore no longer be subjected to the requirements and restrictions of the Waste Framework directive and the Waste Shipment Regulation. Instead it can be brought to the free internal market of the EU under the scope of the FPR without any restrictions or requirements at the national level.

3.2.3 Component Material Categories (CMC's)

Raw materials for the production of PFC's mentioned before, have to be clean and safe. For that reason, component material categories (CMC's) have been defined for materials that may be used for the production of the fertilising products. CMC's that are designated in Annex 2 of the EU Fertilising Product Regulation 2019/1009 are:

1. Virgin material substances and mixes;
2. Non-processed or mechanically processed plants, plant parts or plant extracts;
3. Compost;
4. Energy crop digestate;
5. Other digestate than energy crop digestate;
6. Food industry by-products;
7. Micro-organisms;
8. Nutrient polymers;
9. Polymers other than nutrient polymers;
10. Derived products within the meaning of Regulation (EC) No 1069/2009 (certain animal by-products);
11. By-products within the meaning of Directive 2008/98/EC (certain industrial by-products and ammnonium salts recovered during production processes);

In addition, the following CMC's have been added to annex 2 (amendments by delegated regulations, in force from 16 July 2022; see paragraph § 3.2.5 Strubias below):

12. Precipitated phosphate salts or derivates (including struvietes)

13. Thermal oxidation materials or derivates (including ashes)
14. Pyrolysis or gasification materials.

A proposal for very pure materials that are recovered from waste or animal by-products has been made by the EC-JRC (2021).

15. Recovered high purity materials (under consultation, including certain ammonium salts recovered from waste and or manure)

The second part of Annex II of the EU Fertilising Products Regulation 2019/1009, the specific requirements with respect to the different CMC's have been formulated. The requirements differ between the CMC's depending on material characteristics and risks. In most cases it gives a precise description of the requirements of the starting materials that may be used, the way it is produced and processed , the maximum allowed contents of potential contaminants that are not regulated at the PFC level, and/or the minimum requirements of other quality characteristics. For certain CMC materials, a REACH registration is required.

A recycling-derived or waste product that belongs to one of the CMC's does not get an end-of-waste status. Only the final EU fertilising product belonging to one of the PFC's with the CE marking will obtain the end-of-waste status. The consequence is that, if a recycling-derived product is produced from waste and used as a component material (such as struvite, compost, ashes) it keeps the waste status during transport and processing.

The waste status will limit the practical possibilities to use a material as a component for a fertilising product because of extensive logistic, administrative and financial obligations on the handling, use and transport of waste (see §5.3). This becomes even more stringent if the CMC material has to be transported to an EU fertilising production site in another EU country (see § 5.4) , especially if the fertiliser is produced in a different country than the country where the CMC is produced.

3.2.4 Conformity assessment procedures

Producers of EU fertilising products have to demonstrate that EU fertilising products made available on the market comply with the requirements of the Regulation. Also, the competent authorities in the different countries of the EU need harmonised standards and instructions for the verification of the EU fertilising products. The assessment procedures should be in proportion to the level of risk involved and the level of safety required.

Therefore, in Articles 13-41 and Annex IV of the EU Fertilising Products Regulation 2019/1009 it is described how the conformity assessment procedures with respect to EU Fertilising products will be organised. Four types of procedures may apply:

- Module A – internal production control
- Module A1 – internal production control plus supervised product testing (for ammoniumnitrate fertilisers with high N content)
- Module B – EU type examination followed by Module C – conformity to type based on internal production control
- Module D1 – quality assurance of the production process

The higher the risks involved in the production of a fertilising product, the more requirements are part of the assessment procedure. Module A is the module with the lowest risks, and only requires an internal production control, whereas in modules B and C a notified body examines the technical design of an EU fertilising product and verifies and attests that the technical design of the EU fertilising product meets the requirements of the Regulation. Finally, module D1 is considered as the module with the highest risk and requires a quality assurance of the production process. For most recycling-derived fertilising products the module D1 will be required.

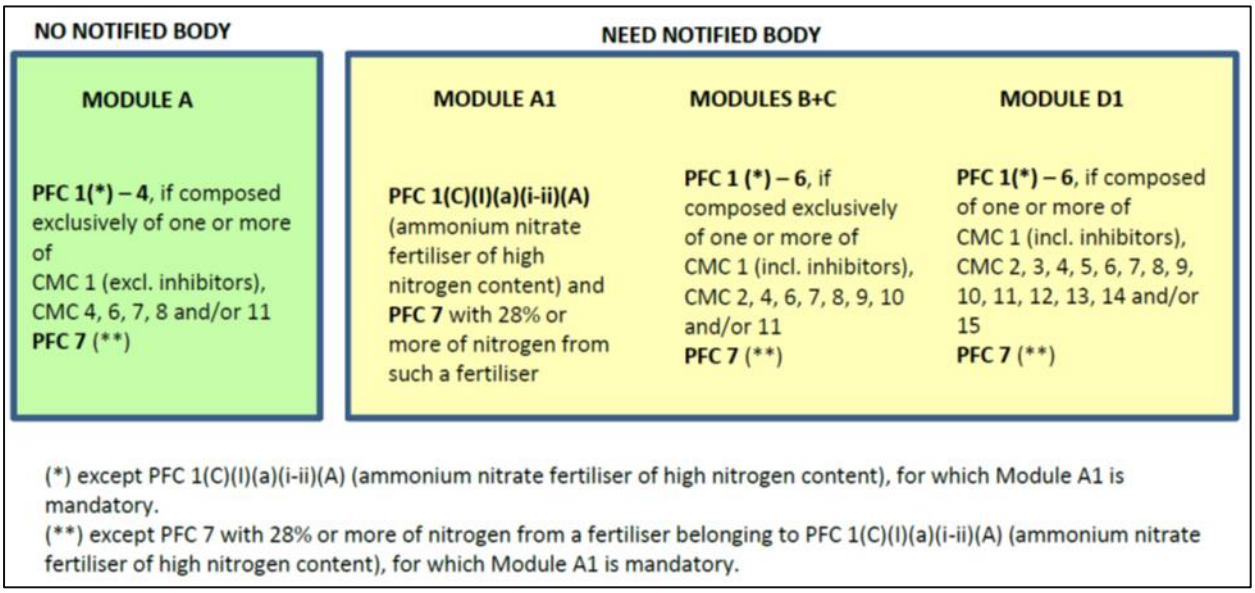

Figure 1 Schematic presentation of the relevant conformity assessment procedure depending on PFC's and CMC's used (source: FAQ document on the FPR, Commission services, version 21/12/2021)

3.2.5 Strubias

The European Commission has asked Joint Research Centre (JRC) to perform a study with the objective to evaluate a possible legal framework for the production of safe and effective fertilisers from the recovered, secondary raw materials struvite, ashes and biochar. These materials did initially not come under the scope of the regulation

EU/2019/1009 on fertilising products but it was recognised that these materials were becoming a substantial source of recovered phosphate within the EU. Because these materials are recovered from waste, they keep the waste status, while there is a market demand for fertilising products based on these recovered products. The acronym STRUBIAS (STRUvite, BIochar, or incineration AShes) was initially chosen as the working title for this project. Throughout the course of the STRUBIAS project, the scope of the CMC's has widened and the description of the considered products has been changed to precipitated phosphate salts, thermal oxidation materials and pyrolysis or gasification materials. The final report has been published (Huygens et al., 2019-II) and proposals for descriptions an criteria of the CMC's have been made and are discussed in various working groups. The CMC's 12,13 and 14 have been added to Annex II of the EU Fertilising Products Regulation 2019/1009 in 2021 by delegated regulation amending EU/2019/1009. They will apply from 16 July 2022.

4 Consequences for RDF products

4.1 Ashes

Ashes should be distinguished at the basis of its' production method. Ashes from incineration could in principle be classified as CMC 13 Thermal oxidation materials or derivates. Ashes from gasification could in principle be classified as CMC 14 Pyrolysis and gasification materials.

The ashes 1 and 2 are produced by incineration and should be evaluated at the basis of CMC 13. Maximum limits have been formulated for PAH_{16} and PCDD/F and for chromium (Cr), thallium (Tl), chlorine (Cl) and vanadium (V). No data are available at this moment for those substances, except for Cr. The Cr-content of ashes 1 and 2 are lower than the limits for Cr.

The ash 3, 4 and 5 are result from gasification and should be evaluated at the basis of CMC 14. Maximum limits have been formulated for H/Corg, PAH and PCDD/F, dl-PCB, chlorine (Cl) and thallium (Tl). No data are available at this moment for those substances.

If the ashes meet the criteria for either CMC 13 or 14, they may be used as a component for an EU fertilising product as defined by a PFC definition. Based on its' properties and fertilising components, ashes could be classified as PFC 1)C)I)a)i *Straight solid inorganic macronutrient fertiliser* or as PFC 1)C)I)a)ii) *Compound solid inorganic macronutrient fertiliser*. The contents of fertilising nutrients should be at least as high as minimum limits, while contaminants like pathogenic micro-organisms and heavy metals should not exceed maximum limits.

In more detail, the requirements with respect to macronutrients differ between the types of fertilisers:

Straight inorganic macronutrient fertiliser:

a) Only one declared macronutrient with content of at least:
   10%N or 12% P2O5 or 6%K2O or 5%MgO or 12%CaO or 10%SO3 or 1% - 40% Na2O
b) One declared primary macronutrient and one or more declared secondary macronutrient
   (N or P2O5 or K2O ≥3%) and (MgO and/or CaO and/or SO3≥1,5%) and/or (NaO≥`1%≤40%), with the sum of the declared nutrients ≥18%

Compound inorganic macronutrient fertiliser:

a) Two or three declared primary nutrients (N and/or P2O5 and/or K2O) ≥3%, and with the total of declared primary nutrients ≥18%, or
b) Two or more declared secondary nutrients 2a2(MgO and/or CaO and/or SO3≥1,5% and/or NaO≥`1%≤40%) and no declared primary nutrient and total of declared nutrients ≥18%

From table 3.1 it cab be seen that the ashes of incineration or gasification of sewage sludge or poultry manure meet the PFC requirements for the minimum contents of macronutrients for a straight or compound solid inorganic macronutrient fertiliser. However, the bed ash3 and the fly ash 4 resulting from the gasification of sewage sludge mixed with green waste had too low contents of macronutrients to comply with the PFC criteria for either straight or compound or PFC criteria solid inorganic macronutrient fertiliser (PFC 1 C I) a)).

Table 3.1. 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
Minimum limit PFC 1) C) I) a) i)a					10	12	6	5	12	10	1
Minimum limit PFC 1) C) I) a) i)b					(3,0	3,0	3,0)	(1,5	1,5	1,5	1,0)
Minimum limit PFC 1) C) I) a) ii)a					3,0	3,0	3,0				
Minimum limit PFC 1) C) I) a) ii)b								1,5	1,5	1,5	1,0

(1) sum of contents of one declared primary nutrient and one or more secondary macronutrient

(2) sum of contents of two or more declared primary macronutrients

(3) sum of contents of two or more declared secondary nutrients

(Declared nutrients: nutrients that are present in at least the minimum required content for the relevant PFC)

In addition, threshold levels for heavy metals are set. For straight or compound solid inorganic macronutrient fertiliser (PFC1C) these are shown in the last line of Table 3.2. As can be seen form the contents or heavy metals in the ashes (Table 3.2), thresholds are exceeded in all the ash products, except -depending on the laboratory- the ashes from poultry manure. Therefore, the ashes do not qualify as a solid inorganic macronutrient fertiliser (PFC 1 C I) a)). For chromium the measurements have been done on Cr-total, whereas the regulation EU/2019/1009 sets a threshold for Cr(IV).

However, if the ashes meet the criteria for CMC 13 or 14, they may be still used as a component for the production of a fertiliser. In that case, the heavy metal contents of the ashes and other components should be balanced to produce a EU fertilising product that does meet the criteria of the PFC. However, for the fly ash 4 this does not seem feasable, because the limit for Ni was exceeded more than 54 (!) times.

Table 3.2. Average contents of heavy metals (in mg/kg DM) in 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 (source: Saju et al., 2021). Numbers in red exceed the maximum limits of PFC 1 C I).

Product	laboratory	Cd	Cr	Cu	Ni	Pb	Zn	As
Ash 1	UGhent	3,4	*73*	426	45	11	1228	n.d.
	ULimerick	0,3	*112*	609	59	20	1797	n.d.
Ash 2	UGhent	0,7	*14*	296	17	78	1417	n.d.
	ULimerick	1,0	*20*	417	22	37	1940	n.d.
Ash 3	UGhent	4,6	*155*	9	345	63	48	n.d.
Ash 4	UGhent	5,8	*7037*	278	4812	232	1061	n.d.
Ash 5	UGhent	6.7	*76*	401	57	7	1961	n.d.
Maximum limit PFC 1) C) I)		3.0 [1)]	2 [2)]	600	100	120	1500	40

1) *If the P2O5 content < 5%, then Cd content should be lower then 3 mg/kg DM; if the P2O5 content > 5%, the Cd content should be lower then 60 mg/kg P2O5.*
2) *This is the maximum limit for Cr VI, not for total Cr.*

4.2 Struvites

Struvites can be classified as CMC 12 Precipitated phosphate salts or derivates. The struvite products should contain at least 16% P2O5 at dry matter basis and at maximum 3% organic carbon at dry matter basis. Dry matter content has to be analysed on samples by continuous drying at 40°C. Moreover, maximum limits are set for macroscopic impurities, pathogenic micro-organisms (*Salmonella* and *E. coli* or *Enterococcaceae),* PAH

and aluminium (Al) and iron (Fe). Struvites from waste waters or sludges from municipal waste water treatment plants limits are set for *Clostridium perfringens* and *Ascaris sp.*.

Struvite is a product requiring specific methods or analysis. Harmonised standards for analysis of struvite will be derived by the CEN, but were not yet available at the time of this study. The content in the struvite products considered here has been analysed by different laboratories (Table 3.3). The dry weight has been measured as weight loss over drying at 105°C, resulting in an overestimation of the moisture content, as the ammonium and crystal water contained in the struvite ($Mg(NH_4)PO_4 \cdot 6H_2O$ for pure struvite) will also evaporate at this temperature. The dry matter contents between 51-61% are unrealistically low for a solid product. Likewise, the organic matter content has been determined by a loss on ignition at 550°C, which also gives an overestimation due to evaporation of crystal water, ammonium and carbonates. This is evidenced by comparing the contents of organic C to the content of organic matter, which would be expected to have a ratio of C_{org} = 0,56xOrganic matter, where the results of laboratories of University of Ghent indicate a ratio of Corg= <0.005 OM. The contents of P2O5 as measured by the laboratories of the University of Ghent and Arvalis were in the expected range for struvites (28% on dry weight for pure struvite). It is not clear why the results from the laboratory of the University of Limerick are much lower.

Struvites that meet the criteria for CMC 12 may be used as a component for a PFC. Based on its' properties and fertilising components, struvite could be classified as PFC 1)C I)a.i)Straight or ii)Compound solid inorganic macronutrient fertiliser. The contents of fertilising nutrients should be above minimum limits, while contaminants like pathogenic micro-organisms and heavy metals may not exceed threshold limits. Based on the analysis results, it can be concluded that minimum limits for fertilising nutrients will be met (Table 3.3). Heavy metal contents are sufficiently low, so that limits will not be exceeded (Table 3.4). For chromium this could not be established, as this was measured as Cr-total, whereas the EU/2019/1009 set a threshold limit for Cr(IV).

The struvites also have to be registered under the REACH regulation.

Table 3.3. 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, %	Na2 O, %
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
Minimum limit PFC 1) C) I) a) i)					10	12	6	5	12	10	1
Minimum limit PFC 1) C) I) a) ii)					3.0	3.0	3.0	1.5	1.5	1.5	1.0

Table 3.4. Average contents of heavy metals (in mg/kg DM) 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 (source: Saju et al., 2021).

Product	laboratory	Cd	Cr	Cu	Ni	Pb	Zn	As
Struvite 1	UGhent	0,1	*1,9*	0,73	0,18	0,09	4,6	n.d.
	ULimerick	0,15	*2,3*	0,32	0,6	2	4,4	n.d.
Struvite 2	UGhent	0,08	*1,7*	0,7	0,89	0,08	4	
	ULimerick	0,15	*2,8*	0,49	0,6	2	4,1	n.d.
Maximum limit PFC 1) C) I)		3,0 [1)]	2 [2)]	600	100	120	1500	40

1) If the P_2O_5 content < 5%, then Cd content should be lower then 3 mg/kg DM; if the P_2O_5 content > 5%, the Cd content should be lower then 60 mg/kg P_2O_5.

2) This is the maximum limit for Cr VI, not for total Cr.

4.3 Compost

Composts may be classified as CMC 3 and may be produced from biowaste (like organic household waste, provided that it has collected separately from regular, non-organic household waste), from products derived from animal by-products that are designated as an organic fertiliser or soil improver under EC 2009/169 (ABP regulation), *provided that these have reached an end point in the manufacturing chain (see further)*, or from living or dead organisms or parts thereof except from the organic fraction of non-seperated collected household waste, sludge or animal by-product falling under the scope of EG/1069/2009.

In addition, CMC 10 will define products derived from animal by-products that may be used as a component material, *provided that they have reached an end point in the*

manufacturing chain. However, the table with the listing and specification of the ABP intended has not yet been released.

As has been indicated before, for CMC 3, each batch shall be regularly moved and turned during the composting process and shall show a minimum temperature-time profile, to ensure a correct sanitation and homogeneity of the material. The following requirements with respect to temperature and time will be applicable:

- At least 3 days at 70°C
- At least 5 days at 65°C
- At least 7 days at 60°C
- At least 14 days at 55°C.

Moreover, requirements for the maximum allowed contents of contaminants have been defined with respect to PAH's, glass, metals and plastics. Finally, requirements for the stability of the compost have been formulated.

If the composts meet the criteria of CMC 3 (household waste compost) or CMC 10 (composted animal manure), they may be used as a component for one of the PFC's. If the compost is to be used directly as PFC, it could potentially be classified as PFC 1 A) I) solid organic fertiliser. In that case the organic carbon (C) content should be at least 15% (about 30% organic matter) on fresh matter basis. This is not always the case with the composts from animal manure, which have a dry matter content between 32 and 62% and a Corg between 11-21% (Table 3.5). Another option is to classify the compost as PFC 3 A) Organic soil improver. In that case, the dry matter content should be at least 20% and the organic C content should be at least 7,5% on fresh matter basis, equivalent to 15% organic matter. This requirement is met by all the compost products considered here.

Table 3.5. 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
Minimum limit PFC 1 A) I) or 3 A)		20	15-7.5	1.0	1.0	1.0				

If it is classified as solid organic fertiliser, additional requirements have been formulated for minimum nutrient contents (> 1% N, > 1% P_2O_5 or > 1% K_2O ánd the sum of N, P and K is at least 4%). This is the case for all composts (Table 3.5). Moreover, heavy metal content should not exceed threshold values. The contents of heavy metals analysed in the investigated composts are shown in table 3.6. The contents of copper, zinc, lead and nickel are below the threshold limits set. For cadmium and chromium, this could however not be established: the detection limit for Cd was above the threshold set in the regulation EU/2019/1009, and chromium was measured as Cr-total, whereas the regulation EU/2019/1009 set a threshold for Cr(VI). Quicksilver and arsenic have not been analysed.

If the composts are classified as organic soil improver, there are no additional requirements for minimum nutrient contents, but maximum contents for heavy metals and pathogens have been formulated. The limits for heavy metals are similar with that of organic fertilisers (table 3.6).

Table 3.6. Average contents of heavy metals (in mg/kg DM) 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	Cd	Cr	Cu	Hg	Ni	Pb	Zn	As
Compost 1	UGhent	*<3,3*	*14*	90		<25	<63	374	n.d.
Compost 2	UGhent	*<3,3*	*5,3*	102		<25	<63	377	n.d.
Compost 3	UGhent	*<3,3*	*15*	106		<25	<63	480	n.d.
Compost 4	UGhent	*<3,3*	*22*	119		<25	<63	502	n.d.
	Arvalis	<0,12	*24*	70		7,5	3	92	n.d.
Maximum limit PFC 1 A) or 3 A)		1,5-2	2 [2)]	300	1	50	120	800	40

1) This is the maximum limit for Cr VI, not for total Cr.

4.4 Digestates

Digestates can be classified as CMC 4: Fresh crop digestate or as CMC 5: Digestate other than fresh crop digestate. It may be produced from energy crops (CMC4) or (CMC5) from biowaste (like organic household waste, provided that it has collected separately from regular, non-organic household waste) or products derived from animal by-products that are designated as an organic fertiliser or soil improver under EC 2009/169 (ABP regulation), *provided that these have reached an end point in the manufacturing chain (see below)*, or from living or dead organisms or parts thereof except from the organic fraction of non-seperated collected household waste, sludge or animal by-product falling under the scope of EG/1069/2009.

Animal by-products that are treated in such a way that they are considered safe to be used without any restrictions as set in the regulation EG//1069/2009 on animal by-products are considered to have reached the end point of the manufacturing chain. These products are listed in the implementation regulation EC/142/2011. Products that have reached the end point do not fall within the scope of the EU/1069/2009 anymore. Digestates are not listed as products that have reached an end point and it is not clear whether they will be included.

In addition, CMC 10 will define products derived from animal by-products that may be used as a component material, *provided that they have reached an end point in the manufacturing chain*. However, the CMC10 table with the listing and specification of the ABP intended has not yet been released and it is unknown if digestates will be added.

During the thermophilic or mesophilic digestion, each batch shall be regularly moved and turned and shall show a minimum temperature-time profile, to ensure a correct sanitation and homogeneity of the material. The requirements with respect to pasteurisation depend on the temperature of digestion and whether the digestion is a thermophilic or mesophilic process.

Moreover, requirements for the maximum allowed contents of contaminants have been defined with respect to PAH's, glass, metals and plastics. Finally, requirements for the stability of the digestates have been formulated.
If the digestates meet the criteria of CMC 4 (energy crops) or CMC 5 (other digestates) or CMC 10 (for digestates at the basis of animal manure), they may be used as a component for one of the PFC's.

If it is used directly as PFC, digestate could potentially be classified as PFC 1 A) 1) solid organic fertiliser or, depending on dry matter content, as a PFC1 A) 2) liquid organic fertiliser. In that case the organic carbon (C) content should be at least 15% for solid and 5% for liquid digestate on fresh matter basis. Another option is to classify it as PFC 3 A) Organic soil improver. In that case, the dry matter content should be at least 20% and the organic C content should be at least 7,5% on fresh matter basis. This criterium is not met by the solid fraction of the digestate not by the unprocessed digestate in this study (Table 3.7).

Table 3.7. Average contents (in % of fresh matter) of dry matter (DM), organic carbon (Corg) and macronutrients in the digestate or solid fraction of digestate, analysed by laboratory of University of Ghent (source: Saju et al., 2021).

Product	laboratory	DM, %	Corg%	N %	P2O5, %	K2O, %	SO3, %	CaO, %	MgO, %	Na2O, %	Sum, %
Solid fraction of separated digestate	UGhent	39	13	0,6	0,3	0,0	1,3	0,9	0,1	0,0	
Digestate	UGhent	16	3,6	0,5	0,6	0,4	0,3	0,6	0,2	0,2	
Minimum limit PFC 1 A) 1)			15	1,0	1,0	1,0					4
Minimum limit PFC 1 A) 2)			5	1	1	1					3
Minimum limit PFC 3 A)		20	7.5	1,0	1,0	1,0					

In addition, maximum contents for heavy metals and pathogens have been formulated for organic fertilisers and organic soil improvers. The contents of heavy metals analysed in the investigated digestates are shown in table 3.8. The contents of copper, zinc, lead and nickel are below the threshold limits set. For cadmium and chromium, this could however not be established: the detection limit for Cd was above the threshold set in the regulation EU/2019/1009, and chromium was measured as Cr-total, whereas the regulation EU/2019/1009 set a threshold for Cr(VI). Quicksilver and arsenic have not been analysed.

Table 3.8. Average contents of heavy metals (in mg/kg DM) in in the digestate or solid fraction of digestate, analysed by laboratory of University of Ghent (source: Saju et al., 2021).

Product	**laboratory**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**	**As**
Solid fraction of separated digestate	UGhent	*<3.3*	*15*	72	n.d.	<25	<63	200	n.d.
Digestate	UGhent	*<3.3*	*14*	228	n.d.	<25	<63	485	n.d.
Maximum limit PFC 1 A) or 3 A)		1,5-2	2 [1)]	300	1	50	120	800	40

1) *This is the maximum limit for Cr VI, not for total Cr.*

4.5 Liquid N containing products

Liquid N containing products, like mineral concentrates, digestates, liquid fraction of manure or digestate, ammonium sulphate, ammonium nitrate, ammonia water and pig urine, can be made from various raw products (e.g. food waste vs. manure,) and production processes (e.g. digestion+separation; stripping and/or scrubbing, etc.). For the products considered here (Table 2.1) the raw materials and production processes are

described in Saju et al. (2021). Based on the raw product and production process they could be classified as CMC 5, 6, 11,15 or possibly 10.

In general, hygienisation is a requirement for all mentioned CMC's. CMC 10 will define products derived from animal by-products that may be used as a component material, *provided that they have reached an end point in the manufacturing chain*. However, the table with the listing and specification of the ABP belonging to CMC 10 has not yet been released.

Most products could be classified as PFC 1 C) I) b) Liquid inorganic macronutrient fertiliser. If it is a single fertiliser the nutrient content should exceed minimum limits (e.g. at least 5% N or at least 1,5% N ánd 0,75% SO3 and the sum of all declared nutrients should be at least 7%) and if it is a compound fertiliser, the limit for minimum nutrient contents are similar (e.g. at least 1,5% N ánd 0,75% SO3 and the sum of all declared nutrients should be at least 7%). This is not the case for all investigated liquid products. In some cases the nutrient contents are lower than the required minimum contents (table 3.7). If however the products classify as a CMC they may be used as a as a component for the production of an EU fertilising product. In dependence of the properties (a.o. nutrients and heavy metal contents) of the other components and the mass ratio between the components, a PFC could be produced that meets the criteria for nutrients and heavy metals.

Table 3.9. Average contents (in % of fresh matter) of dry matter (DM), organic matter (OM) and macronutrients in a number of liquid N containing products, analysed by laboratory of University of Ghent (source: Saju et al., 2020).

Product	**DM ,**	**OM, %DM**	**N**	**P2O5 ,**	**K2 O,**	**SO 3,**	**CaO**	**MgO**	**Na2O**	
AS	25	n.d	**3,9**	0,0	0,0	**7,1**	0,0	0,0	0,0	**11,1**
AN	23	n.d	**8.2**	0,0	0,0	0,0	0,0	0,0	0,0	5,7
AW1	0,1	n.d	**10,7**	0,0	0,0	0,1	0,0	0,0	0,0	10,8
Pig urine	2,2	36	0,6	0,0	0,4	0,2	0,0	0,0	0,2	1,4
MC-FW	3	55	0,3	0,0	0,3	1,3	0,0	0,0	0,3	2,3
AW2	0,1	n.d	**16,8**	0,0	0,0	0,0	0,0	0,0	0,0	16,8
CON-FW	13	62	0,5	0,2	1,2	0,3	0,1	0,0	2,0	4,5
LFDig	2	35	0,5	0,1	0,4	0,0	0,0	0,0	0,1	1,1
LFMan	1,6	41	0,3	0,0	0,3	0,1	0,0	0,0	0,1	0,8
PFC 1 C) I) b)			1,5-5,0	1,5	1,5	0,75	0,75	0,75	0,50-40	7,0

Heavy metal contents are generally low at fresh matter basis, but within the scope of EU 2019/1009 they are evaluated at the basis of dry matter. The detection limits are generally below the threshold levels for heavy metals set in the regulation EU/2019/1009 relatively high, except for the detection limit for Cd as measured in the CON-FW (concentrate after evaporation of liquid fraction of food waste. The heavy metals contents in the liquid N products are generally below the threshold levels set in EU/2019/1009. Chromium was measured as Cr-total, whereas the threshold level in EU/2019/1009 is set for Cr(VI). Except for the product Con-FW, the contents of Cr-total were lower than the threshold limits Cr(VI) (table 3.10). The content of Cd in the liquid fraction of manure (LFMan) exceeded the threshold limit.

Table 3.10. Average contents of heavy metals (in mg/kg DM) in a number of liquid N products, analysed by laboratory of University of Ghent (source: Saju et al., 2021).

Product	Cd	Cr	Cu	Ni	Pb	Zn	As
AS	<0.16	0,23	0,12	<1.3	<3.1	4,5	n.d.
AN	<0.16	0,25	0,01	<1.3	<3.1	0,71	n.d.
AW1	<0.16	0,13	0,23	<1.3	<3.1	0,98	n.d.
Pig urine	<0.16	0,14	0,25	<1.3	<3.1	0,55	
MC-FW	<0.16	1,1	0,01	<1.3	<3.1	0,76	n.d.
AW2	<0.16	0	0,25	<1.3	<3.1	0	n.d.
CON-FW	*<3,3*	*145*	0,15	3,1	<63	3,3	n.d.
LFDig	<0.16	0,28	0,74	<1.3	<3.1	3,1	
LFMan	10	0,31	13	22	<3.1	22	
Maximum lim PFC 1) C) I)	3,0 [1)]	2 [2)]	600	100	120	1500	40

1) If the P_2O_5 content < 5%, then Cd content should be lower then 3 mg/kg DM; if the P_2O_5 content > 5%, the Cd content should be lower then 60 mg/kg P_2O_5.

2) This is the maximum limit for Cr VI, not for total Cr.

5 Other EU Regulations and Directives

In addition to the Fertiliser Regulation EC 2003/2003 and the Fertilising product Regulation (FPR) EU 2019/1009, the following EU Regulations and Directives are of relevance for the trade and use of recycling-derived fertilisers:

- EC Regulation 2019/515 on Mutual recognition for the trade of fertilising products without a CE-status between EU countries (5.1);
- EC Regulations 1069/2009 and 142/2011 on Animal By-Products for fertilisers derived from animal by-products, like animal manure (5.2);
- The Waste Framework Directive (2008/98/EC) and the EC Regulation 1013/2006 on shipment of Waste are of relevance for fertilisers derived from waste (5.3 and 5.4);
- The Nitrate Directive (91/676/EEC) is of relevance for recycling-derived fertilisers that are rich in nitrogen (N), especially if those fertilisers have been derived from animal manure (5.5);
- The Sewage Sludge Directive 86/278/EEC for products derived from sewage sludge (45.6);
- Moreover, for all EU fertilisers, REACH (1907/2006) and EC regulation 1272/2008 on classification, labelling and packaging of substances and mixtures (5.7 and 5.8 respectively) should be taken into account.

In Article 24 of the FPR EU 2019/1009 it is indicated that the 'Regulation should not prevent the application of existing Union legislation relating to aspects of protection of human, animal and plant health, of safety and of the environment not covered by this Regulation.' The 'Regulation should therefore apply without prejudice to…' a list of 16 Regulations and Directives, amongst which the Nitrates Directive 91/676/EEC, EC Regulation 1907/2006 and EC Regulation 1272/2008. So, the Regulations and Directives described below, don't give a complete overview of all relevant Regulations and Directives, but it are the most relevant ones within the scope of the ReNu2Farm project.

5.1 EC Regulation 2019/515 on Mutual recognition

The aim of this regulation is to ensure the free movement of goods on the Internal Market in the non-harmonised area of the EU through mutual recognition between Member States. It obliges Member States to accept products lawfully marketed in other Member States unless the Member State of destination can demonstrate that the product poses a risk for human health or the environment.

This regulation is of relevance for the trade of fertilising products without a CE-status between EU countries. Once a CE-status has been obtained, there will be no limitations anymore for the free trade of fertilisers.

In principle, mutual recognition should be provided for fertilising products, so that a product will get access to the internal market when it is recognized as fertilising product in a member state. In practice, all member states have national fertiliser legislation with definitions, requirements and criteria that have to be fulfilled. These differ between member states, and different procedures have to be followed in every member state. Lack of transparency of the legal structures relating to fertilisers, especially recycled-derived fertilisers, pose a significant barrier to the producers of non-EC fertilising products. Moreover, there will often be a language barrier. As national legislation of most countries is only published in the language of the member state, it is often not available in an appropriate form for other countries (depending on the language). A request for a recognition as fertiliser in various countries might be time consuming and there is a risk that double work has to be done.

The Mutual Recognition Regulation should offer a scope for the admission of fertilising products even if they do not meet all the requirements from the technical rules. It should be noted however, that most member states define the requirements as a measure to protect the health and life of humans, animals or plants. This is one of the defences that may be used by Member States to justify national measures that impede cross-border trade (TFEU Treaty on the functioning of the European Union, article 36).

The implementation of the principles of the Mutual Recognition Regulation appears to be problematic for many Member States. They are reluctant to accept national authorisations delivered by other Member States, as they are not convinced that the requirements relating to the protection of human health or the environment are equivalent to their own. This is seriously affecting the free movement of national fertilisers on the Internal Market and hence obliges operators to apply for authorisation of their products according to separate national procedures.

5.2 EU regulation 1069/2009 on Animal By-products

The Animal By-Products (ABP) regulation lays down public health and animal health rules for animal by-products (=entire bodies or parts of animals which are not intended for human consumption) and derived products (=items obtained from processing of animal by-products). These are designed to prevent and minimise risks to human and animal health and to ensure the food and feed chain is safe.

Within the regulation three categories of animal by-products are distinguished, which differ in its' risk for public and animal health. Materials in category 1 show the highest risk and in category 3 the lowest. Animal manure is considered as an animal by-product and is classified as category 2 material, while bone meal, blood meal, feather meal etc. of healthy animals are classified in category 3. All fertilising products that contain animal manure are regulated by legislation on animal by-products. Organic fertilisers and soil

improvers from animal by-products may be placed at the EU market, with the following prerequisites (Article 32):

- They are derived from category 2 or category 3 material;
- They have been produced according to the conditions of pressure sterilisation or similar;
- They come from approved establishments or plants;
- If produced from meat-and-bone meal, provisions should be taken to prevent that it is used as animal feed.

Within the Animal By-Product Regulation, obligations for operators have been formulated with respect to the collection, transport and traceability (Section 1), for registration and approval (Section 2) and for own checks, hazard analysis and critical control points (Section 3). Additional requirements have been formulated for imports and exports. These obligations and additional requirements form an administrative, logistic and financial burden on the (transnational) trade and transport of fertilising products (derived from) animal by-products, as each step in the chain (production site, transporter, vehicle, storage site and end receiver) has to registered, approved, controlled and certified, and each shipment has to be notified with an extensive track and trace system.

These obligations apply until an animal by-product has reached an End point in the manufacturing chain (Article 5), beyond which they are no longer subject to the requirements of the ABP regulation. Those end point products may subsequently be placed on the market without the restrictions under this regulation and shall no longer be subject to controls in accordance with this regulation.

Up till now, no end point of the manufacturing chain has been declared for any animal-by product derived fertilising products. This hinders the development of transnational market for these products. Especially for high quality animal by-product derived fertilisers such as ammonium nitrate and ammonium sulphate from stripping and/or scrubbing processes this implies that there is no fair level playing field. These products have the restrictions from the ABP regulations based only on their origin whereas they cannot be chemically distinguished from chemically produced fertilisers that can be marketed without these restrictions .

In the Fertilising Product Regulation 2019/1009 it is announced (in Article 46) that Article 5 of the Animal By-Product Regulation will be modified using the following text parts (among others):

1. *For derived products referred to in Articles 32 (about organic fertilisers and soil improvers), 35 and 36 which no longer pose any significant risk to public or animal health, an end point in the manufacturing chain may be determined, beyond which they are no longer subject to the requirements of this Regulation.*

Those derived products may subsequently be placed on the market without restrictions under this Regulation and shall no longer be subject to official controls in accordance with this Regulation.

……..

4. *Within six months after 15 July 2019, the Commission shall initiate a first assessment of derived products referred to in Article 32 that are already widely used in the Union as organic fertilisers and soil improvers. This assessment shall cover at least the following products: meat meal, bone meal, meat-and-bone meal, hydrolysed proteins of Category 3 materials, processed manure, compost, biogas digestion residues, feather meal, ….. **Where the assessment concludes that those derived products no longer pose any significant risk to public or animal health, the Commission shall determine an end point in the manufacturing chain ….**.'.*

This is important for the free trade of fertilisers based on animal manure and other animal by-products from category 2 and 3, because that means that all the restrictions for animal by-products are no longer of relevance once the products have reached the end point in the manufacturing chain.

Consequences:

- the use, marketing and (trans) national transport of animal by-products or derived products is regulated at EU level;
- obligations and restrictions from animal by-product regulation ensure safety for animal and human health but at the same time pose an administrative, logistic and financial burden for producers and users;
- an end-point can be derived once products are treated so that they pose no risk for animal or human health. These products are not subject anymore to restrictions and obligations from ABP regulation;
- end points have not been declared for fertilisers derived from animal by-products, but the EC has commissioned an assessment of derived products to be used as an EU fertilising product and obtain the end point of the manufacturing chain.

5.3 Directive 2008/98/EC on waste (Waste Framework Directive)

The Waste Framework Directive (Directive 2008/98/EC) aims to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use. It establishes a legal framework for treating waste in the EU.

The Waste Framework Directive sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling and recovery. It explains when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste

criteria), and how to distinguish between waste and by-products. The Directive lays down some basic waste management principles: it requires that waste is managed without endangering human health and harming the environment, and in particular without risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest. Waste legislation and policy of the EU Member States shall apply as a priority order the following waste management hierarchy: prevention, re-use, recovery for other purposes such as energy and disposal.

The Directive introduced the "polluter pays principle" and the "extended producer responsibility". It includes recycling and recovery targets. The Directive requires that Member States adopt waste management plans and waste prevention programmes.

Producers or holders of waste must treat it themselves or have it handled by an officially recognised operator. They require a permit and are inspected periodically. Competent national authorities must establish waste management plans and waste prevention programmes.

The waste framework directive strictly defines ‘products’, ‘by-products’ and ‘waste products’. It also gives the criteria for an End-of-Waste status.

Specified waste may get an end-of-waste status (Article 6) ‘when it has undergone a recovery, including recycling, operation and complies with specific criteria to be developed in accordance with the following conditions:

- the substance or object is commonly used for specific purposes
- a market or demand exists for such a substance or object
- the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and
- the use of the substance or object will not lead to overall adverse environmental or human health impacts.
- The criteria shall include limit values for pollutants where necessary and shall take into account any possible adverse environmental effects of the substance or object.’

It proves very difficult to get a recognition at the level of the EU or at the national level for an End-of waste of products. Therefore, most producers opt for a self-declaration of End-of-Waste for their products. This however is uncertain and the recognition of this self-declared End-of-waste state can differ between member states.

These differences limit the development of a transnational market for recycling-derived fertilising products as an end-of-waste declaration has to be obtained in every member state. This is further complicated by the lack of transparency in regulatory structure in the different member states and the language barriers.

In addition, member states differ in how they regard and regulate the production and use of recycling-derived fertilising products. Definitions and requirements on the production and use of products like composts, digestates and struvite differ widely. This creates an uneven level playing field between producers and users of recycling-derived fertilising products between the different member states.

Fertilising products which are produced from waste and which meet criteria for one of the Product Function Categories (PFC's) of the EU Fertilising product Regulation 2019/1009, may get the end-of-waste status, which facilitates the free trade and the use of the fertilising product at the EU market. As has been stated in the former chapter, components for fertilising products that meet the requirements for one of the CMC's of the FPR, will not get an end-of-waste status. This may hinder the export and import of components (CMC's) of fertilising products from one EU country to another.

5.4 EC regulation 1013/2006 on Shipment of Waste

Regulation (EC) 1013/2006 deals with supervising and controlling shipments of waste within EU borders and shipments to/from the European Free Trade Association (EFTA), the Organisation for Economic Cooperation and Development (OECD) and non-EU countries that have signed the Basel Convention act. The regulation addresses the problem of uncontrolled transport of waste and lays down procedures for the transboundary shipments (i.e. transport) of waste. It implements into EU law the provisions of the "Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal" as well as the OECD Decision. The Regulation includes a ban on the export of hazardous wastes to non-OECD countries ("Basel ban") as well as a ban on the export of waste for disposal.

The Waste Shipment Regulation is relevant to fertilising products if they have not yet achieved the end-of-waste status, requiring mutual notification between departing and receiving states. Even if the shipment is between Member States and if none of the states rejects the shipment it may cause considerable delays (Hermann & Hermann, 2019).The obligations and additional requirements on transport and handling of waste products form an administrative, logistic and financial burden on the (transnational) trade and transport of recycling-derived fertilising products, as each step in the chain (production site, transporter, vehicle, storage site and end receiver) has to registered, approved, controlled and certified, and each shipment has to be notified and approved with an extensive track and trace system.

If a recycling-derived product is approved as a CMC for EU fertilising products, it will still have the waste status and be subject to all the restrictions and obligation on handling and transport of waste. This means that the fertiliser production site will have to be approved to receive and handle waste.

5.5 Nitrate directive

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.

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.

Implementation measures of the Nitrates Directive are (among others):

- Designate areas of land which drain into waters at risk of pollution, the nitrate vulnerable zones (NVZ's)
- Establish action programmes for these areas to reduce nitrate pollution of waters;
- Monitor the effectiveness of the action programmes;
- Measures already included in codes for Good Agricultural Practice, become mandatory in NVZ's.
- other measures, such as limitation of fertiliser application (mineral and organic), taking into account crop needs, all nitrogen inputs and soil nitrogen supply and the maximum amount of livestock manure to be applied (corresponding to 170 kg nitrogen /hectare/year in NVZ).

All member states have implemented the mandatory action programmes. All action programmes use the maximum limit of 170 kg nitrogen per hectare per year in NVZ from livestock manure as is formulated in the directive. Some countries, all agricultural land is declared NVZ (for instance the Netherlands, Germany), other member states have designated specified areas as NVZ.

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.

5.5.1 Manure definition

The implication of the strict interpretation of the definition of livestock manure, means that recycling-derived fertilising products which are derived from animal manure will remain to be regarded as animal manure by definition, even if they have been processed and cannot be distinguished from equivalent products which are processed chemically. . This will be the case for e.g. composts and digestates based on animal manure, but also for liquid N-products that have similar composition as chemical fertilisers 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, limiting their marketability. The legal status of animal manure of those product will also limit

possibilities for transport, etc. because they remain animal by-products, in case the end point in the manufacturing chain has not been declared.

5.5.2 RENURE / SAFEMANURE

The production of high quality derived fertilisers (ammonium nitrate, ammonium sulphate) that cannot be distinguished from chemical fertilisers was not foreseen. The consequence is that there is no fair level playing field for animal by-products derived fertilisers solely on base of origin.

The results of the Safemanure project have been published by the Joint Research Centre (Huygens et al., 2019-I). Within that scope, the authors explored which criteria could allow nitrogen (N) fertilisers, 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 report the following criteria for RENURE were formulated:

- RENURE materials should have a mineral N:total N ratio ≥ 90% or a total organic carbon (TOC):total N ratio ≤ 3, where the ratios should be adjusted for any Haber-Bosch-derived N added during the manufacturing process.
- RENURE materials should not exceed the following limit values:
- Cu: 300 mg kg-1 dry matter;
- Hg: 1 mg kg-1 dry matter; and
- Zn: 800 mg kg-1 dry matter.

In addition, member states should take the following provisions:

- Timing and application rates should be synchronised with nutrient requirement of plants, thus preventing leaching losses;
- Ammonia emissions during storage and application to the field should be prevented.

5.6 Sewage Sludge Directive 86/278/EEC

The aim of the Sewage Sludge Directive 86/278/EEC is to encourage the use of sewage sludge in agriculture and to regulate its use in such a way as to prevent harmful effects on soil, vegetation, animals and man.

In summary, it prohibits the use of untreated sludge on agricultural land unless it is injected or incorporated into the soil. Treated sludge is defined as having undergone "biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use". To provide protection against potential health risks from residual

pathogens, sludge must not be applied to soil in which fruit and vegetable crops are growing or grown, or less than ten months before fruit and vegetable crops are to be harvested. Grazing animals must not be allowed access to grassland or forage land less than three weeks after the application of sludge. The Directive also requires that sludge should be used in such a way that account is taken of the nutrient requirements of plants and that the quality of the soil and of the surface and groundwater is not impaired.

The Directive specifies rules for the sampling and analysis of sludges and soils. It sets out requirements for the keeping of detailed records of the quantities of sludge produced, the quantities used in agriculture, the composition and properties of the sludge, the type of treatment and the sites where the sludge is used. Limit values for concentrations of heavy metals in sewage sludge intended for agricultural use and in sludge-treated soils are in Annexes I A, I B and I C of the Directive. Several EU member states have adopted even lower limit values.

Sewage sludge can contain heavy metals in relatively high concentrations and vast amounts of sewage sludge are therefore considered unsafe for use in agriculture. These are disposed of via other routes, mainly incineration or landfilling. Thereby, the nutrients (N, P2O5) contained in the sewage sludge are lost from the nutrient cycle. Therefore, it is important that measures are adopted to encourage the recycling of nutrients from sewage sludge in a safe way. The use of struvite and ashes from incineration of sewage sludge has been regulated in an amendment of the FPR, as proposed by the Strubias study of the JRC-EC (Huygens et al., 2019-II).

The implication for recycling-derived fertilising products are:

- The application of sewage sludge as a fertiliser is possible.
- Only sewage sludge and derived products with levels of contaminants that are safe to use can be applied on soil as a fertiliser.
- Several member states are diverging from direct application to treatment and recovery of P
- As an outcome of the Strubias-study (paragraph 3.2.4), ashes and struvites from sewage sludge are included as component material (CMC 12-13) for EU Fertilising products (EU 2019/1009).

5.7 EC regulation 1907/2006 (REACH)

REACH (EC 1907/2006) aims to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances. This is done by the four processes of REACH, namely the registration, evaluation, authorisation and restriction of chemicals. REACH also aims to enhance innovation and competitiveness of the EU chemicals industry.

All manufacturers and importers of chemicals have a general obligation to submit a registration to the European Chemicals Agency for each substance manufactured or imported in quantities of 1 tonne or more per year per company (legal entity). In the registration dossier, they must identify the risks that are linked to the substances they produce and market and indicate how these risks are managed.

This obligation applies to substances as such and in mixtures. A special registration regime applies for substances in articles. Without registration, substances cannot be manufactured or imported into the EU.

The legislation does not apply to waste, as that is already extensively regulated under other legislation.

EU fertilisers are all registered in REACH. The fertiliser industry jointly registers their fertilising products.

Recycling-derived fertilisers based on recovered nutrients are not exempted from registration in REACH since the products are sold on the European market. Selling a product on the EU market obliges manufactures and/or importers to register it in REACH. However, compost and biogas are exempted from the obligation to register, based on appendix V of the Regulation. However, there is still confusion about which products from nutrient recovery technologies need to be registered (Verni, 2019).

5.8 EC regulation 1272/2008 (CLP)

Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures lays down uniform requirements for the classification, labelling and packaging of chemical substances and mixtures according to the United Nations' Globally Harmonized System (GHS). It requires companies to classify, label and package appropriately their hazardous chemicals before placing them on the market. The aim of the regulation is to ensure that European Union workers and consumers are clearly informed of the hazards associated with chemicals by means of a system of classification and labelling and that the same hazards are described and labelled in the same way in all EU countries. The Regulation supplements REACH (1907/2006; see 4.7).

Substances and mixtures must be labelled with the following information:

- supplier identity;
- name of the substance or mixture and/or identification number;
- nominal quantity of the products available to the general public;
- hazard pictograms (graphic composition combining a symbol and another visual element);
- signal words ('Warning' or 'Danger');
- risk phrases ('Fire or projection hazard', 'Fatal if swallowed', etc.);

- safety advice (‘Keep only in original container’, ‘Protect from moisture’, ‘Keep out of reach of children’, etc.).

For EU Fertilising products the labelling requirements have been worked out and described in Annex III of the EU Fertilising products Regulation 2019/1009.

6 Conclusions

Until the new EU Fertiliser regulation 2019/1009 will enter into force, the legislative framework on recycling-derived fertilising products is complex, confusing and sometimes conflicting. As has been stated before, this was one of the main reasons to revise EC 2003/2003.

Until July 2022, the requirements and criteria from this complex system of regulations and directives and national legislation pose a logistic, administrative and financial burden on the marketing, transport and usage of recycling-derived fertilising products. This hampers the development of a transnational market and slows down the development and implementation of innovative production techniques until then. From July 2022 onwards, when the new EU Fertilising product Regulation 2019/1009 is in force, the situation will be much better and possibilities to trade and use of recycling-derived fertilising products within Europe will have improved.

It is concluded that most recycling-derived fertilisers (RDF's) can get a CE mark within the scope of the revised Fertilising product Regulation (FPR; EU 2019/1009) from July 2022 onwards (EC 2003/2003 is withdrawn then). Once RDF's use a CE-mark, the free trade between member states within the European Union is possible, but other relevant EU Regulations and Directives should be taken into account. The most relevant ones are:

- EC Regulation 764/2008 on Mutual recognition for the trade of fertilising products without a CE-status between EU countries;
- EC Regulations 1069/2009 and 142/2011 on Animal By-Products for fertilisers derived from animal by-products, like animal manure;
- The Waste Framework Directive (2008/98/EC) and the EC Regulation 1013/2006 on shipment of Waste are of relevance for fertilisers derived from waste;
- The Nitrate Directive (91/676/EEC) is of relevance for recycling-derived fertilisers that are rich in nitrogen (N), especially if those fertilisers have been derived from animal manure;
- The Sewage Sludge Directive 86/278/EEC for products derived from sewage sludge;
- Moreover, for all EU fertilisers, REACH (1907/2006) and EC regulation 1272/2008 on classification, labelling and packaging of substances and mixtures should be taken into account.

With respect to the investigated RDF's, the following opportunities and bottlenecks are foreseen:

- The investigated ashes from incineration or gasification of sewage sludge and/or animal manure have macronutrient contents that are sufficiently high, but for the

ashes of the gasification of a mixture of sewage sludge and green cuttings the macronutrient contents were too low to be classified as a Solid inorganic macronutrient fertiliser (Product Function Category (PFC) 1 C I) a)). Moreover, the heavy metal contents in the ashes exceeded the maximum limits for Inorganic macronutrient fertilisers. However, the ashes could meet the criteria for CMC 13 and/or 14 and could be used as a component for a fertiliser. It depends on the properties (a.o. heavy metal contents) of the other components and the mass ratio between components, whether a PFC could be produced that meets the criteria for heavy metals, or not.

- The investigated struvites show good possibilities to get a CE mark within the scope of EU 2019/1009 and could be classified as PFC 1 C) I) a) Solid inorganic macronutrient fertiliser. However, also struvites with a higher organic matter content are brought at the market. In the case the organic C content is higher than 3% on dry matter basis, the product will not be classified as CMC 12 and it is unclear if it could be classified as another CMC.
- The investigated composts show good possibilities to get a CE mark within the scope of EU 2019/1009 and could be classified as PFC 1 A) I) Solid, organic fertiliser or PFC 3 A) Organic soil improver. Hygienisation will be a prerequisite in all cases. For composts derived from Animal By-products an End point in manufacturing chain will have to be defined in the Animal By-Products (ABP) regulation, so that it can be classified in CMC 10 in the FPR. It is still unsure if this will be declared for composted animal manure in future. Heavy metal contents of the investigated products remain below the maximum limits.
- Some of the investigated liquid N products have relatively low nutrient contents, which makes it difficult to be classified as a CE marked Fertilising product. The nutrient contents of 5 of the 9 investigated products are too low. Moreover, in some of the products the contents of Cr(VI) and Cd may be too hight. This will also be a limitation for getting a CE mark.
- If ashes and struvite meet the criteria for CMC's, they could be used in principle as a component for an EU Fertilising product. However, when classified as a CMC the products will still have the legal status of waste, with all the associated administrative and logistic requirements. This will hamper the production of an EU Fertilising product from these components, especially if the final Fertilising products are produced in a different country than the country where the ash and struvite are produced.

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