



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement No 773649.

Efficient Carbon, Nitrogen and Phosphorus cycling in the European Agri-food System and related up- and down-stream processes to mitigate emissions



Start date of project: 2018-09-01

Duration: 48 months

D5.3. Environmental Policy Analysis

Deliverable details	
Deliverable number	D5.3
Revision number	Circular Agronomics-D5.3-E-0122-Enviromental Policy Analysis
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Due date	0820 (update 0122)
Delivered date	2020-08-28 (update 0122)
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Dissemination level	Public
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1 INTRODUCTION

Circular Agronomics (CA) provides a comprehensive synthesis of practical solutions to improve the current carbon (C), nitrogen (N) and phosphorus (P) cycling in European agro-ecosystems and related up and downstream processes within the value-chain of food production. CA is a frontrunner project exploiting affordable solutions to meet, among others, the requirements of agriculture, water and waste legislations as well as the EU policy targets regarding emission reduction (mainly NH₃, NO_x and GHG: CO₂, CH₄, N₂O). This report aims to provide an overview of current policies and highlight the main achievements as well shortcomings in relation to increased circularity and sustainable nutrient use in the EU, and in particular in the Case Study regions of CA.

The first part of this report identifies key policies related to environmental EU legislation focusing on four main areas: *Agriculture, Waste, Emissions to the Environment and Circular Economy*. An overview of each is policy is presented with a particular emphasis on its links to the work conducted in the context of CA. In the second part of the report specific descriptions of obstacles to roll-out the next level of efficiency in agriculture's circular economy are also provided.

A novel approach in policy and product/nutrient life-cycling is the obligation to cope with the issue of waste or secondary-raw materials-status of the current linear economy. Its results will contribute to the enforcement of existing European legislation and will support the development of recommendations in the project documents of WP6.

2 METHODOLOGY

In order to conduct an evaluation of the current policies related to environmental EU legislation, emphasising the obstacles of developing a circular economy in agriculture and a related governance analysis, the following methodology has been used:

1. *Identification of the key policy areas and corresponding current policies (§3 EU ENVIRONMENTAL POLICY ANALYSIS):*

Four key policy areas were selected in order to cover all CA topics. A preliminary screening of the European directives, regulations and communications was carried out in order to identify the most relevant within each key area. Case study activities have been considered to evaluate the relevancy of the policies. The main sources used were official pages from the EU bodies and reports derived from EC contracts. The selected policies are presented on the one hand focusing on their main points, and on the other placed in the context of CA and its case studies.

2. *Implementation of the policy analysis through case studies experience (§4 EU ENVIRONMENTAL POLICY EVALUATION THROUGH CASE STUDIES EXPERIENCE):*

The case studies were consulted to deepen the preliminary policy analysis in order to enrich the evaluation with their own expertise. The engagement of the case studies took place through three different assessments. The case studies provided a comprehensive overview on both European and National policies along their value chains; answering a survey in order to identify both general and specific policy challenges and obstacles for a circular economy in agriculture; compiling a stakeholders table in order to identify key stakeholders involved in the development of a circular economy for agriculture.

3. *Identification of crucial factors for the practical implementation of circular economy in agriculture (§5 GENERAL CONCLUSIONS):*

According to the policy analysis and to the results emerged from the case studies assessments, the conclusions have been drawn with the objective of implementing a more efficient circular economy in agriculture in the context of the work done in CA.

3 EU ENVIRONMENTAL POLICY ANALYSIS

3.1 Background literature

There are already a good number of publications analysing the agro-environmental policy framework with respect to agriculture, emissions, sustainability and circularity. Some of them have been studied and summarised here in order to analyse the relevant background knowledge and define a starting point for the following evaluations. Barriers, opportunities and recommendations have been highlighted.

The need of closing the P loop was born from the awareness that phosphate life cycle is predominantly linear, from P-rock mining to fertiliser production, agriculture, and food consumption, with the P excess ending up in soil and runoff and cause eutrophication (Barquet et al. 2020). Currently, the European Commission has expressed its fundamental interest to substantially improve the resource efficiency of the European economy and enable the transition towards the Circular Economy (Domenech et al. 2019).

The literature search revealed an initial list of barriers, opportunities and recommendations in relation to helping the agricultural sector transition towards a more circular economy. .

Some of the criticisms made on the current policy framework on resource efficiency refer to the lack of policy alignment (Domenech et al. 2019, Kanter et al. 2020) and dependency on the final choice of national instruments and priorities and the low consideration given to the reduction in inputs and consumption in contrast to the output side (Domenech et al. 2019). The narrow focus on specific nutrient recovery technologies has also received criticism, as it could lead to new lock-ins preventing further action (Barquet et al. 2020). In terms of opportunities, the main focus has been placed on the demand side (Domenech et al. 2019) and the new fertilising regulation could be a promising tool to level the playing field between conventional and waste-derived fertilisers (Barquet et al. 2020). Member States also have an important role to play in setting the right policy and economic incentives to progress towards resource efficiency (Domenech et al. 2019). The main recommendations found in literature relate to enhanced cooperation between all stakeholders and shifting mindsets towards the 'reduce-reuse-recycle-recover' narrative. This implies changing farm structures to allow more efficient use of manure and other nutrient sources in agriculture, increasing stakeholder collaboration in particular between treatment plants, fertiliser industry and farmers (Barquet et al. 2020), placing the focus on agri-food chain actors capable of influencing farm level N management, from the fertiliser industry to wastewater treatment companies, in order to shift the regulatory burden away from farmers alone (Kanter et al. 2020), as well as finding the right incentives to boost circular nutrient technologies and practices (Rosemarin et al. 2020) and considering ensuring fair P fertiliser pricing by internalising externalities of phosphate mining (Barquet et al. 2020).

3.2 Overview of EU environmental policy

Agriculture, Waste, Emissions to Environment and *Circular Economy* were selected as key areas to foster a faster exploitation of the project results and to achieve the effective implementation of European environmental legislation.

Figure 1 provides an overview of the selected key areas (*Agriculture, Waste, Emissions to Environment* and *Circular Economy*) and the relationship between them. Figure 2 links the selected areas with specific policies (directives, regulations and communications of European legislation) which have been analysed in this report to show how they are boosting or hampering a more circular and sustainable nutrient use in EU agriculture.

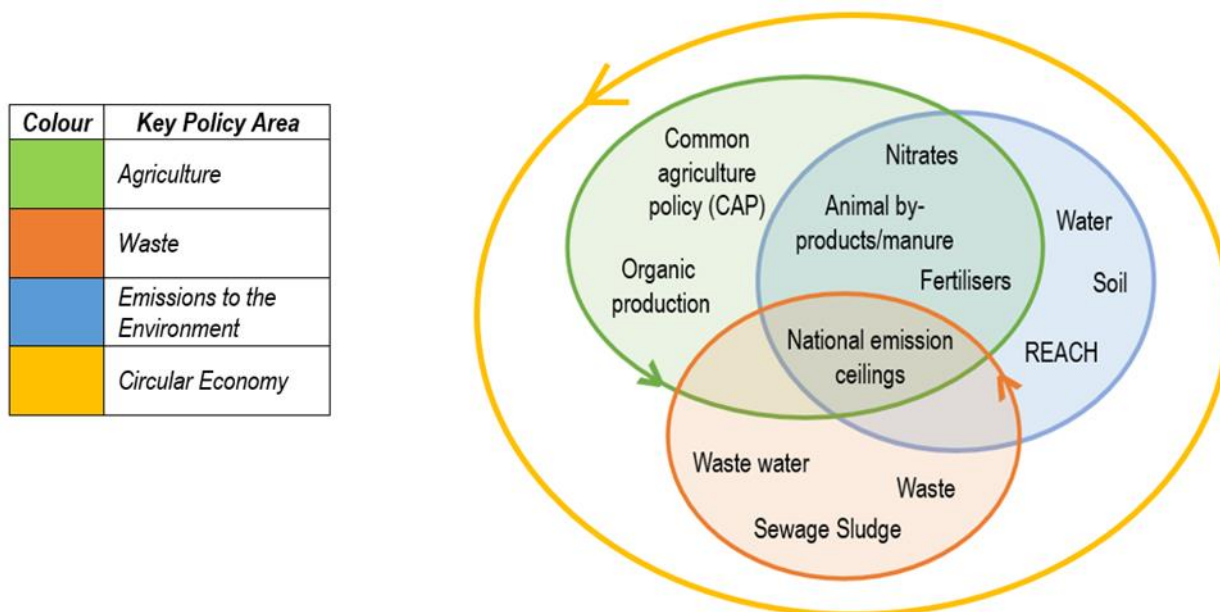


Figure 1 - Key areas of the project. Source: Own elaboration.





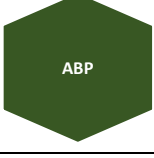
Agriculture	Waste	Emissions	Circular Economy
Common Agriculture Policy	Waste Framework Directive – 2008/98/EC	REACH – 2006/1907/EC	Circular Economy Action Plan
Nitrate Directive - 1991/676/EC	Sewage Sludge Directive – 86/278/EEC	National Emission Ceilings Directive (NECD) –2016/2284/EU	Green Deal
Fertilising products regulation -2019/1009/EU	Urban Waste Water Directive – 1991/271/EEC	Water Framework Directive (WFD) –2000/60/EC	Nationally determined contributions
Organic production Regulation - 2018/848/EU		Groundwater Directive – 2006/118/EC	
Animal by-products Regulation – 2009/1069/EC		Thematic Strategy for Soil Protection – COM/2006/0231	

Figure 2 - Selected and analysed EU policies and related key areas. Source: Own elaboration.

3.3 Agriculture

The main relevant legislation in agriculture which affects all project activities and case studies are listed in Table 1.

Table 1 – Overview of the Agriculture Key area relevant policies

	Common Agriculture Policy	<ul style="list-style-type: none"> Rules for direct payments to farmers Maintaining rural areas and landscapes Tackling climate change/sustainable management of natural resources Common organisation of markets in agricultural products
	Nitrate Directive - 1991/676/EC	<ul style="list-style-type: none"> Reduction of water polluting nitrates from agricultural sources Limits for N-containing fertilisers: 170 kg N/ha/year from livestock manure Promoting good farming practices Rules for nitrate-vulnerable zones
	Fertilising products regulation - 2019/1009/EU	<ul style="list-style-type: none"> Opens the single market for fertiliser products Establishes common safety standards, quality requirements and labelling for fertiliser products Introduces limits for toxic contaminants for the first time
	Organic production Regulation - 2018/848/EU	<ul style="list-style-type: none"> Limited use and conditions for organic farming inputs
	Animal by-products Regulation – 2009/1069/EC	<ul style="list-style-type: none"> Use, storage, distribution, disposal ABP category 2: manure and its derived products

3.3.1 Common Agricultural Policy (CAP)

General information

The Common Agricultural Policy consists of a series of rules and mechanisms regulating the production, trade and processing of agricultural products and promoting rural development.

CAP requires farmers to assume responsibility for environment protection and sustainable agriculture, responsibility for looking after the countryside and its biodiversity and for using prudently our natural resources, soil, air and water. It acts as a policy mechanism to provide for a safety-net helping the farming sector to survive to bad vintages, ensure food supply over time and the viability of the sector in the long run, also to the benefit of the upstream sector, processing industry, retailers and consumers. Nevertheless, the priorities of CAP have focussed mainly on competitiveness of the agriculture sector so far.

A more sustainable agriculture is aimed through the transition led by the CAP which needs to ensure that agriculture plays its full role in relation to the environment and climate challenge at the same time [...] (European Commission, 2018).

The Common Agriculture Policy (CAP) has been continuously evolving since it was launched in the 1960s, in order to adapt for the new needs of European citizens and the increasingly global challenges. Last reform Europe 2020 (2014-2020) focus is attention on sustainability, proposing:

Table 2 – The CAP objectives

3 strategic objectives	1. sustainable food production	through	<ul style="list-style-type: none"> ➤ greener agricultural practices, ➤ research and dissemination of knowledge, ➤ a fairer system of support for farmers, ➤ a stronger position for farmers in the food supply chain, ➤ help consumers make informed choices in the food sector through EU voluntary quality labels, ➤ promote innovation in food production and processing to increase productivity and reduce environmental impact.
	2. sustainable management of resources		
	3. a balanced territorial development		

On 2018 the EC presented the new Common Agricultural Policy proposals for 2021-27 which response more to the challenges of climate change and generational renewal. At the same time, the financial support of European farmers for a sustainable and competitive agricultural sector continues with a focus of small and medium sized farms (European Commission, 2018). The future of the CAP will be built on a more result-oriented policy which is based on nine objectives (Figure 3):

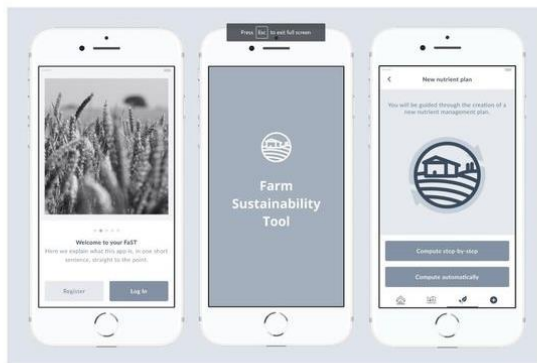
The requirements for environmental protection include preserving carbon rich soils through the protection of wetlands and peatlands as well as protecting and preserving landscapes and biodiversity. The new CAP includes high ambitions for environmental and climate action and the digitalisation of the agricultural sector. In line with those objectives, the Farm Sustainability Tool for Nutrients (FaST) is being developed which aims to increase the competitiveness, climate change actions and environmental care, providing both desired economic and environmental benefits.



Figure 3 – The 9 CAP2021-27 objectives. Source: EC

[Link to Circular Agronomics](#)

A mobile tool for farm-tailored operational advice
>>> start with a functional **Nutrient Management** planning core



made available by Member States to all CAP beneficiaries

Figure 4 – FaST demonstration. Source: EC

The Farm Sustainability (FaST) (Figure 4) is a proposed application tool based on current policies in line with CA. It proposes an obligatory management of nutrients, in order to improve water quality and crop rotation. To be used by farmers and free of charge, the FaST tool will automatically provide information on the parcels selected, including crops, the number of animals on the farm and the amount of manure generated by them. Additional data on soil, protected areas and legal limits on the use of nutrients will be available for nutrient management.

In June 2021 the European Court of Auditors wrote a special report (ECA, 2021) on the Common Agricultural Policy and climate. With the EC attributing more than a quarter of the total CAP budget to mitigating and adapting to climate change during the 2014-2020 period, the report aimed to understand how the policy is working to reduce greenhouse gas emissions from agriculture. It emerged that CAP climate action had little impact on agricultural emissions and a low climate mitigation potential. The report recommend that the Commission should take action so that the CAP reduces emissions from agriculture, take steps to reduce emissions from cultivated drained organic soils and report regularly on the contribution of the CAP to climate mitigation. The EU Commission has replied, partially accepting the recommendations, exposing that the Commission has taken action by including higher ambition for climate action into the CAP proposal for period 2023-2027. Moreover, Member States will submit CAP strategic plans which are analysed by Commission services. After adoption of these plans, Member States will report on their implementation in yearly intervals.

Circular Agronomics' contribution to lowering the impact of agriculture on GHG emissions focuses on developing increasing knowledge on the following issues: (i) developing feeding strategies and feed additives for livestock, (ii) applying N emission reduction strategies in animal housing, (iii) processing manure and recovering nutrients to reduce emissions and leakage, and (iv) the impact of applying organic amendments to soils vis a vis increasing soil organic carbon stocks using hyperspectral imagery.

3.3.2 Nitrates Directive – 1991/676/EC

General information

The Nitrates Directive (Figure 4) is one of the first EU legislation on the protection of waters against pollution caused by nitrates from agricultural sources. It aims to reduce water pollution from the spreading or discharge of livestock effluents and the excessive use of fertilisers by regulating the nitrogen dosage in quality and quantity (total N per hectare by any type of fertilising). The limits for N-containing fertilisers (e.g. 170 kg N/ha/year from livestock manure) also include, among others, application periods, manure storage facilities and buffer zones along water bodies in order to prevent any further pollution caused by the lixiviation of nitrogen to ground and surface waters.

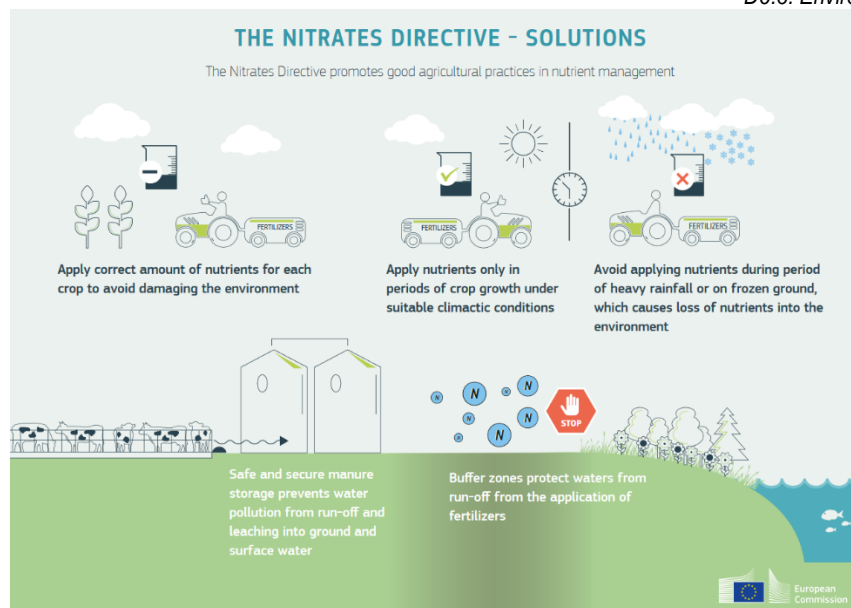


Figure 5 – Overview of the Nitrates directive. Source: EC

The Directive obliges Member States to carry out a series of actions successively, among others:

- Nitrogen vulnerable zones (NVZ), where nitrates concentrations > **50 mg/l** exist or are likely to occur.
- Establish **codes of good agricultural practice** and, if necessary, a program including provisions for the training and information of farmers, to promote their application.
- Develop mandatory **action programs for designated NVZ** with measures to limit land-application of all nitrogen-containing fertilisers and, in particular, set limits for the application of livestock manure.
- Action plans for NVZ only (e.g. Czech Republic, Italy, Spain,) or throughout the whole country (e.g. Austria, Germany, Netherlands).
- Test the concentration of nitrates in fresh soil and surface water at sampling stations, at least once a month and more frequently during floods.
- The link with groundwater policy is clear in this respect, the measures for action of the Nitrates Directive are also listed in the Water Framework Directive.

All 27 Member States have drawn up action programmes to cut nitrate pollution that include a set of measures laid down in the Directive, relating to prevent and reduce pollution, for example, by limiting fertiliser and manure use during certain times of the year, and by setting out conditions for their application. Most action programmes cover all the vital measures, and all of them include the limit of 170 kg nitrogen per hectare per year from livestock manure that is set out in the Directive. It is possible that Member states according to their national legislation give different input definitions of the N accounted: The Netherlands account for total N in digestate if at least 50% of the input material is livestock manure and the co-material is part of a specific list. Austria, Germany or Italy account only N from livestock manure. At the same time, other Member States (Czech Republic or Spain) do not provide any explanation of their N accounting calculations. Furthermore, the Directive allows Member States to get derogations to go beyond the 170kg limit, under strict conditions.

The Nitrates Directive has many country specific rules. Denmark has been a frontrunner in the uptake of manure treatment technologies, because the nitrogen pollution pressure from Danish agriculture is severe. A series of policy action plans have been implemented in order to mitigate the effects of N surplus, while maintaining agricultural production. Through a combination of approaches and measures addressing the whole N cascade (from command and control legislation, over market-based regulation and governmental expenditure to information and voluntary action) Denmark has started to improve the quality of ground- and surface waters, and reduced N deposition. (Dalgaard T. et al., 2014)

[Link to Circular Agronomics](#)

The area of EU territory subject to the implementation of action programmes has grown and cuts in livestock numbers and fertiliser use are helping, but agriculture is still a big source of nitrogen in surface waters. The Commission will continue to work with Member States, supporting them in order to achieve the Directive's objectives.

A study about manure nitrogen efficiency throughout Europe (Velthof et al. 2010) outlined what needs to be done in order to guarantee a balance between crop nitrogen and nitrogen availability. Their recommendations are in line with the approaches explored in CA.:

- Improve N efficiency by tightening the N cycle.
- Increase the manure-N efficiency by reducing NH₃ emissions and matching the N input in livestock diets with their nutrition requirements.

The efficiency of manure-N is also being seen to increase when applying slurries in the fields by injection or by boom spreaders with trailing shoes. A research carried out as part of a wider EU-commissioned study investigated the impact of the Nitrates Directive (Velthof et al. 2010). The results indicate that the implementation of the Nitrates Directive in the EU-27 has already produced significant decreases in nitrogen emissions. Modelled scenarios with and without implementation of the Directive showed that it had resulted in a 16% reduction of nitrate leaching by 2008. Further decreases are expected with the designation of more NVZs and stricter implementation of the action programmes. These improvements could be assisted by introducing new measures, such as decreasing protein in livestock diets. Separating manures into liquids and solids could also assist efforts by allowing nitrogen and phosphorus to be applied more efficiently.

Recently, harmonised criteria have been established for materials derived from processed manure referred to as RENURE (Recovered Nitrogen from manURE). In short, this should allow RENURE materials to be applied in areas where nitrogen pollution in waters exceed the threshold established in the Nitrates Directive for manure application provided the application of good management practices (Huygens et al. 2020).

Cost-efficient targeted nitrogen (N) regulation of agriculture with low impact on the environment is the new N regulation paradigm. A new concept consisting of integration and interpretation of data on the geological and geochemical conditions of the subsurface is crucial for assessing the nitrate flowpaths and reduction processes. For example the new concept is highly needed in large parts of Denmark where the redox structures are complicated and where intensive agriculture is highly developed. Providing subsurface knowledge for locally targeted N regulation of agriculture is paramount to lower the environmental impact, to support sustainable economic and environmental development. (Hansen B. et al., 2021)

3.3.3 Regulation laying down rules on the making available on the market of EU fertilising products (FPR) – 2019/1009/EC

General information

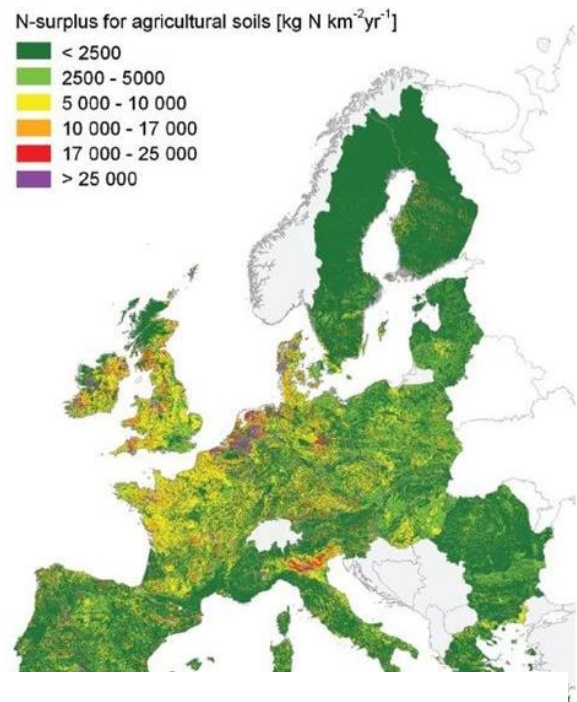


Figure 6 – N-surplus for agricultural soils in EU. Source: "Integrating nitrogen fluxes at the European scale", University of Reading.

The FPR replaces the Fertilisers Regulation 2003/2003/EC and lays down new rules relating to the placing on the market of fertilisers, as well as the provisions regarding their labelling and packaging, reduce existing trade barriers and potential risks for public safety from the use of certain categories of fertilisers. The FPR covers a diversity of fertilisers (mineral, organic, soil improvers, growing matters, etc.). The former Fertiliser Regulation was applied to inorganic mineral fertilisers only. The new FPR harmonises the requirements for fertilisers produced from phosphate minerals, organic or secondary raw materials in the EU, opening up new possibilities for new production and marketing on a large scale. It is in parallel to national legislation and in mutual recognition.

New rules ensure EU-wide that fertilisers have to meet a certain quality and safety standards to get a CE mark for free trading within the EU market. Fertilisers are classified according to their Product Function Category (PFC) incl. both nutrient and maximum contaminant concentrations (Annex I), and to into defined Component Material Categories (CMC, Annex II). Following the labelling requirements (Annex III) and Conformity Assessment Procedures (Annex IV), fertilisers can enter the European market as CE product.

[Link to Circular Agronomics](#)

The new Regulation specifies the following as acceptable input materials for composts and digestates:

- municipal biowaste separately collected at source and similar,
- animal by-products Cat. 2 and 3, including manures,
- animal and plant materials,

The **key elements** of the new rules are:

- Opening the Single Market for bio-based fertilisers, by defining the conditions under which these can access the EU Single Market.
- Strict rules on safety, quality and labelling requirements for affixing the CE mark and to be traded freely across the EU.
- EU fertilising products and component materials divided into different product function categories, which should each be subject to specific process requirements and control mechanisms.
- Introducing new limit values for contaminants in fertilisers.

Key Advantages of new regulations:

- Boosting circular economy and the use of organic and bio-based fertilisers: Promotes increased use of recycled materials for producing fertilisers, while reducing dependence on synthetic nitrogen and imported P.
- Eases market access for innovative, organic fertilisers, which would give farmers and consumers a wider choice and promote green innovation.
- Establishes EU-wide quality, safety and environmental criteria for “EU” fertilisers.
- Making it easier for producers of organic and recovered fertilisers to sell with harmonized quality standards for all types of fertilising material that can be traded across the European Union
- Increasing the consumer’s confidence by guaranteeing the safety of fertilisers with regard to human health and the environment (in particular toxic elements, organic contaminants).
- Manufacturers of fertilisers that do not bear the complex CE marking will still have the possibility of placing them on their national market in line with the national requirements.
- Since distributors and importers are close to the market place, they should be involved in market surveillance tasks carried out by competent national authorities.
- Full harmonisation of the internal market would remove all costs related to mutual recognition and/or divergence of national rules, as well as ensure a uniform level of protection of human health and environment.



Missed chances related to the new regulations:

- Currently it excludes recycled fertilisers and soil amendments. Such forms of processed manure will be regulated by CMC 10 ABP, but are also animal by-products (ABP). ABPs are regulated by the regulation on ABP EC/1069/2009 and EC/142/2011 which fall under the responsibility of DG SANTÉ and which is thus responsible for assessing the criteria for CMC 10: the so called endpoints of ABP regulation¹¹. DG SANTÉ has not yet determined the final endpoints of ABP regulation and thus the designation of animal products of CMC 10 is still not clear. Until DG SANTÉ can give the endpoints for ABPs and designated animal by-products, it will not be possible to harmonise the free trade of fertilising products made from manure
- The existing EU rules do not affect the so-called national fertilisers placed on the market of the Member States in accordance with national legislation. Some Member States have very detailed national rules whereas others do not. Producers can choose to market a fertiliser as EC fertiliser or as national fertilisers.
- Notified bodies are not obliged by any binding timeframe for giving their assessment to requesting manufacturers. There is no specification and the procedure will depend on repeatability and nature of product concerned which is combined with a high risk for fertiliser producers. Most farmers are not aware of the new policy content of the EU Circular Economy Fertilising Products Regulation, despite its importance and the significant consequences for farmers in short term.

3.3.4 Animal by-products Regulation (ABP) – 2009/1069/EC

General information

This Regulation prescribes the health rules for animal by-products and derived products not intended for human consumption. Such products must be directed towards safe means of disposal in order to control the risks. The regulation predicts a comprehensive framework for the community health rules of the animal by-products process from the collection to the final distribution. It provides detailed hygienisation rules for composting and anaerobic digestion plants (for biogas production) which treat animal by-products for technical products (compost, fertilisers, others).

The “Regulation laying down health rules as regards to animal by-products and derived products not intended for human consumption - 142/2011/EU” is implementing the Regulation 1069/2009/EC (ABP). It restricts the types of animal by-products that may be transformed into a biogas or composting plant. Materials related with this project and allowed under certain conditions include: manure and digestive tract content, former foodstuffs and waste from the food industry containing animal products.

Link to Circular Agronomics

According to the regulation the animal by-products should be derived into three different categories which represent different grades of the risk posed to humans, animals and environment. E.g. manure and its derived products which are used in the case studies are category 2:

Table 3 – Categories of the ABP

Category n.	1	2	3
<i>Risk level</i>	Very high risk	High risk	Low risk
<i>Input</i>	BSE (Bovine spongiform encephalopathy) carcasses and suspects Specified Risk Material Catering waste from international transport	Condemned meat Manure and gut contents	Catering waste from households, restaurants Former food Much slaughter house waste e.g. waste blood & feathers
<i>Proceeding</i>	Must all be destroyed, not for use in composting or biogas plants	Can be used in composting and biogas plants after rendering. Manure and gut contents only can be used after pre-treatment	Can be used in composting and biogas plants without pre-treatment
<i>Project relevant</i>	No	Yes	Yes

3.3.5 Organic production Regulation – 2018/848/EU (NEW)

General information

It establishes the principles of organic production and lays down the rules concerning organic production, related certification and the use of indications referring to organic production in labelling and advertising, as well as rules on controls additional to those laid down in Regulation (EU) 2017/625. It limits the use and the conditions for organic farming inputs, among others, fertilisers and soil conditioners.

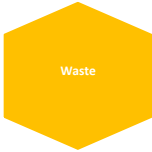
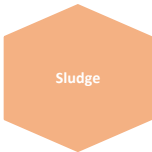

Regulation 848/2018 establishes a voluntary scheme, contrary to the other EU regulations previously analysed which define mandatory requirements. This regulation leverages the sensitivity of consumers: thanks to their choices for the certified products, producers are encouraged to extend certified organic production.

Many other European policies take advantage from voluntary schemes, based on consumer sensitivity, to promote environmental sustainability and circular economy (i.e. Regulation (CE) n. 1221/2009 of the European Parliament and of the Council of 25 November 2009 on the voluntary adhesion of organizations to a Community eco-management and audit system (EMAS), which repeals regulation (EC) no. 761/2001 and Commission Decisions 2001/681 / CE and 2006/193 / CE). A more detailed analysis of these policies will be carried out in the case study examples.

3.4 Waste

The main relevant legislation related to waste which affect all project activities and case studies are listed in the following Table 4.

Table 4 – Overview of the Waste Key area relevant policies

	Waste Framework Directive – 2008/98/EC	<ul style="list-style-type: none"> • Waste management • Definition of waste and by-products • End of waste criteria
	Sewage Sludge Directive – 86/278/EEC	<ul style="list-style-type: none"> • Use of sewage sludge in agriculture
	Urban Waste Water Directive – 1991/271/EEC	<ul style="list-style-type: none"> • Protection of water environment from adverse effects of urban waste water/certain industrial discharges • Discharges requirements (BOD, COD, TSS, TN and TP) • ANNEX III: industrial sectors (i.e. milk, meat, fruit and vegetable production)

3.4.1 Waste Framework Directive – 2008/98/EC

General information

The Waste Framework Directive covers the collection, transport, recovery and disposal of most types of waste. It sets the principle by which Member States must adopt measures to encourage sorting and valorisation of them.

Link to Circular Agronomics

The Waste Framework Directive notably distinguishes between waste and by-products, hence it determines at which stage the waste has been sufficiently valorised to be no longer considered as a waste. The particularity of this definition largely depends on the intention at the outset: if further use of the waste is certain and without environmental risks, it will be considered as a by-product at that stage. In contrast, when market demand exists for the by-product, it reaches the end of waste status. Both by-product and end of waste status is relevant for the case studies. However, waste which has undergone valorisation may still be considered as waste and may thus re-enter the waste circuit, depending on the intention.

The Directive states that specified waste ceases to be waste when it has undergone a recovery (including recycling) operation and complies with the criteria to be developed in line with certain legal conditions, in particular:

- the substance or object is commonly used for specific purposes,
- there is an existing market or demand for the substance or object,
- the use is lawful (substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products),
- the use will not lead to overall adverse environmental or human health impacts.

After having agreed this methodology with the Member States, the Commission is now preparing a set of end-of-waste criteria for priority waste streams.

Table 5 – Definitions of by-product and End-of-waste

By-product	End-of-waste
The by-product prevents the production of waste: it is a material that always remains such and that does not become waste at any time in its life cycle. It results from a production process, but the evaluation for reuse in other production cycles occurs before the producer can identify it and manage it as a waste.	The end-of-waste, as its name indicates, is a waste that ceases to be such, through recovery operations that prepare it for its re-use. In the beginning, it is considered waste in all respects, only later, through certain material recovery operations, it can recover utility for the purposes of a given production process.

The Directive creates a hierarchy of waste (Figure 7) that aims to improve waste prevention by presenting waste prevention programs as a political instrument for member states. Waste recycling and processing are being promoted with objectives such as separation criteria and energy efficiency. The producer's responsibility has increased and member states have to find a way to translate this principle, taking into account their national administrative structures and the role played by municipalities/communes.

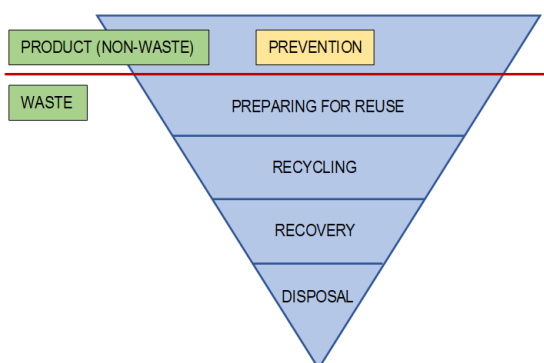


Figure 7 – Waste hierarchy. Source: Modified from EC

An object is considered to be a by-product, or a waste ceases to be a by-product, if certain conditions are met. In the formulation proposed by the Commission, the task of ensuring compliance with these requirements is facilitated by recognizing greater initiative for the Member States. Where no criteria have been established at EU level, Member States can determine, on a case-by-case basis, detailed criteria on the application of conditions to substances, specific objects or waste.

Some new definitions will be inserted, such as "material recovery", which specifies that the recovery of material concerns any recovery operation, except for the recovery of energy and the reprocessing of materials that must be used as fuels or other means to generate energy. Includes preparation for reuse, recycling and filling. One of the main examples is food waste, which is in fact indicated among the priority flows of the Action Plan. The new definition specifies that food waste consists of food for human consumption, edible or non-edible, removed from the production or supply chain to be discarded, including at the level of primary production, processing, transport, storage, sale retailers and consumers, with the exception of losses in primary production activities. For this waste stream, reduction targets are set that will act not only on the generation of waste but also on the losses that occur along the entire supply chain, including primary production, transport and storage.

3.4.2 Urban Waste Water Directive – 1991/271/EEC

General information

The Directive 91/271/EEC concerning urban waste water treatment aims to protect the water environment from the adverse effects of discharges of urban waste water and from certain industrial discharges. In 1998 the Commission issued Directive 98/15/EC to clarify the requirements of the Directive in relation to discharges from urban waste water treatment plants to sensitive areas which are subject to eutrophication. The Commission Decision 2014/413/EU defines the information that Member States should provide the Commission when reporting on the state of implementation of the Directive according to Article 17. More practical and legal relevant for the approaches of CA is the Sewage Sludge Directive, since waste water should not be used without any former treatment process to reduce the environmental impact.

3.4.3 Sewage Sludge Directive – 86/278/EEC

General information

The Sewage Sludge Directive 86/278/EEC aims to regulate the use of sewage sludge in agriculture in such a way as to prevent harmful effects on soil, vegetation, animals and man, while encouraging its correct use (Council Directive 86/278/EEC, 1986). Normally, sludge has to be treated before being used in farming. However, in some EU countries farmers may be allowed to use untreated sludge if it is injected or worked into the soil.

“Treated sludge: 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.” (Sewage Sludge Directive)

The Directive gives use obligations to avoid potential health risks from residual pathogens and requires that the 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.

Moreover, 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.

Although at Community level the reuse of sludge accounts for about 40% of the overall sludge production, landfilling as well as incineration in some Member States are the most widely used disposal outlets despite their environmental drawbacks. The European Commission is currently assessing whether the current Directive should be reviewed. For example, the current Directive sets limit values for seven heavy metals. Since its adoption, several Member States have enacted and implemented stricter limit values for heavy metals and set requirements for other contaminants.

Link to Circular Agronomics






The European Commission has launched a study (lead by consultancy team of Milieu Ltd, WRc PLC and RPA Ltd) to gather existing information on the environmental, economic, and social as well as health impacts of present practices of sewage sludge use on land. This study also assessed the risks and opportunities that can be foreseen in coming years. The study identified possible options for European policy and estimated their costs and benefits.

In the context of the revision process of the Sewage Sludge Directive it has been found that further information are urgently needed about the presence of emerging pollutants in the sewage sludge which could contaminate terrestrial and aquatic environment when the sludge is used in agriculture. Therefore, the Commission has dedicated one of the FATE series monitoring projects (monitoring of the fate and impact of pollutants on the terrestrial/aquatic interface) to the sewage sludge.

3.5 Emissions

The main relevant emission legislation related to agriculture which affect all project activities and case studies are listed in the following Table 6.

Table 6 – Overview of the Emissions Key area relevant policies

	REACH – 2006/1907/EC	<ul style="list-style-type: none"> • Chemicals registration rules • Fertiliser registration rules apply to manufactures depending on substance tonnages (Article 12: e.g. 1-10 t/a)
	National Emission Ceilings Directive (NECD) – 2016/2284/EU	<ul style="list-style-type: none"> • National emission reduction commitments • Emission inventories • Air pollution control measures
	Water Framework Directive (WFD) – 2000/60/EC	<ul style="list-style-type: none"> • Sustainable water management for “good status” of EU water bodies
	Groundwater Directive – 2006/118/EC	<ul style="list-style-type: none"> • Uniform EU-wide quality standards for nitrate: max. 50 mg N/L
	Thematic Strategy for Soil Protection – COM/2006/0231	<ul style="list-style-type: none"> • Preventing soil degradation & preserving its functions soil use and management patterns • Restoring degraded soils to level of functionality • Food safety (contaminants in soils)

3.5.1 REACH – 2006/1907/EC

General information

REACH is an abbreviation for “Registration, Evaluation, Authorization and Restriction of Chemicals”. REACH aims to better protect human health and the environment from the manufacturing, import and use of chemicals, to provide an efficient functioning of the internal market for substances and to achieve sustainable development, by eliminating dangerous substances or substituting them with less dangerous substances. Under this Regulation, industry takes greater responsibility to manage the risks from chemicals and to provide safety information on the substances. Importers and manufacturers of substance in quantity must register their substance(s) with the European Chemicals Agency (ECHA).

The Secretariat of the Agency shall:

- Make the information identified in the database(s) publicly available, free of charge, over the Internet.
- Provide technical and scientific guidance and tools for the operation of this regulation.
- Advise and assist manufacturers and importers in registration.

Link to Circular Agronomics

The article 12 sets the scope of information to be submitted depending on tonnage of the substances. Decentralized bio-based fertiliser products like in CA case studies will be manufactured in rather many small amounts than in big quantities up to 1 tonne or 10 tonnes per year. Hence, information on, among others, physicochemical properties, need to be considered and the *Annex III: criteria for substances registered in quantities between 1 and 10 tonnes*.

3.5.2 National Emission Ceilings Directive (NECD) – 2016/2284/EU

General information

The NEC directive establishes the emission reduction commitments for the Member States' anthropogenic atmospheric emissions, among others, nitrogen oxides (NO_x), ammonia (NH₃) and fine particulate matter (PM_{2,5}). It requires monitoring and reporting of pollutants and their impacts through the establishment of national programmes for air pollution control.

The main measures by the governance are the implementation of National Air Pollution Control Programmes [Commission Implementing Decision (EU) 2018/1522], which enforces EU Member States to ensure that the reduction commitments for 2020 and 2030 are met. It contributes to air quality objectives, as well as to ensuring coherence with plans and programmes set in other relevant policy areas, including climate and agriculture. The 2020 Policies and Measures (PaMs) to reduce air pollutants emissions are already available on the website of EEA and being considered for adoption, highlighting that further efforts by member states are needed to achieve emission reduction commitments by 2030. The Commission is required to examine the national air pollution control programmes, including the trajectory between 2020 and 2030, in the light of the Directive's requirements.

Link to Circular Agronomics

When drawing up, adopting and implementing the Programme, Member States shall e.g. include the mandatory measures, and may include the optional measures, in Part 2 of Annex III. This is relevant for the CA project, because it is required to the Member States to establish a national advisory code of good agricultural practice to control ammonia emissions, covering at least the following items:

1. Nitrogen management, taking into account the whole nitrogen cycle.
2. Livestock feeding strategies.
3. Low-emission manure spreading techniques.
4. Low-emission manure storage systems.
5. Low-emission animal housing systems.
6. Possibilities for limiting ammonia emissions from the use of mineral fertilisers.

Implementing the measures, Member States shall ensure that impacts on small and micro farms are fully taken into account.

3.5.3 Water Framework Directive (WFD) – 2000/60/EC

General information

The Water Framework Directive aims to protect and improve the aquatic environment, delegating clear responsibility to national authorities, through specific measures for the progressive reduction or cessation of discharges, emissions and losses of priority substances. It comprises a series of prescribed steps that should be undertaken by all EU members so as to achieve a "good status" for all water bodies, i.e. ground and surface waters (rivers, lakes, transitional waters, and coastal waters), and to avoid long-term deterioration of freshwater quality and quantity.

Even though this Directive has been referred to as a great opportunity for the restoration of water bodies and pollution reduction in Europe, after many years it still has not delivered its main objectives of non-deterioration of water status and the achievement of good status for all EU water (Voulvolis, 2016). The implementation of the Water Framework Directive remains a challenge because according to (European Commission, 2012a) fifteen years after the Directive was introduced, still 47% of EU surface waters do not reach the good ecological status as the objective of the law for the year 2015.

The approach of the Directive is based on the coordination of administrative arrangements within river basin districts (RBD) in order to ensure that Member States which share the same water bodies assume the joint responsibility in their management.

Link to Circular Agronomics

The Directive had to be integrated in national laws, including practices such as balanced fertilisation. Many countries such as Sweden, Denmark, Germany, Belgium and the Netherlands, already have manure-related laws aiming at implementing balanced fertilisation. Hence, both sustainable agriculture practices and nutrient efficiency are important aspects, which Circular Agronomics aims to develop and promote.

3.5.4 Groundwater Directive – 2006/118/EC

General information

This Directive establishes groundwater quality standards and measures to prevent or limit inputs of pollutants into groundwater. The quality criteria take into account local characteristics. Member States should establish standards at the most appropriate level and take into account local or regional conditions.

The Groundwater Directive complements the Water Framework Directive (WFD). It requires to achieve the WFD:

- groundwater quality standards,
- pollution trend studies,
- pollution trends to be reversed,
- measures to prevent or limit inputs of pollutants into groundwater,
- reviews of technical provisions of the directive,
- compliance with good chemical status criteria (based on EU standards of nitrates and pesticides and on threshold values established by Member States).

Link to Circular Agronomics

The Groundwater Directive is linked with the Nitrates Directive (91/676/EEC), which aims to reduce and prevent water pollution caused by nitrates from agricultural sources. It obliges Member States to designate vulnerable zones of all known areas in Member States whose waters – including groundwater – are or are likely to be affected by nitrate pollution. The link with groundwater policy is clear in this respect, i.e. nitrate contamination levels should not be over the trigger value set at 50 mg/l. The measures for action of the nitrates directive are also listed in the Water Framework Directive (Annex VI) and the Groundwater Directive (Annex IV, part B). Still aquifers all over Europe are in poor conditions...e.g. due to diffuse losses from agricultural activities, in particular fertilising.

3.5.5 Thematic Strategy for Soil Protection – COM/2006/0231

General information

The Thematic Strategy for Soil Protection consists of a Communication from the Commission to the other European Institutions, a proposal for a framework Directive (a European law), and an Impact Assessment.

The Communication explains why action is needed to ensure a high level of soil protection, sets the overall objective of the Strategy and explains what kind of measures must be taken. It proposes a ten-year work program for the European Commission. Within this common framework, the EU Member States will be in a position to decide how best to protect soil and how use it in a sustainable way on their own territory.

At the moment, only a few EU Member States have specific legislation on soil protection. Soil is not subject to a comprehensive and coherent set of rules in the Union. Existing EU policies in areas such as agriculture, water, waste, chemicals, and prevention of industrial pollution do indirectly contribute to the protection of soils. But as these policies have other aims and scope of action, they are not sufficient to ensure an adequate level of protection for all soils in Europe.

Link to Circular Agronomics


The Communication is linked to the context of CA considering a potential soil protection through sustainable agriculture practices, less nutrient loss, soil improvement through organic fertilisers and organic soil improvers.



A more detailed analysis of these policies will be carried out in the case study examples.

3.6 Circular Economy

The main relevant EU plans, pledges and strategies which affect all project activities and case studies are listed in the following Table 7Table 6.

Table 7 – Overview of the CE Key area relevant policies

	<p>Circular Economy Action Plan</p>	<ul style="list-style-type: none"> • Increasing circularity of EU's economy • Preserving natural environment • Promoting markets for climate-neutral & circular products/services • Sustainable products policy/modernisation of waste laws/market for secondary raw materials
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	<p>Green Deal</p>	<ul style="list-style-type: none"> • Highlights potential of circular economy for new economic activities and jobs • Boost circular economy
	<p>Nationally determined contributions</p>	<ul style="list-style-type: none"> • GHG emission reduction of at least 40% below 1990 levels by 2030 • Agriculture: 10% of total EU's GHG emissions

3.6.1 Circular Economy Action Plan and Green Deal

General information

The European Commission agreed on an ambitious Circular Economy Package, which includes measures that stimulate Europe's transition towards a circular economy, boost global competitiveness, foster sustainable economic growth and generate new jobs.

It consists of an EU Action Plan for the circular economy that establishes a concrete and ambitious programme with measures covering the whole cycle: from production and consumption to waste management and the market for secondary raw materials and a revised legislative proposal on waste. It promotes "closing the loop" of product lifecycles through greater recycling and re-use, and bring benefits for both the environment and the economy.

Since January 2018 the set of measures include:

- Communication on the Interface between chemicals, products and waste legislation.
- Monitoring framework for the circular economy.
- Report on Critical Raw Materials and the circular economy.

In 2019 the European Commission adopted a Report on the implementation of the Circular Economy Action Plan COM/2019/190, which includes a specific paragraph on Closing Loops of Recovered Materials. Boosting the use of secondary raw materials (SRMs) is one of the objectives of the circular economy action plan. There is an ongoing wide ranging debate on the way how to tackle the four main obstacles impeding the safe uptake of SRMs:

- Strong support for improving substance traceability and information flows.
- Better enforcement and use of other measures to ensure a level playing field between EU and non-EU operators.
- Improved harmonisation and mutual recognition of end-of-waste criteria.
- And support for reinforcing circular economy aspects in instruments such as the Eco-design directive.

Access to information about presence and composition of hazardous substances in waste stream is key to improving re-use and recover technologies, which facilitate the end of waste and circular economy approaches. The European Chemical Agency sets up a database to gather information on substances of concern in products and in products when they become waste.

As part of its continuous effort to transform Europe's economy into a more sustainable one and to implement the ambitious Circular Economy Action Plan, in March 2020 the European Commission adopted a new Circular Economy Action Plan in line with the Green Deal. It focuses on establishing a strong and coherent product policy framework that will make sustainable products, services and business models the norm and transform consumption patterns so that no waste is produced in the first place, with the aim to ensure that the resources used are kept in the EU economy for as long as possible. Furthermore, it includes the will to develop an Integrated Nutrient Management Plan, with a view to ensuring more sustainable application of nutrients and stimulating the markets for recovered nutrients.

Link to Circular Agronomics

To build confidence in secondary raw materials, the Commission in cooperation with the European Standardisation Organisations has initiated a standardisation process and as a first step launched a comprehensive analysis of related standardisation activities.

The action plan also seeks to boost the market for reused water, in order to tackle water scarcity across the EU. The Commission proposed dedicated legislation setting minimum requirements for reused water for agricultural irrigation. In addition, practices on water reuse are integrated into water planning and management or in the review of the relevant BREFs.

Moreover, the new Fertilising Products regulation introduces harmonised rules for organic fertilisers manufactured from secondary raw materials such as agricultural by-products and recovered bio-waste. The new regulation:

- Will substantially reduce significant market entry barriers for more sustainable and circular products.
- Includes new limits on hazardous substances for all fertilisers, including from virgin raw materials, lowering the risk of material cycles containing dangerous levels of certain toxic elements.
- Includes end-of-waste criteria, thereby contributing to the smooth functioning of the interface between chemicals, products and waste legislation and giving investors more legal certainty.

Products derived from manure, wastewater and sewage sludge are still to be assessed and shall be easily included in the list of CMC when the conformity with the legal requirements is approved. Consequently, the products of the case studies, e.g. $(\text{NH}_4)_2\text{SO}_4$ from a digested material also with shares of wastewater, sewage sludge or manure can be theoretically included as CMC in the FPR after a comprehensive assessment of the components.

3.6.2 Nationally determined contributions

General information

Since the unique Paris Agreement in 2016, all nations worldwide, including the EU have the mutual ambition to combat climate change and adapt to the respective effects. They aim to keep a global temperature increase well below 2°C in this century, and even further to 1.5°C. Therefore, each state formulated pledges in Nationally determined contributions. The EU Member States have promised to reduce the EU GHG emissions by at least 40 % below 1990 levels by 2030. The agricultural sector alone contributes to about 10% of the total EU's GHG emissions. Therefore, more sustainable and climate-friendly agricultural practices and products, such as bio-based fertilisers and their application technique are urgently required. The CA approaches are not just circular economy approaches, but also climate measures for mitigation and adaptation. They need to be implemented in agriculture as soon as possible, especially because the sector itself is highly dependent and sensitive to climate changes. In order to improve resilience and ensure food security, the climate actions, in particular, of the agricultural stakeholders are of crucial importance.

4 EU ENVIRONMENTAL POLICY EVALUATION THROUGH CASE STUDIES EXPERIENCE

The aim of this section is to identify very specific and practical policy barriers which might discourage or stop the take up of the practices being tested at the case study level to improve circularity in agriculture. Input from the case studies has been received with specific focus on the relevant regulations through the value chain diagram (§4.1), on the potential obstacles through a detailed survey (§4.2) and on the current governance within the agricultural sector through a specific analysis (§4.3 **Errore. L'origine riferimento non è stata trovata.**). In terms of governance, the relevant stakeholders for each region were identified at different levels, with particular emphasis on the national level because of its influence and relevance related to each case study.

4.1 Case studies value chain diagrams

The CA case studies have compiled **value chain diagrams** related to their research activities and productive process. The main objective is to provide a comprehensive overview on both European and National policies along their value chains, in order to individualize the policy evaluation due to national and case studies experiences. All value chain policy analysis are summarised in Annex I.

In a first step, each case study selected the environmental EU policies which concern their respective value chains. Based on that, each processing step has been associated with a number of inherent EU policies and in addition to corresponding national equivalents (Figure 8). In the following, the case study analyses are briefly presented highlighting interesting specifics:

- In the **Austrian case study**, nutrient cycles at dairy farms are closed while reducing GHG emissions. The outlined value chain starts from the resources used (e.g. seeds, energy, water) in organic farming and ends with the

produced dairy commodities while recirculating nutrients through the by-product manure. Ruminant feed is mostly based on forage. Concentrate is limited to 5 % of the diet and stems from the Lungau region. Associated EU policies are, among others, the Nitrate Directive or the Organic Production Regulation which need to be considered in the value chain at different stages. Dairy farmers in the case study voluntarily committed themselves to comply with the Organic Production Regulation that is therefore a key policy to be considered. This means in practice, that the farmers do not use chemical synthetic pesticides and fertilisers. In addition, higher standards in animal husbandry (e.g. more area per livestock unit) are obligatory. Further requirements are defined in national law, such as the Bio-Austria Production guideline or the Austrian animal welfare act for animal husbandry.

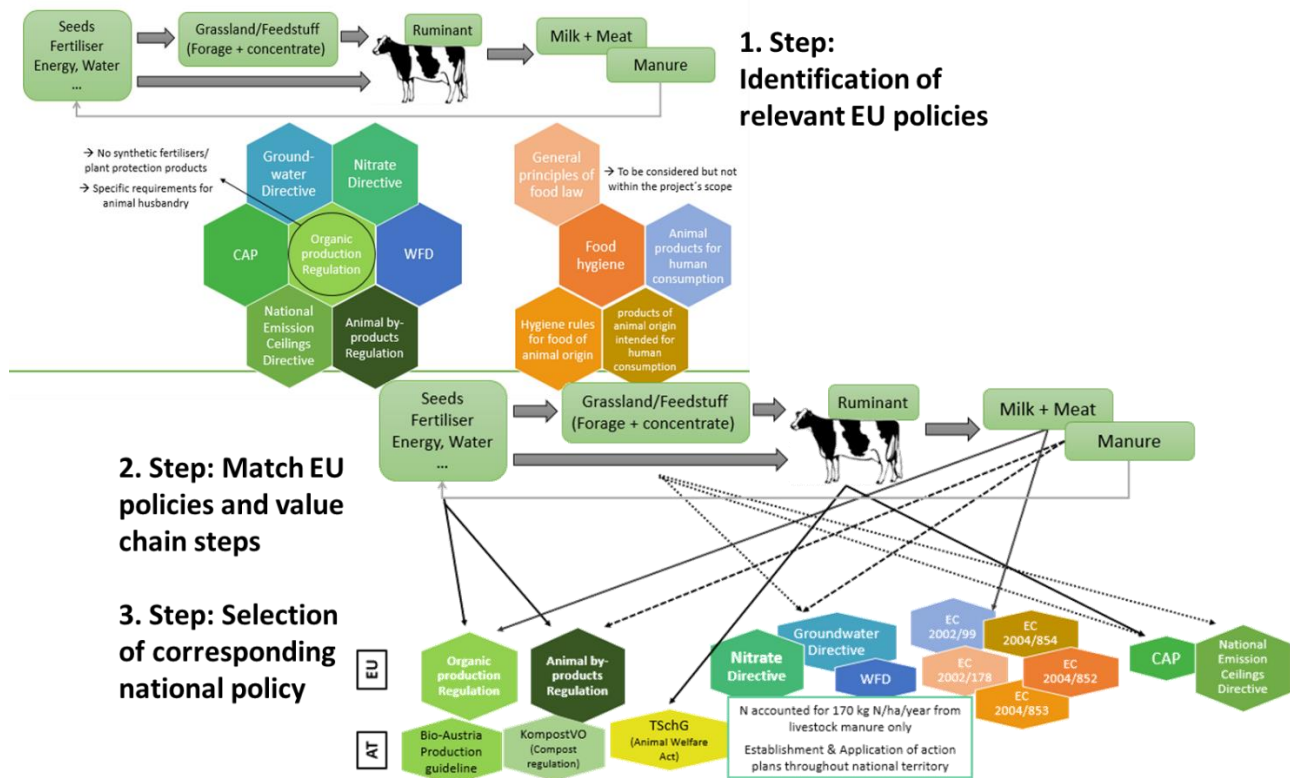


Figure 8 – Steps of the value chain policy analysis through the example of the Austrian case study. Source: Own elaboration.

For the management of grassland, farmers receive payments from the first and second pillar of the CAP. The fertilisation of grassland is subject to the nitrate and groundwater directive as well as the WFD, which define the application, storage and maximum quantities of livestock manure. Furthermore, grassland management must take the NEC directive into account. Finally, the produced food (milk and meat) is subject to several laws and directives concerning food hygiene and safety.

- The **Czech case study** works with thickened acid whey with ca. 18-20% DM for soil enrichment by recirculating carbon to the agricultural field. The processing and treatment consist mainly in multiple filtration steps. Acid whey is within the Component Material Categories (CMC 6: Food industry by-products) and can be used as fertilising product according to the EU Fertilising Products Regulation. Soil conditioner has to be approved and registered by Czech Fertiliser Act (156/1998 Sb.). It has to comply Order 377/2013 Sb. for time-limit of placement into soil + maximum application dosage per ha. Furthermore, it has to comply the Czech Fertiliser Requirement Order 474/2000 Sb. for requirements for fertiliser/soil conditioner where it will be evaluated as liquid and/or organic soil conditioner. Based on the results and achieved product qualities, the product Function Category (PFC) is met: PFC 3 (Soil improver, most probably) or PFC 1 (Fertiliser). Once we promote the produced acid whey as soil conditioner to other countries throughout the EU, the fertilisers has to fulfil the “Regulation (EU) 2019/515 on the mutual recognition of goods lawfully marketed in another Member State and repealing Regulation (EC) No 764/2008” regarding the application of certain national technical rules to products lawfully marketed additionally. The latter regulation is not analysed into detail because market rules are not the focus of the project.

- The aim of the **case study Brandenburg, Germany** is the improved nitrogen efficiency, among others, through the management of treated residues application and recovered mineral fertilisers from digestates. The relevant policies vary according to the raw substrate (here: manure) for the digester and secondary N recovery processing (degassing and stripping). Other possible inputs are agricultural waste, food waste, waste water or a mix of different waste streams, therefore the Waste Directive, The Urban Waste Water Directive or Sewage Sludge Directive need to be considered additionally. Manure is not considered to be a waste, that's why its storage, collection or transportation is regulated by the EU Animal By-Product Regulation (Figure 9). The CAP is more supporting large-scale farming, among others, because of its area-based payments rather than in particular incentivising sustainable agricultural practices and circularity approaches. Based on the Nationally Determined Contributions (NDC) on EU level, the Federal Climate Protection Act, which is currently drafted and discussed in German, will set limits of GHG emissions to the agricultural sector in future. Contributing a significant amount to global warming through carbon dioxide, methane and nitrous oxides, especially the origin, transportation and type of fertiliser combined with the application on the field will be very relevant. Hence, farmers need to adapt their common to more climate-friendly practices.

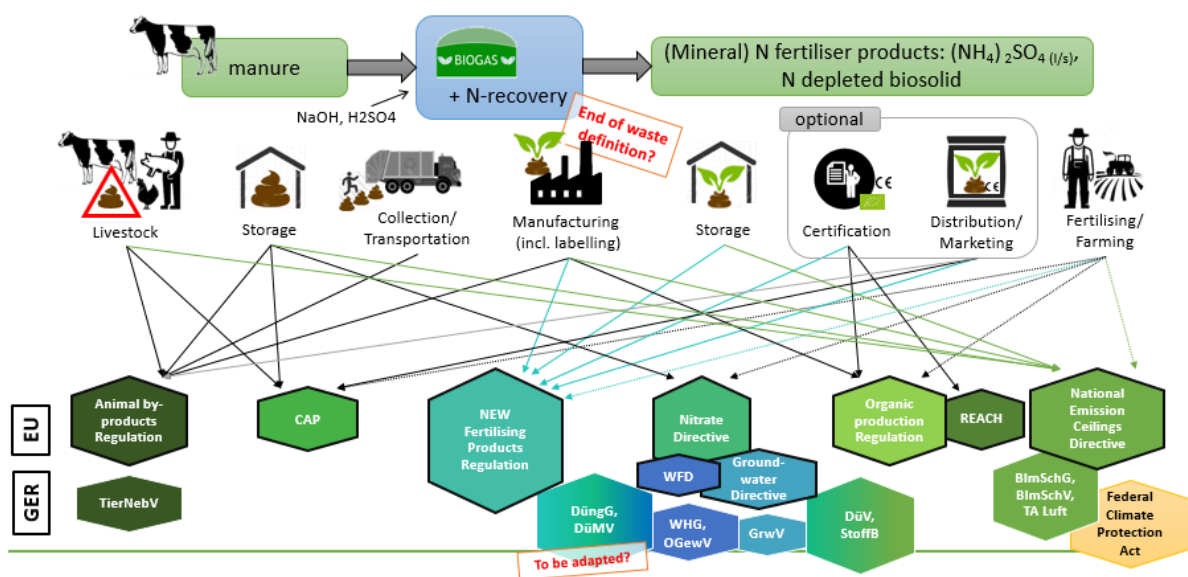


Figure 9 – Policy framework along the entire value chains of case study example Germany. Source: Own elaboration.

In the context of recent legislation amendments, the new FPR is exemplary applied to this CA case study into detail. In the German case study, a nitrogen fertiliser product about 50 % $(\text{NH}_4)_2\text{SO}_4$ is expected to be produced next to a nitrogen depleted biosolid. According to the FPR, now the N fertiliser product can be considered as an actual mineral fertiliser meeting the PFC requirements depending, in particular on nutrient type, compositions and quantities or physical properties (see figure x). The input substrate used in CA is manure or a mixed digestate which would be categorised in CMC 5 (digestate other than fresh crop digestate), except the still excluded sources listed the FPR (e.g. sewage sludge which is subject in ongoing discussion until today).

On the one hand, the FPR sets obligatory nutrient contents to which the fertilising products are equally characterised. On the other hand, contaminant in the fertilisers are limited, in particular, heavy metals like cadmium or copper concentrations. In the German case study, they are not likely to appear in relevant amounts at least in the final fertilising product ammonium sulphate even by using sewage sludge as raw substance due to the treatment procedure.

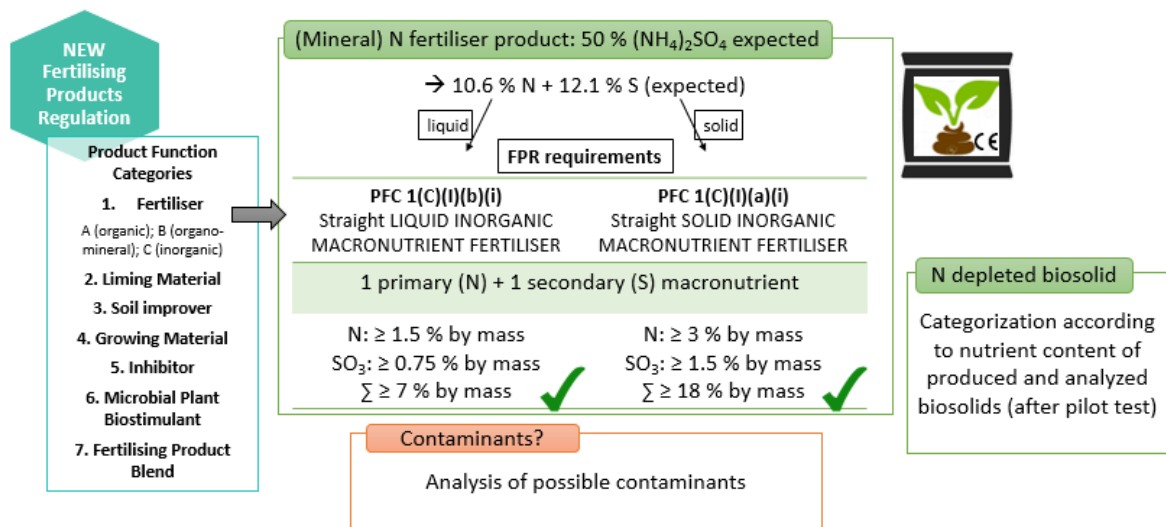


Figure 10 – Detailed study of new FPR. Source: Own elaboration.

- The **Italian case study** in the Emilia-Romagna region is about an agricultural system with biogas production where the residue (digestate) is microfiltered and used in drip lines fertigation to recycle nutrients and to enhance the nutrient use efficiency (NUE). In combination with conservation tillage strategies, soil organic matter increases. In line with the principles of the EU Circular Economy Action Plan, all the activities (recycling of carbon + nutrients + water) aim to an increasing circularity of EU's economy across different sectors (here: agriculture, energy, water). Among the EU legislation, the greatest impact on the case study have the Nitrate Directive in combination with the Water Framework Directive. They promote good farming practices and Best Available Technologies (BAT) with the purpose of increasing NUE and, thus, reducing losses in the environment. The practices included in the case study try to prove that. At the same time, the National Emission Ceiling Directive shall reduce emissions to air which will be targeted through the selection of fertiliser type (microfiltered digestate) and the application techniques (fertigation drip lines coupled with minimum or no tillage). Beyond the specific innovations introduced in the case study, biogas production and use is regulated by the Animal By-Products Regulation (if manure is used for digestion) and the Renewable Energy Directive. With regard to the innovation represented by alternative methods of minimum or no tillage, these are mainly influenced by the Rural Development Programmes under the CAP. The (no) tillage methods represent measures/actions resulting from the Thematic Strategy for Soil Protection to restore degraded soils, prevent soil degradation and preserve its functions. Depending on the type of biogas plant and the digestate produced, these innovative measures can be introduced also in farms under the Organic Production Regulation.
- The **Gelderland case study, Netherlands** focuses on dairy cattle sector. In the Netherlands, the cattle is fed primarily with grass but also receive concentrate feed, usually soy-based. During the feed production, soybeans are transformed and a part of it is discarded. This rest product is rich in nitrogen, phosphorus and potassium that can be recovered and transformed into a promising slow-release fertiliser called struvite ($\text{NH}_4\text{MgPO}_4 \cdot 6\text{H}_2\text{O}$ and $\text{KMgPO}_4 \cdot 6\text{H}_2\text{O}$). Within the CA project, the fertiliser production occurs in Belgium and the struvite is applied in the Netherlands. The fertiliser production is regulated by various policies at the Belgian, Dutch and European levels: Materialen Decreet (BE), Uitvoeringsbesluit Meststoffenwet (NL), NEW Fertilising Products Regulation (EU) and REACH (EU) define what can be considered as a fertiliser. The Omgevings Vergunning and VLAREM II in Belgium, the Uitvoeringsbesluit Meststoffenwet in the Netherlands, as well as the Water Framework Directive, Nitrate Directive and National Emission Ceilings Directive in Europe regulate the storage and application of fertilisers. Following the nutrient recovery, the depleted solid is incorporated into feed and this is regulated by the Feed Chain Alliance.
- The **Spanish case study** is focused on specific challenges of the Catalonia region such as high livestock intensification and consequent high manure generation, as well as the associated emissions to air, soil and water

when manure is used for fertilisation. In the Spanish case study, the solar drying process applied to anaerobic digestate (5.4 % dry matter) can generate a product of about 90.6 % of dry matter. Hence, total nitrogen (TN), phosphorus and potassium recovery indexes increase significantly (55.8 % TN or 50.6 % total ammonia nitrogen of solar dried matter (D), 76.8 % P₂O₅-D and 32.2 % K₂O-D). These NPK recovery indexes made the product suitable to be used in field for agronomic uses, according to European legislation (FPR). Other products will be obtained by using the same technology which will be also categorised following the FPR. The three key legislations considered within the Catalonia case study are therefore: (i) The FPR, as the first aim is to provide manure with high-quality fertiliser characteristics. (ii) The National Emissions Ceilings Directive (and specifically its transposition to the National Spanish law, 818/2018), since one of the aims is to reduce ammonia and greenhouse gas emissions during manure storage, treatment, and application. The new pending law on Climate Change and Energy Transition in discussion (see also § Policy obstacles survey) could gain priority for this case study since it also will include specific targets for GHG emissions. (iii) The Nitrate Directive since one of our main challenges is to reduce N surplus in soil and leaching to water in certain areas. In this last case, the main legislation to be considered in the Catalonia case study would be the regional one (Decree 153/2019) on management of soil fertilisation and livestock manure, and the approval of action programmes in vulnerable areas in relation to nitrate pollution from agricultural sources.

Comparing the value chain diagrams, the case studies have a common EU policy framework for shared values (i.e. human and environmental health, production rules, product requirements). Consequently, they share in general also the same complex environmental and product requirements, incentives and barriers. The EU sets definitions, conditions and determines targets (i.e. max. 50 mg N/L in groundwater, NVZ, good conditions of water bodies), while the adaptation to national conditions and the detailed implementation of legislations, action plans or technical guidelines are elaborated by each member state. Groundwater monitoring and the declaration of NVZ differ significantly within the EU: countries like Austria, Germany and the Netherlands designated NVZ throughout the entire agricultural land and apply an action programme. Other Member States, such as Italy, Spain or the Czech Republic, instead have chosen to designate specific areas according to individually defined criteria based on the definition of polluted waters (Annex 1 of the Nitrate Directive). In any case, the maximum of the organic fertiliser application of 170 kg N/ha/year from livestock manure restrict agricultural circularity severely.

Some national legislations therefore set even stricter limits than the EU requires (concerning heavy metals, synthetic organic compounds or microbial contamination) to achieve specific environmental targets. The application of sewage sludge in agriculture is e.g. already partly banned in Germany or Austria based on potential contaminating substances like heavy metals, which significantly hampers any circularity solutions. Different EU and national legislation hindering the roll-out of circular economy in Agriculture was also found as one of the key challenges in the case study survey (§ Policy obstacles survey).

4.2 Policy obstacles survey

A brief internal survey of nine questions has been conducted amongst the six project case studies in order to identify both general and specific policy challenges and obstacles for circular economy in agriculture (scope of case studies approaches only). The questions and the applied methodology were based on previous project discussions and conversations. The survey is used as an additional tool and complements the policy and governance analyses of the project. In the following, the results are presented and interpreted (see Annex II for entire survey responses).

According to the responses, the main policy obstacles and challenges have been clustered into three key categories. These concern: i) the product itself (quality, declaration and definition), ii) the fertiliser market and iii) the actual application of nutrient recycling or related technology (Table 8). Some of the main barriers are very specific depending on the case study, the national policy framework or both.

An example relates to the different legal requirements the levels of heavy metals allowed in fertilising products. When producing and getting a recovered fertiliser the heavy metal content is one of the criteria that needs to be controlled. However, conventional mineral fertilisers as produced today are not subjected to this. Contaminants like cadmium (Cd) have been found in mined phosphate rock for decades which is "accepted". Attempts to stop this inequality and establish the same stringent legal requirements for recovered and classic conventional mineral fertiliser in the past have failed. Recently, first success was achieved by the amendment of the European FPR which requires e.g. Cd levels to drop in all

mineral fertilisers no matter which material they are derived from. The implementation of the FPR and the corresponding market reaction will still take time, but recovered materials like struvite will have the advantages to be a source of P free of Cd by then.

This is one but a significant example of why commercial fertilisers still appear to be more attractive by law to the current market conditions (considering legal requirements, application, price, etc.). Additional administration challenges, such as construction permission for nutrient recovery facilities or product registration, prevent the establishment of new sustainable and circular technologies. Further on, the market prices for agricultural/dairy products are very competitive. Profit margins are so small that farmers often depend on the direct payments of the CAP and cannot afford any investments or financial or production risk. In addition, food retailers and costumers are used to buy conventional products to a favourable price or pay only slightly higher amounts for organic products which cover not the real production costs.

The obstacles and challenges have been linked to the relevant EU policies identified in the project (Table 8). Market or food related policies, among others, the General Principles of Food law or Food Hygiene are not considered, because they are not directly within the scope of the project. The level of relevance indicates where national legislation needs to be considered in terms of tackling the identified obstacles/challenges.

Table 8 – Main policy obstacles identified by case study survey

Impact area	Identified obstacles/challenges	Related EU policy within the scope of the project	Level of relevance
Product quality	<ul style="list-style-type: none"> - Difficult to obtain “end-of-waste status” by law, digestate not considered as commercial fertiliser - different legal requirements (compared to classic fertilisers) - public acceptance 	<i>Fertilising Product Regulation, ABP, Waste Framework Directive, Sewage Sludge Directive, Urban Waste water Directive, Nitrate Directive</i>	EU
Market	<ul style="list-style-type: none"> - Obtaining higher prices for organic milk products in dairy factories, placing food product in the food retail market - proper marketing activities for the product to be recognized 	<i>CAP, Organic Production Regulation</i>	EU and national
Application/technology	<ul style="list-style-type: none"> - Restrictions in Nitrate directive on fertilisation periods, limits for proper dosage of acid whey to the field - Too long periods to obtain licenses for implementing a new technology/treatment and getting construction permit - lack of real incentives for the optimized use of digestate - lack of equipment for conservation agriculture, in particular no till seeders (policy hasn't yet pushed hard enough in this direction) - product registration for soil placement - proper acid whey storage 	<i>CAP, Nitrate Directive, REACH</i>	EU and national

Regarding the legislation, there is no general statement possible. Legal definitions are equally ranked from not clear to clear in the case studies. Hence, the understanding of legislation is estimated as average/good amongst the case study approaches, though actual practitioners and other stakeholders (like large-scale farmers or fertiliser industry) might have more knowledge of corresponding laws affecting their activities. Political commitment to support circular economy solutions is evaluated as medium. In this context, policy incentives are missing but in different ways and depths according to all case studies. According to the survey results some of the shortcomings include the lack of policy support for i) nutrient recovery, ii) R&D (demonstration and market replicable studies) and iii) financing (especially for small-scale farmers).

Furthermore, general information for public is considered to be weak. These issues seem to be important across all Case Study regions.

Too long agreement processes have been recognized by half of the case studies as main problem related to policy amendments, while new regulations are not mentioned as necessary (Figure 11). The differences between national and European law were emphasised as a significant challenge, in particular in terms of a their missing harmonization which hinders trade.

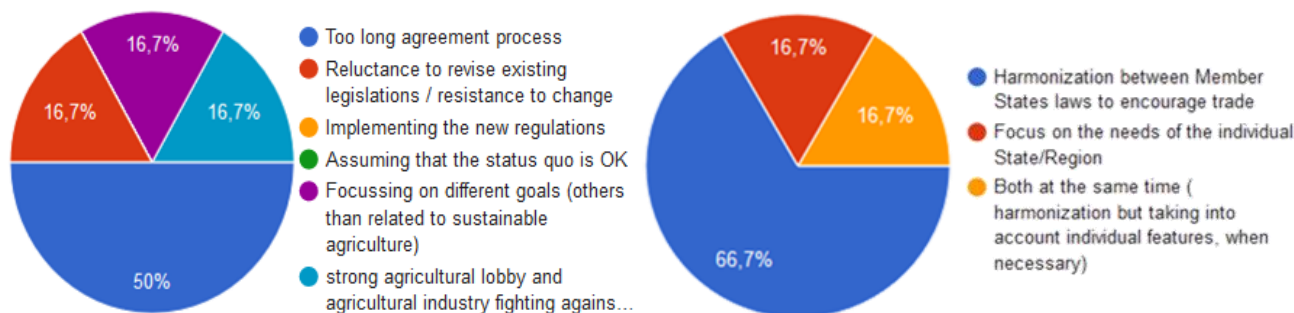


Figure 11 – Main problem related to policy amendment (left) and important aspects regarding national policy (right). Source: Own elaboration.

The legislation reliability and related insecurities for farmers has been ranked as a medium concern. A concrete issue that applies to all EU Member States in general concerns the quality parameters that are based on detection limits rather than on real environmental effects.

An interesting specific challenge in the Spanish case study is the lack of security for national livestock-farmers according to the survey responses. In Spain, the farmers are “strongly influenced” by the national Renewable Energy legislation and simultaneously no clear, secure and supporting EU agriculture policies are provided which prevent investments of farmers in environmental sustainable practices and related technology. The agro-industrial biogas sector has been in a difficult situation in Spain, when the publication of the Royal Decree-Law 1/2012 caused the cancellation of the procedures for pre-allocation of remuneration. Economic incentives for new electrical energy production facilities from co-generation, renewable energy sources and waste were eliminated which were established in the Royal Decree 661/2007. That represented a major setback for the sector’s expectations. Until 2019, all new legislation (electricity generation tax, hydrocarbon tax, etc.), additionally hampered to build new projects and, hence, innovations. Despite, some biogas plants have been built in Spain recently without incentives for any kind of renewable energy generation. That is how some Spanish investors and engineering companies have demonstrated resilience and tenacity. However, the Spanish Government has recently promoted some legislative actions due to the Covid-19 crisis, which represent a turnaround in the current and conservative Spanish legislation on climate change. On the one hand, the bill on Climate Change and Energy Transition (not a law still) was approved in May, 2020, which aims emissions neutrality by 2050. On the other hand, the Spanish Cabinet has just approved (June, 2020) a Royal Decree-law with measures on energy matters and other aspects towards the economic recovery. The decree eliminates barriers for the implementation of renewable energy sources, defines new business models, contributes to research and innovation, and promotes energy efficiency, among others. Thus, in the context of the social and economic recovery after COVID-19, a stable framework is established. This will allow Spain and the agricultural sector to take advantage of its potential, in terms of job creation and economic activity, linked to a clean, fair, reliable and economically competitive energy transition, among others, through the digestion of manure. The trend to the production of biomethane to be injected to the natural gas supply network instead of the production of bioenergy from CH₄ is addressed in Spain, now. The investments are expected to increase in the coming years. The bigger gas companies are now interested in the biomethane sector and this will allow to restart the biogas market.

Finally, the majority of the case studies assess missing collaborations between stakeholders as a significant barrier for an efficient implementation of circular economy solutions, in particular between policy makers and practitioners, but also between policy makers and scientists. Comprehensive knowledge of the benefits and a clear communication of nutrient recovered products as a high value sustainable product instead of using “dirty” waste, are still challenging for circular economy approaches, including the fertiliser and food retail market. That is also why financial incentives for recovered

products do not or only barely exist. Missing successful demonstrations e.g. caused by EU budget allocations, political agreements or pressures from other industrial and political sectors represent still obstacles to overcome.

4.3 Governance analysis

Agriculture features many public and private organizations working together across sectors and scales to pursue the goal of sustainability. Very little comparative empirical data has been collected to assess where and how these networks operate. The aim of the following analysis is to characterize the governance patterns within the case studies, analyze the network structures and understand the roles of various actors working collaboratively toward agricultural development goals. The following steps were followed:

1. A review on the role and characterisation of stakeholders involved in the agriculture sector from global, European to the national level and the identification of relevant stakeholder groups for CA.
2. The identification of relevant stakeholders per case study in order to understand their role and importance. This was done with the contribution of case study partners dwelling from their experience and knowledge. Stakeholders were classified according to six categories identified in step 1: policy makers, national agencies, NGO/Associations, Institutions/Research, Agricultural suppliers and services, and farmers.
3. A brief analysis on the potential interactions between stakeholders.

4.3.1 Stakeholder overview

A stakeholder is an actor (persons or organizations) who has a vested interest in the policy, project or program that is being promoted (Kammi 1999). Stakeholders must play a central role in setting up priorities and objectives, in order to ensure relevance and appropriateness. Effective stakeholder engagement is also likely to enhance the acceptance of decisions taken.

An example of a list of agricultural stakeholders can be given in the following table. The complexity of agricultural land use and food production systems also means that many different organisations have interests in farming. All these need to be considered as stakeholders.

Table 9 – Agriculture stakeholders example. Source: Integrated environmental health impact assessment system.

Type	Examples	Interest/role
Farmers and their agents	Land owners, farm workers, unions, farmers' associations	Victims of exposure; risk management and reduction; potential victims/beneficiaries of risk response
Agricultural suppliers and services	Seed suppliers, pesticide manufacturers, fertiliser manufacturers, transport companies	Risk management and reduction; potential victims/beneficiaries of risk response
Food distributors and processors	Food wholesalers and retailers, transport companies	Potential victims/beneficiaries of risk response
National/regional health protection agencies	Public health institutions, food standards agencies, occupational health and safety agencies, local/regional health boards and environmental health departments	Risk management and regulation; risk communication
National/regional environmental protection agencies	Ministries of environment, environmental regulatory agencies, local authorities	Risk management and regulation
European and international agencies	European Commission (Directorates for Agriculture, Environment, Health); WHO, FAO	Risk management and regulation; risk communication
NGOs	Pesticide action groups, organic farming groups, animal welfare groups	Risk communication; representatives of victims of exposure; lobbyists for action
Others	1) Rural residents 2) National and local media 3) Scientists (epidemiologists, toxicologists, environmental scientists)	1) Victims of exposure 2) risk communication

		3) risk analysis, risk communication, potential beneficiaries of risk response
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Global level

In a global level the parties involved in agriculture are considered to be the NGOs and International Agencies, such as: Member countries with their specific bodies represent national interests and positions in international multilateral bodies, such as the World Trade Organization (WTO) and the Organization for Economic Cooperation and Development (OECD), and other international bodies multilateral.

Realizing food security for all and ensuring that everyone has constant access to adequate and sufficient quantities of high quality food is at the heart of the efforts of the **Food and Agriculture Organization of the United Nations (FAO)**. In fact, the major objectives of the organization by the 194 member states are: the elimination of hunger, food insecurity and malnutrition; the eradication of poverty, guaranteeing social and economic progress for all; the management and sustainable use of natural resources: land, water, air, climate and genetic resources for the benefit of current and future generations.

The **World Trade Organization (WTO)** is the only international organization dealing with the global rules of trade between nations. Its main function is to ensure that the flow of trade is as smooth, predictable and as free as possible. The WTO is a forum for Governments negotiating trade agreements, it settles trade disputes between its members and it supports the needs of developing countries.

The mission of the **Organization for Economic Co-operation and Development (OECD)** is to promote policies to improve the economic and social well-being of people around the world. The OECD acts as a forum in which governments can work together to share experiences and find solutions to common problems.

The **World Food Programme (WFP)** is an UN body which is the world's largest humanitarian organisation providing food assistance and promoting food security. Furthermore, the **International Fund for Agriculture Development (IFAD)** is dedicated to eradicating poverty and hunger in rural areas of developing countries.

European level

The decision-making process of the European Union involves three institutions as a matter of priority: The *Commission*, the *European Parliament* and the *Council*. The Commission promotes general interests and oversees the application of EU law under the control of the European Court of Justice. The Commission has the power of legislative initiative: it prepares legislative acts to be submitted to the European Parliament and Council for subsequent evaluation and approval. The European Parliament fully shares the role of co-legislator with the Council: the main proposals put forward by the European Commission are being reviewed by the Parliament and the Council, which they approve (if necessary by amending it) or reject the proposal. If the European Parliament is an important seat of decision-making at the EU level, the Council of the European Union is the community institution that represents the governments of each country.

According to the agriculture legislative process, there are some important steps to highlight:

- the European Commission regularly consults civil dialogue groups and agricultural committees to best shape law and policies governing agriculture. Expert groups provide input to the European Commission, for example the agricultural market task force (AMTF) on unfair trading practices.
- The European Commission carries out impact assessments when planning, preparing and proposing new European legislation, examining a need for EU action and the possible impacts of available solutions. They are a key part of the EU's better regulation agenda. Impact assessments for agriculture and rural development took place in 2003 (mid term review), 2008 (health check – SEC(2008) 1885), 2011 (CAP towards 2020 – SEC(2011) 1153 final).
- The European Commission regularly publishes the public opinion reports (also called Eurobarometer) on Europeans, agriculture and the CAP. The Eurobarometer surveys, run in all EU countries, provide valuable information on citizens' perception of CAP. This includes awareness of the support provided through the CAP, its performance, quality matters, environment, importance of the CAP and much more.

Given the particularity of agricultural issues, the meetings and work of the Agriculture and Fisheries Council are prepared by the **Special Committee on Agriculture (SCA)**. The SCA files notably the aspects related to the Common Agriculture Policy, in particular common market organizations, agricultural structures, rural development. The SCA is composed of senior officials who are responsible for agricultural policy either in the member states' permanent representations or in their ministries. Furthermore, the members of the European Commission participate in all SCA meetings.

The **Agriculture and Fisheries Council (AGRIFISH)** adopts legislation in a number of areas relating to the production of food, rural development and the management of fisheries. The Agrifish Council works in most cases in cooperation with the European Parliament, bringing together the ministers from each EU member state. The legislative acts prepared by the Commission are transmitted to the Agrifish Council for drafting of the final position, which will then be opposed to that of Parliament for the subsequent enactment of the legislative act. Areas under agricultural policy include the Common Agricultural Policy (CAP), rules on the internal market for agriculture, forestry, organic production, quality of production and food and animal feed safety.

National level

At national level the type of subject becomes specific for each Member State: Ministries, Public Institutions, Departments, Agencies and local authorities.

- National/regional agencies
- food distributors and processors (food wholesalers and retailers, transport companies),
- agricultural suppliers and services (seed suppliers, pesticide manufacturers, fertiliser manufacturers, transport companies),
- farmers and their agents (land owners, farm workers, unions, farmers' associations).

They all could be potential victims/beneficiaries of risk response and of exposure.

4.3.2 Case Study stakeholder mapping

In the next paragraph are presented the **Stakeholder tables** compiled by CA case studies and the relevant conclusions.

The provided empty table had to be filled according to the following stakeholders categories, bringing out the role and interest/influence of each stakeholder:

1. Policy makers
2. National agencies
3. NGO/Associations
4. Institutions/Research
5. Agricultural suppliers and services
6. Farmers.

The complete table is presented in Annex III. The results of the analysis are shown in the graph below, which is an overview of the different stakeholders identified by each case study. Each stakeholder category has also been associated to a specific interest and role, as the stakeholders identified by the case studies represent similar parts and it was therefore easy to cluster them.

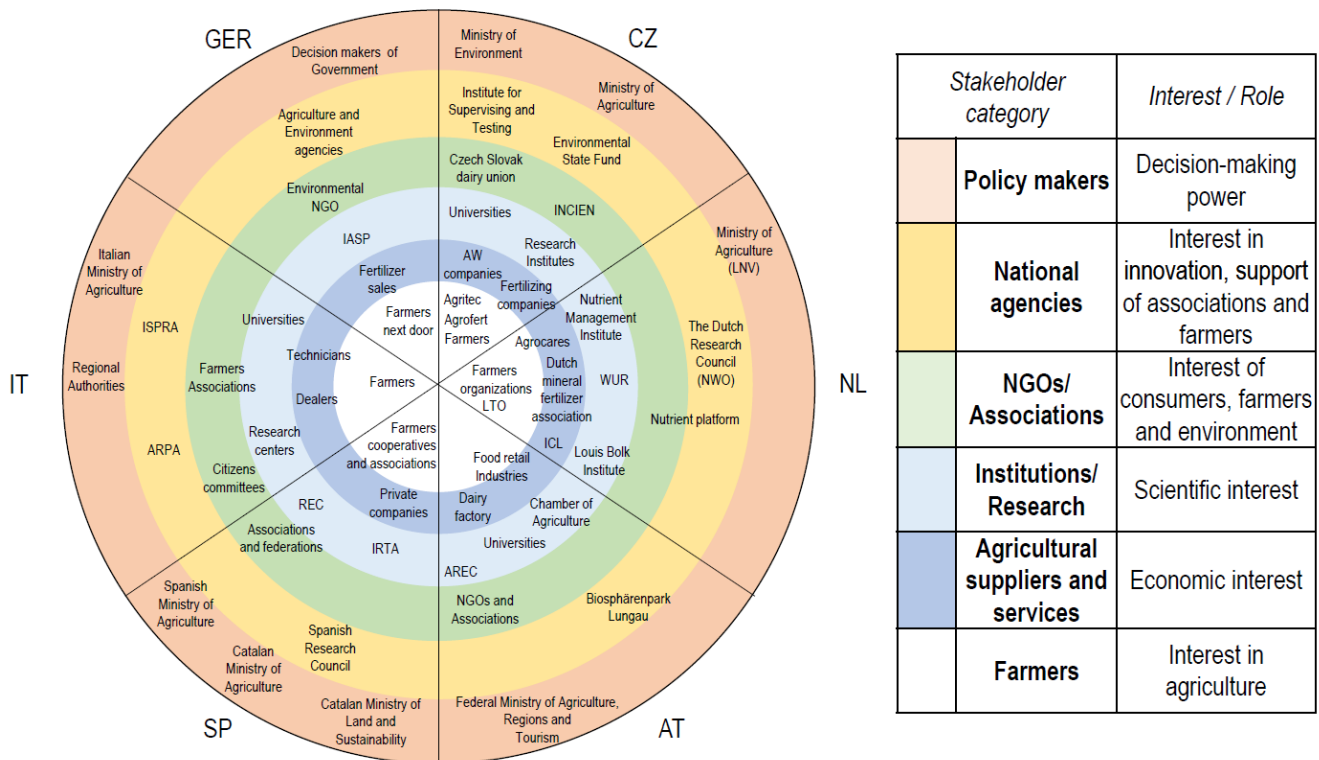


Figure 12 – Case studies Governance Analysis. Source: Own elaboration.

The graph in Figure 12 can be read as a **target**: In the core there are the farmers, the main important actors. In the outer level there are the other categories of stakeholders till reaching the policy makers, which are considered to have the most policy-related power and surround all the other stakeholders. The slices represent the six case studies. Inside each slice can be visualized the direction of the **decisional flow**, which goes from outside to inside, and the **informative flow**, which can go from a stakeholder to another, according to the different needs. This highlights that the decisional flow has one direction only from the decision-makers to the farmers (from the outer level to the core), instead the informative flow can have different directions between the categories.

Some considerations emerge from this analysis:

- The **farmers** are the main important core actors, potential victim due to the exposure of risks and the beneficiaries of good practices and policies. Their interest is in an efficient agriculture and they hold practical experience. Hence, their knowledge is specific and crucial for the other stakeholders. They are subject to decisions made by others.
- **Agricultural suppliers and services** are in close contact with the farmers, but their own economic interest might lead farmers not to make the best decisions. This is a consequence of having different interests (e.g. maximum sale profit vs. maximum yield), but highlights the importance of communication between the parts or even identifying a mutual interest.
- **Institutions and research** are mostly an independent entities because they have a specific interest in science and progress. Their studies are very important because they can be related to technical or other innovations and potential evolution of practices, policies, etc.
- **NGOs and associations** represent and protect the farmers, the consumers or the environment, depending significantly on their core business and objectives. Their respective interest is highly linked with their beneficiaries or members. They are very important because they act either as intermediary or as provocateur between the farmers and others stakeholders.
- The **national agencies** act similarly to the NGOs and associations, having a less specific interest in the protection of an individual stakeholder group. They focus on the public interest and they aim to support the national agriculture, enforcing and implementing current laws.

- **Policy makers** have been identified with the national Ministries of Agriculture and Environment. They have the legislative and decisional power. Their decisions influence all other stakeholders. They are advised mostly by agricultural experts, but should consider the issues which arise from farmers, researchers, social, environmental, financial and economic interests.

In conclusion, it emerges the importance of the interaction between the stakeholders of each category. All stakeholders need to work together to identify cross-cutting aspects, mutual aims and obstacles to achieve the best conditions to develop agriculture and circular economy. Three approaches to enhance the communication and the support between stakeholders emerge:

1. **Top down approach:** policy makers should draw viable solutions in the agricultural market through the harmonisation of policies and respective definitions and the emission of concrete measures afterwards implemented by farmers at the regional level. Other top down policy solutions are the implementation of incentives for sustainable farming and circular economy in agriculture. The access to additional funding, loans for organic farming practices and for investments in nutrient recycling technology needs to be both simplified and facilitated. Since the agricultural sector has generally quite small profit margins and it highly depends on the weather conditions, the core business for farmers is maximising the yields to monetarily survive each year, instead of retrofitting and implement sustainable agricultural practices. For this reason it is required a comprehensive facilitation by law and policies, but also by human and financial resources and, in general, more institutional capacities in order to implement and enforce the existing and future policies or regulations. These top down measures should provide the support of farmers and facilitate the “green decision making processes”, which so long requires very complex paper work so far.
2. **Bottom-up approach:** the several stakeholder groups have different interest and priorities, like the fertiliser industry to sell fertilisers or farmers to produce food products that the market demands. Through the share of their respective knowledge and their individual needs, common solutions can be developed to implement more sustainable practices. The required changes in policies have to be drafted and delivered to policy and decision makers, if they are not already present in the discussions.
3. **Equal approach:** roundtables or public conventions should be organised involving all agricultural stakeholders in order to enable the communication between them. For example, there is no or little consumers awareness, acceptance and demand for fertilisers containing recovered nutrient or willingness to pay higher prices due to, among others, more expensive organic production or GHG reducing tillage. Based on this missing attention and low knowledge, a good basis for a change of paradigms are transparent value chains and products, public campaigns by governments and comprehensive information.

5. GENERAL CONCLUSIONS

Where different national policies are present and hinder the roll out of Agriculture, the CAP ensures common rules for EU. The common strategic objectives provided in the CAP are the very basis for achieving synergy, mutual learning, criteria for best practice, economic and social cohesion. At the same time, the implementation of this policy reflects the diversity of the economic, ecologic and cultural values, leaving space for discretion to the translation into national law by the Member States. There is no doubt that without a common policy, Member States would proceed with national policies with variable scope and with different degrees of public intervention. The CAP ensures common rules in a single market; addresses market volatility where needed; safeguards the progress made in recent reforms towards increased competitiveness of European agriculture; and provides a common trade policy allowing the EU to negotiate as one vis-à-vis global trading partners.

Where a linear economy and a high production of waste is present, a Circular model for agriculture ensures circulation and higher resource efficiency. A common and shared **circularity model for agriculture** should be in the interest of all Member States in order to mainstream higher resource efficiency and to adapt to climate change. A sustainable agriculture with the recovery of resources and their circulation create a system that no longer requires external inputs, build biodiversity and intelligently use its own materials. The need for new requests for virgin materials and energy, the environmental pressures associated with the extraction of resources, emissions into the atmosphere and the production of waste would be reduced. The dependency on nutrient imports and related price or supply uncertainties can

be reduced. Hence, a sharing of resources with a very low impact on the environment and for the individual economies would be favoured.

Where a waste can't be reused and recirculated, the Waste Directive ensures end-of-waste criteria to enable the use of secondary raw materials. Another barrier to the closing of nutrient cycles is related to the end-of-waste criteria and the treatment of recovered products under legislations such as Waste Framework Directive. As long as recovered products from waste do not cease to be waste they can't be treated as recovered materials. Moreover, unclear complex procedures and uncertain conformity assessments results constrains the use of these products in agriculture, discouraging investments, technology innovation and nutrient recovery. According to the **Waste Framework Directive**, it is necessary to clarify the distinctions between natural agricultural substances like recovered nutrients used in agricultural activity, that are excluded from the scope of the waste legislation, and the notions of waste, by-product and cessation of waste status. Additionally, there are differences by definition of residual production/by-product used directly as fertiliser, separately from the use of the same as a component. With reference to the relationship between waste and by-products, the opportunity to allow easier demonstration for the qualification of a production residue as a by-product and not as waste, when this is used for the production of a fertiliser. One of the key principles to give effect to a more intelligent use of waste flows is to define a new category of resource, such like "secondary raw materials" which can be traded and used just like primary raw materials. Recycled nutrients from former waste streams would represent secondary raw materials, for which the development of quality standards is necessary. Nutrients are e.g. present in organic waste material, and can be reused as fertilisers in agriculture. Their use in agriculture can replace the demand for primary raw materials, that are processed to produce fertilisers with a significant negative environmental impact, and that depend on imports, e.g. of phosphate rock, a limited resource to the EU.

As a starting point, the Fertilising Products Regulation connects circular economy and agriculture enabling the use of certain secondary raw materials for the production of fertilising products. The agricultural theme enters the centre of the circular economy question especially in consideration of closing the nutrient loop. A first step to connect circular economy and agriculture was made with the new **Fertilising Products Regulation** that enable the use of secondary raw materials for the production of fertilising products since June 2019. The regulation harmonises EU rules, expanding its scope and establishing a regulatory framework that enables the production of fertilisers from recovered bio-wastes and other secondary raw materials. The Regulation boosts domestic sourcing of plant nutrients which is essential for a sustainable European agriculture, including the critical raw material phosphorus. It also contributes to a better implementation of the waste hierarchy, by minimising landfilling or energy recovery of bio-wastes, and hence to solving related waste management problems. Nevertheless, still certain waste streams, such as waste water or sewage sludge, are still excluded as potential source, although safe nutrient recovery could be realised. In addition, the circulation of fertilisers based on recycled nutrients is currently hampered by different quality and environmental standards or approval processes across the Member States. The new FPR involves new measures to facilitate the EU wide recognition of organic and waste-based fertilisers, thus stimulating the sustainable development of an EU-wide market.

Overall, the long term aspiration must be to achieve full coherence between policies and establish clear communication and collaboration between stakeholders. This will help to achieve the aim of a circular economy in the agricultural sector, based on more sustainable practices that reduce climate and environment emissions, enhance resilience and food security.

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- <https://ec.europa.eu/environment/water/water-framework/groundwater/framework.htm>
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- <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0190&from=EN - footnote50>
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Project Number:
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D5.3. Environmental Policy Analysis

ANNEXES

ANNEX I



Horizon 2020 European Union
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Innovation (773649)



Preliminary results of environmental policy analysis

Milestone 10
months 18,
lead: KWB



Environmental Policy – EU agriculture legislations



Horizon 2020 European Union
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CAP Common agriculture policy

General Framework:
104 billion EUR (2014-2020) direct payments and rural development
rules for direct payments to farmers
Maintaining rural areas and landscapes
Tackling Climate Change/Sustainable management of natural resources → Green measures (crop diversification, permanent grassland)
common organisation of markets in agricultural products
management and monitoring of CAP

ABP Animal by- products Regulation

2009/1069/EC
ABP category 2: manure and its derived products
Use, storage, distribution, disposal

Organic production Regulation

(NEW 2018/848/EU)
2007/834/EC
Limited use and conditions for organic farming inputs: fertilisers/soil conditioners/...
→ Annex I 2008/889/EC

2019/1009/EU
Promotion of fertiliser production from domestic sources, transforming waste into nutrients for crops & harmonising cadmium limits for phosphate fertilisers (end of waste status)
Categorisation of fertilising product function (PFC: nutrients/contaminants) & component material (CMC: input material)
Requirements -> no risk to human, animal or plant health, to safety or environment
Obligations of manufacturers/distributors
Market rules (EU and national) & very complex product labelling (CE mark, e.g. all CMC above 5 %)
“notified bodies” as conformity assessment body officially designated by national authorities

FPR NEW Fertilising Products Regulation

→ FPR in parallel to national law and fertiliser requirements (mutual recognition)

Environmental Policy – EU emission legislations



Horizon 2020 European Union
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Nitrate Directive

1991/676/EC

Reduction of water polluting nitrates from agricultural sources

Promoting good farming practices

limits for N-containing fertilisers (e.g. amounts, application period): 170 kg N/ha/year from livestock manure

Monitoring network (surface/groundwater)

Rules & mandatory action programmes for nitrate-vulnerable zones (NVZ)

NECD

National Emission Ceilings Directive

2016/2284/EU

national emission reduction commitments for any year from 2020/2030 for PM 2.5, NMVOC, SO₂, NO_x (6%/19%), NH₃ (42%/63%)

Emission inventories

Air pollution control measures

Emission reduction through selection of fertiliser type and application techniques

WFD

Water framework directive

2000/60/EC

comprehensive, cross-border approach: water protection in river basin districts

sustainable water management for “good status” of EU water bodies

BAT (Best available technology)

Ground-water Directive

2006/118/EC

uniform EU-wide quality standards for nitrate: max. 50 mg N/L

REACH

2006/1907/EC

Registration, Evaluation, Authorisation and Restrictions of Chemicals

Fertiliser registration rules apply to manufactures depending on substance tonnages (Article 12: e.g. 1-10 t/a)

Environmental Policy – EU waste legislations



Horizon 2020 European Union
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Waste Framework Directive

2008/98/EC

basic concepts and definition for waste (waste, by-products, recycling, recovery)
end-of-waste criteria → secondary raw material
waste management hierarchy
"polluter pays principle" & "extended producer responsibility"
waste management plans & waste prevention programmes



Urban Waste Water Directive

1991/271/EEC

Protection of water environment from adverse effects of urban waste water/certain industrial discharges
discharges requirements (BOD, COD, TSS, TN and TP)
ANNEX III: industrial sectors (i.e. milk, meat, fruit and vegetable production)

Sewage Sludge Directive

1986/278/EEC

regulates agricultural application of sewage sludge (i.e. for fruit/vegetable crops, grasslands)
compromising quality of soil/surface & ground water
Definition of sludge treatments required
recording requirements (quantities of sludge produced/used in agriculture, sludge composition/properties, treatment type, applied sites)
. Annexes I A-C: Limit values for 7 heavy metals concentrations

Review in discussion

Environmental Policy – EU plans/pledges/strategies



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Circular Economy Action Plan

increasing circularity of EU's economy across sectors

Promoting markets for climate-neutral & circular products/services

sustainable products policy/modernisation of waste laws/market for secondary raw materials

5 priority sectors: plastics, food waste, biomass/bio-based products, critical raw materials, construction and demolition

NEW/coming soon: EU Industrial Strategy, Climate Change, preservation of natural environment

Thematic Strategy for Soil Protection

COM/2006/0231

Preventing soil degradation & preserving its functions

soil use and management patterns

Restoring degraded soils to level of functionality

Food safety (contaminants in soils)

Research and Development funds

NDC

Nationally determined contributions

GHG Emission reduction of "at least 40% below 1990 levels" by 2030

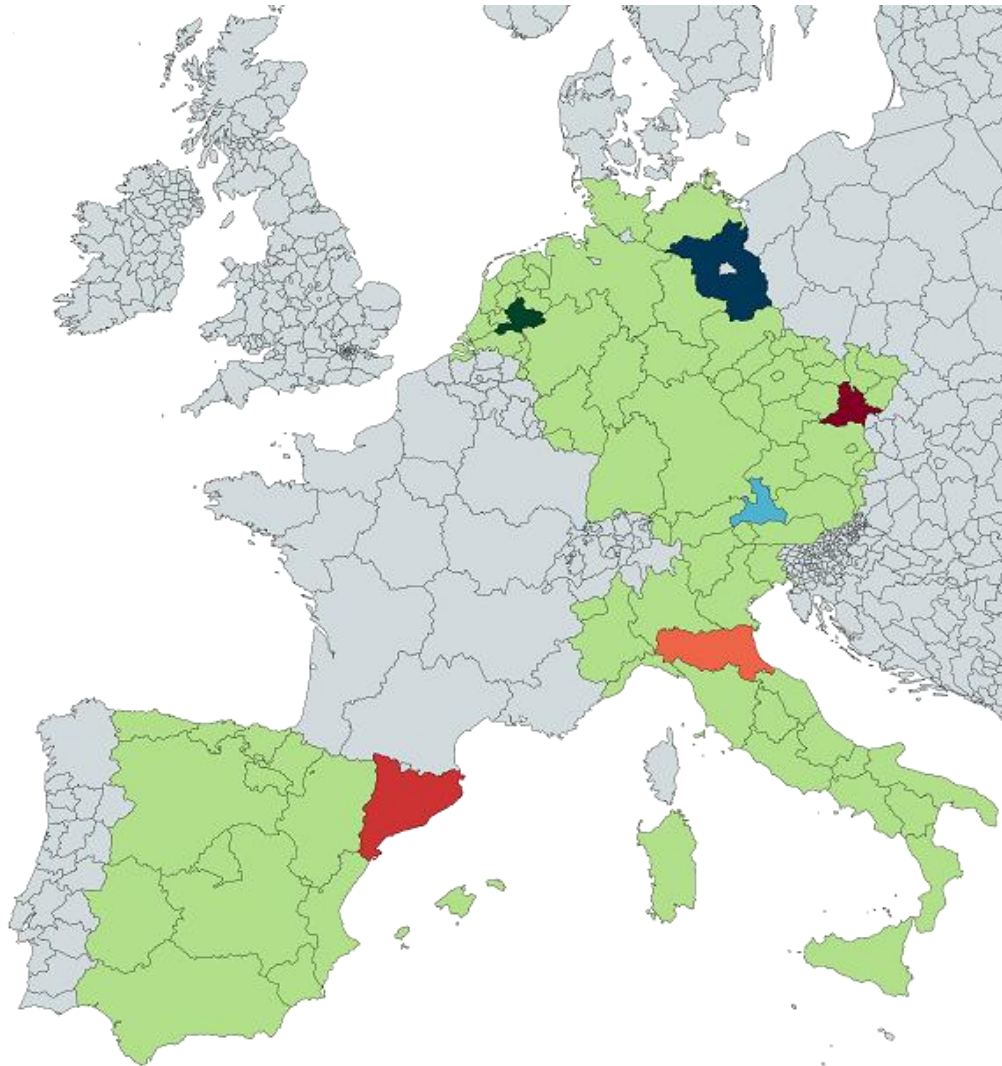
Agriculture: 10% of total EU's GHG emissions

Categories: manure management, urea application, agriculture soils

Green Deal

highlights potential of a circular economy for new economic activities and jobs

Boost Circular Economy



Environmental Evaluation according to current **legislation (EU + national)**

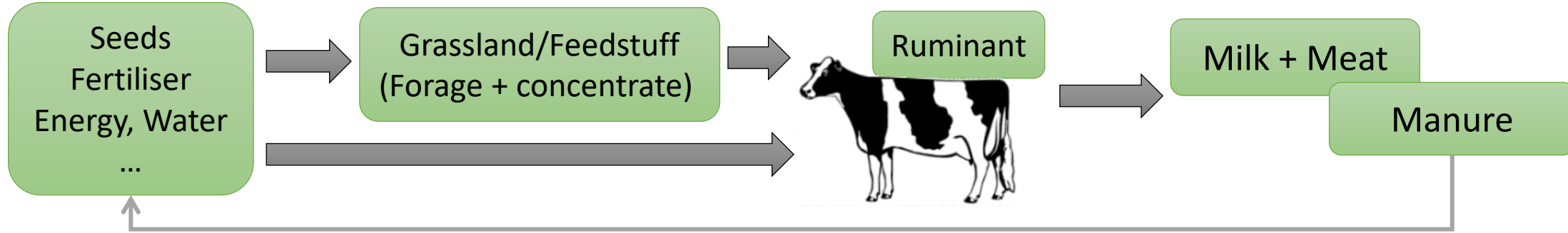
- ▶ Case study Lungau, AT
- ▶ Case study Dyjákovice, CZ
- ▶ Case study Brandenburg, DE
- ▶ Case study Emilia-Romagna, IT
- ▶ Case study Gelderland, NL
- ▶ Case study Catalonia, ES

Environmental Policy

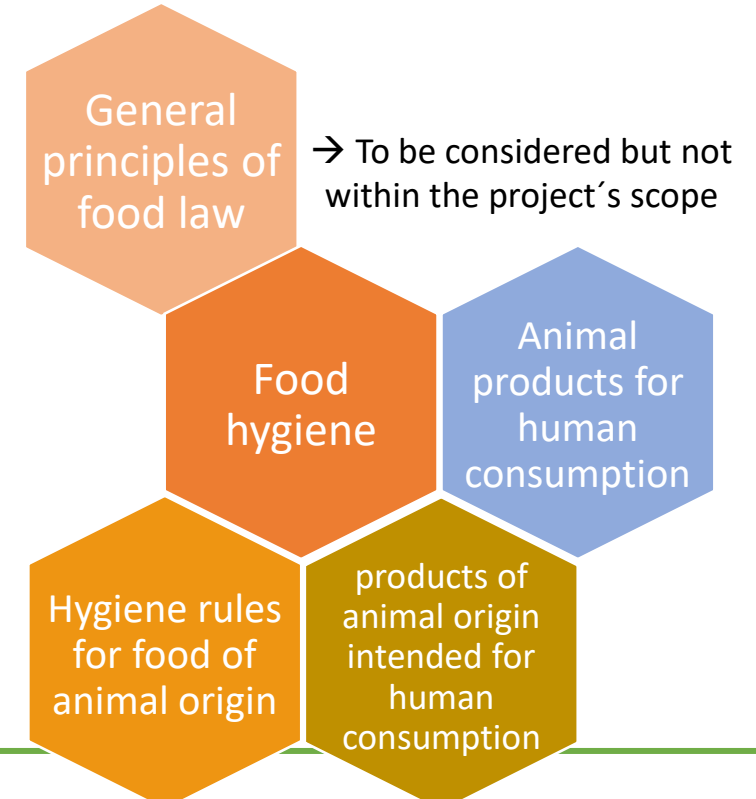
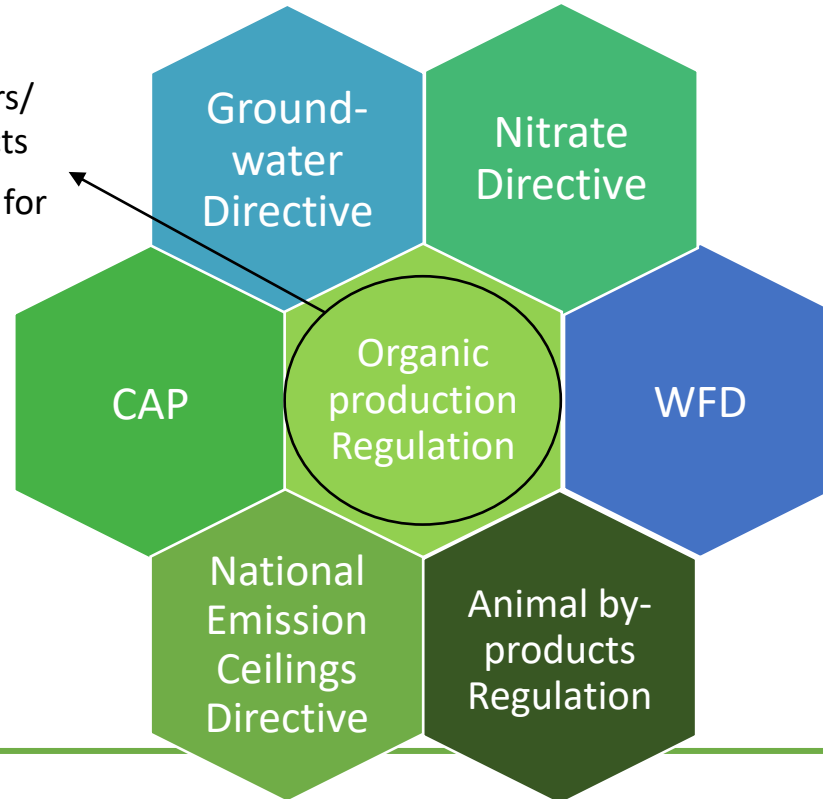
Case study Lungau, Austria



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- No synthetic fertilisers/
plant protection products
- Specific requirements for
animal husbandry

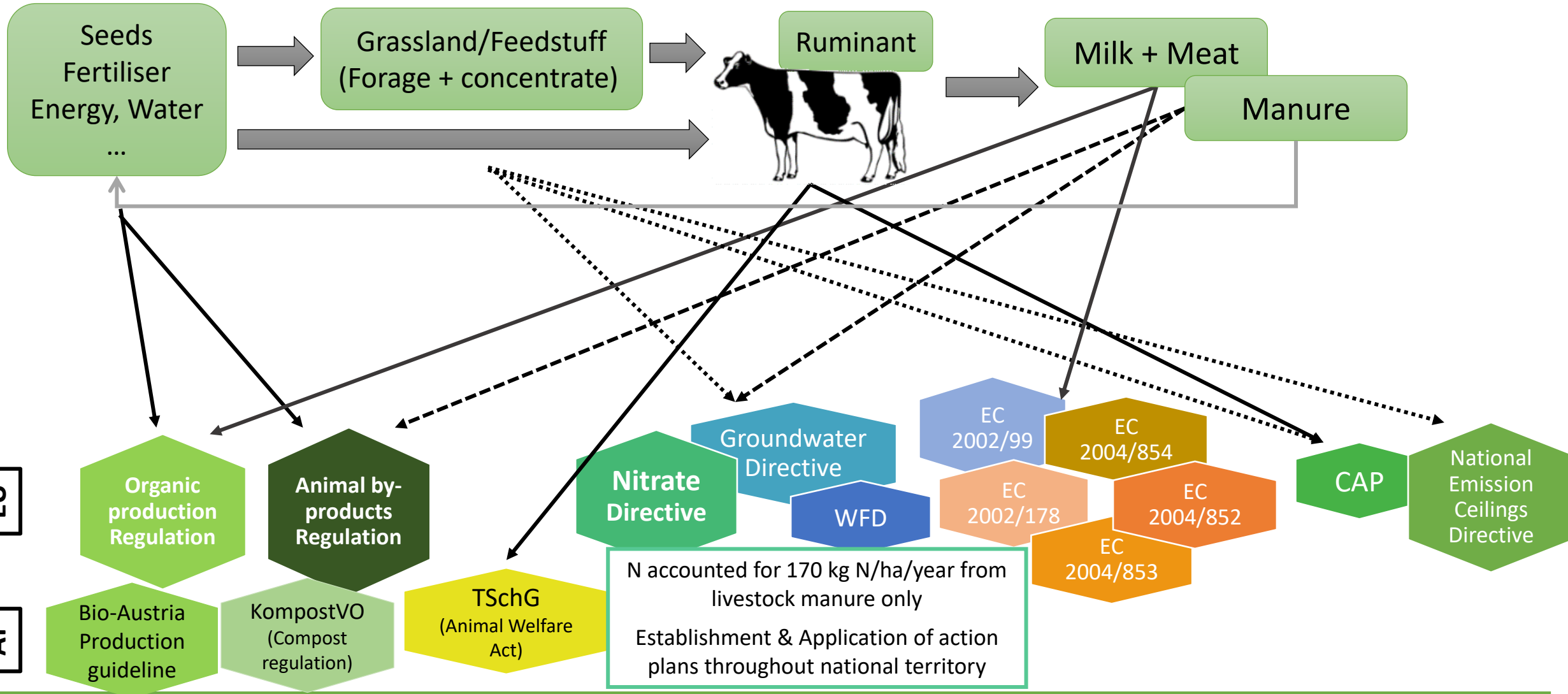


Environmental Policy

Case study Lungau, Austria



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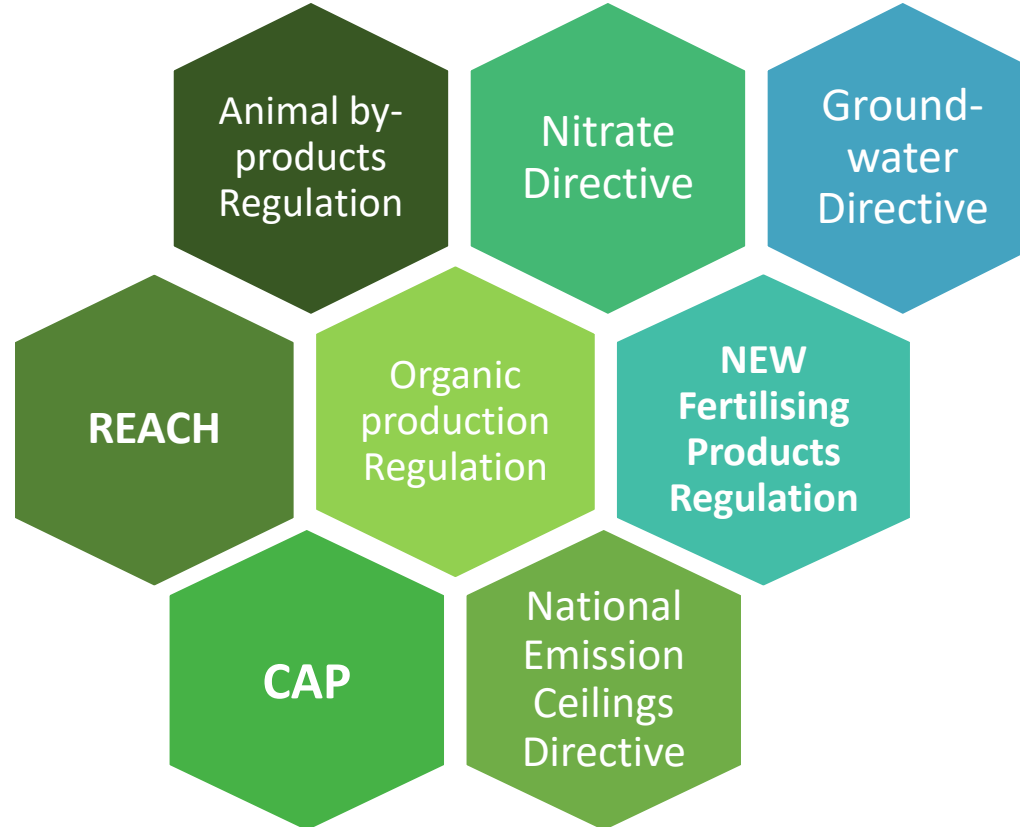
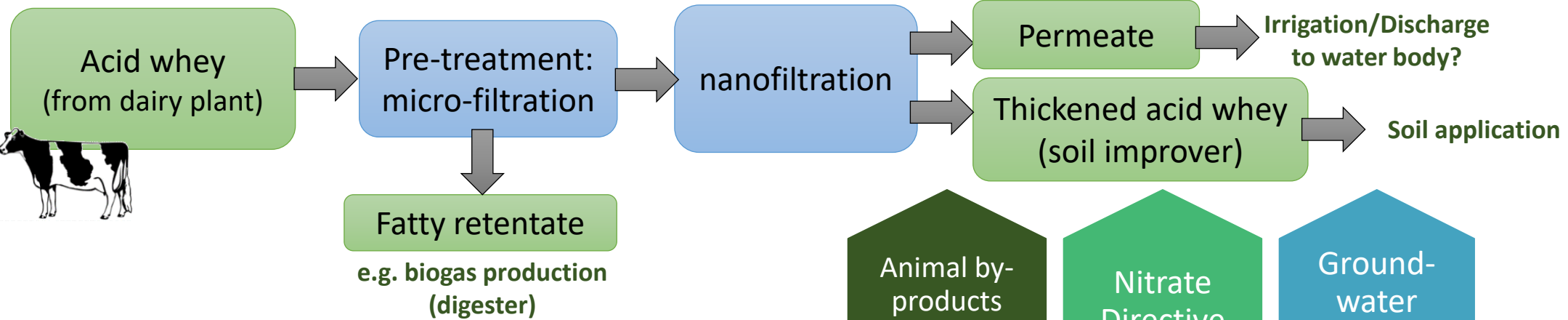


Environmental Policy

Case study Dyjákovice, Czech Republic



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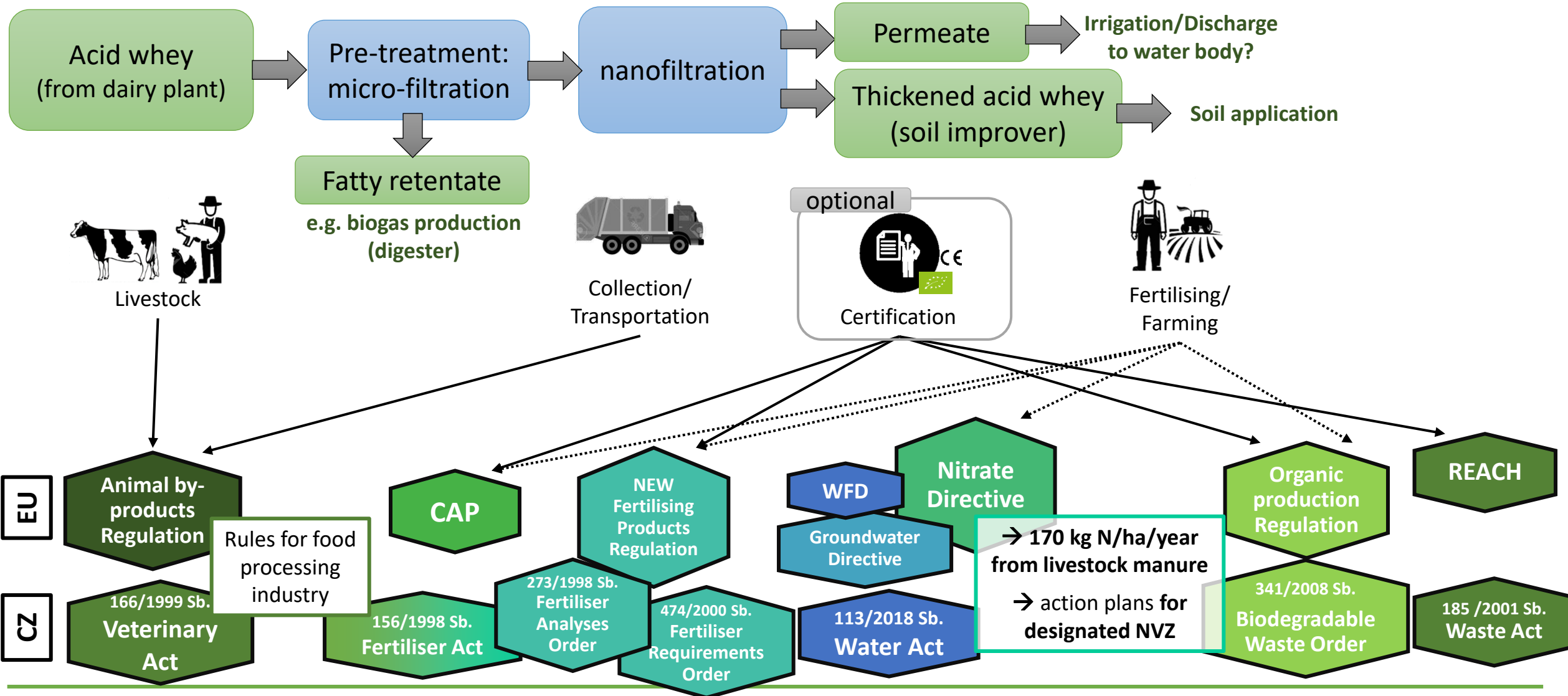


Environmental Policy

Case study Dyjákovice, Czech Republic



Horizon 2020 European Union
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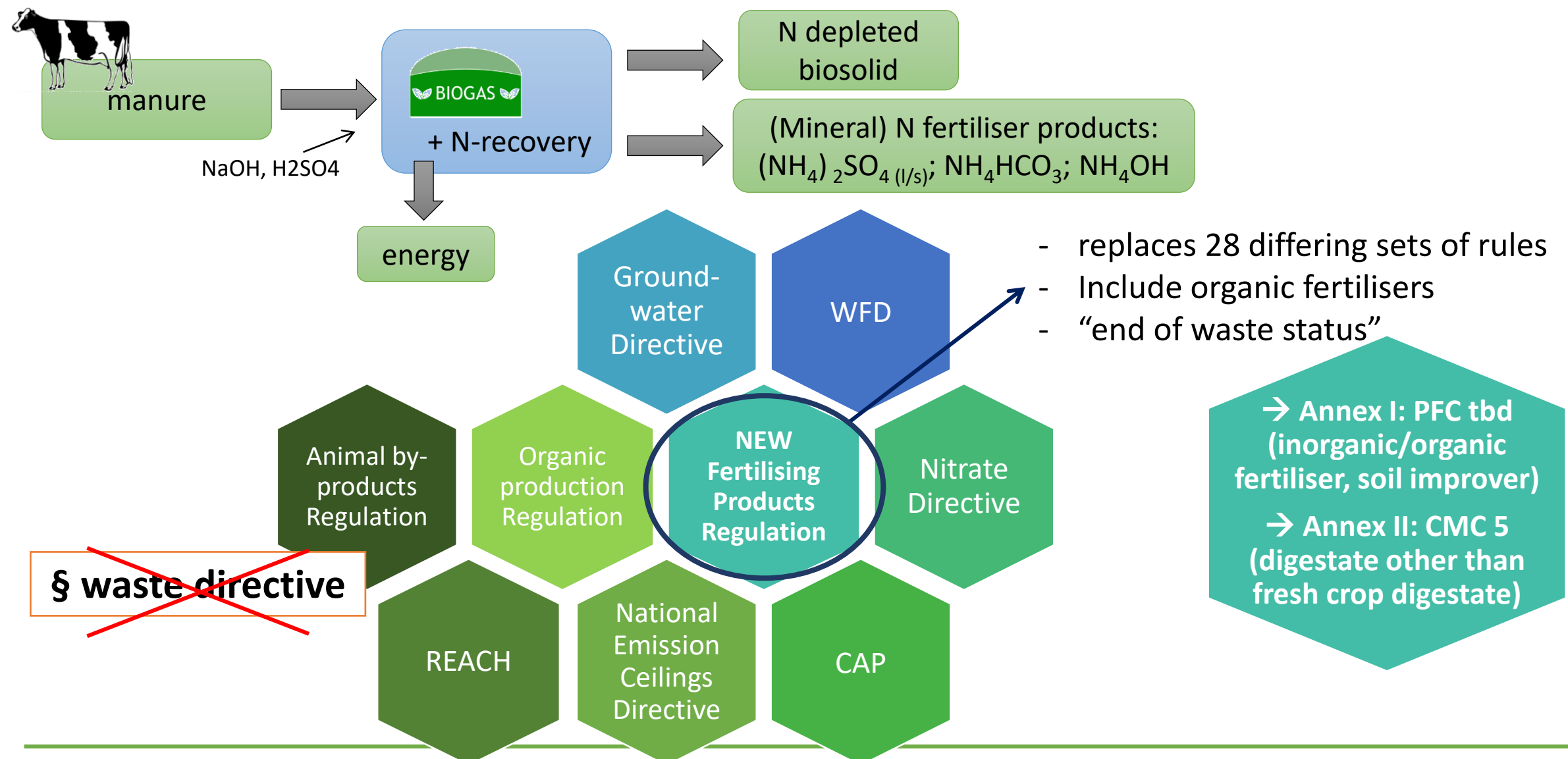


Environmental Policy

Case study Brandenburg, Germany



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- replaces 28 differing sets of rules
- Include organic fertilisers
- “end of waste status”

→ Annex I: PFC tbd (inorganic/organic fertiliser, soil improver)

→ Annex II: CMC 5 (digestate other than fresh crop digestate)

**NEW
Fertilising
Products
Regulation**

- Product Function Categories**
1. **Fertiliser**
A (organic); B (organo-mineral); C (inorganic)
 2. **Liming Material**
 3. **Soil improver**
 4. **Growing Material**
 5. **Inhibitor**
 6. **Microbial Plant Biostimulant**
 7. **Fertilising Product Blend**

(Mineral) N fertiliser product: 50 % (NH₄)₂SO₄ expected

→ 10.6 % N + 12.1 % S (expected)

liquid / solid

FPR requirements

PFC 1(C)(I)(b)(i) Straight LIQUID INORGANIC MACRONUTRIENT FERTILISER	PFC 1(C)(I)(a)(i) Straight SOLID INORGANIC MACRONUTRIENT FERTILISER
1 primary (N) + 1 secondary (S) macronutrient	
N: ≥ 1.5 % by mass SO ₃ : ≥ 0.75 % by mass Σ ≥ 7 % by mass ✓	N: ≥ 3 % by mass SO ₃ : ≥ 1.5 % by mass Σ ≥ 18 % by mass ✓



N depleted biosolid

Categorization according to nutrient content of produced and analyzed biosolids (after pilot test)

Contaminants?

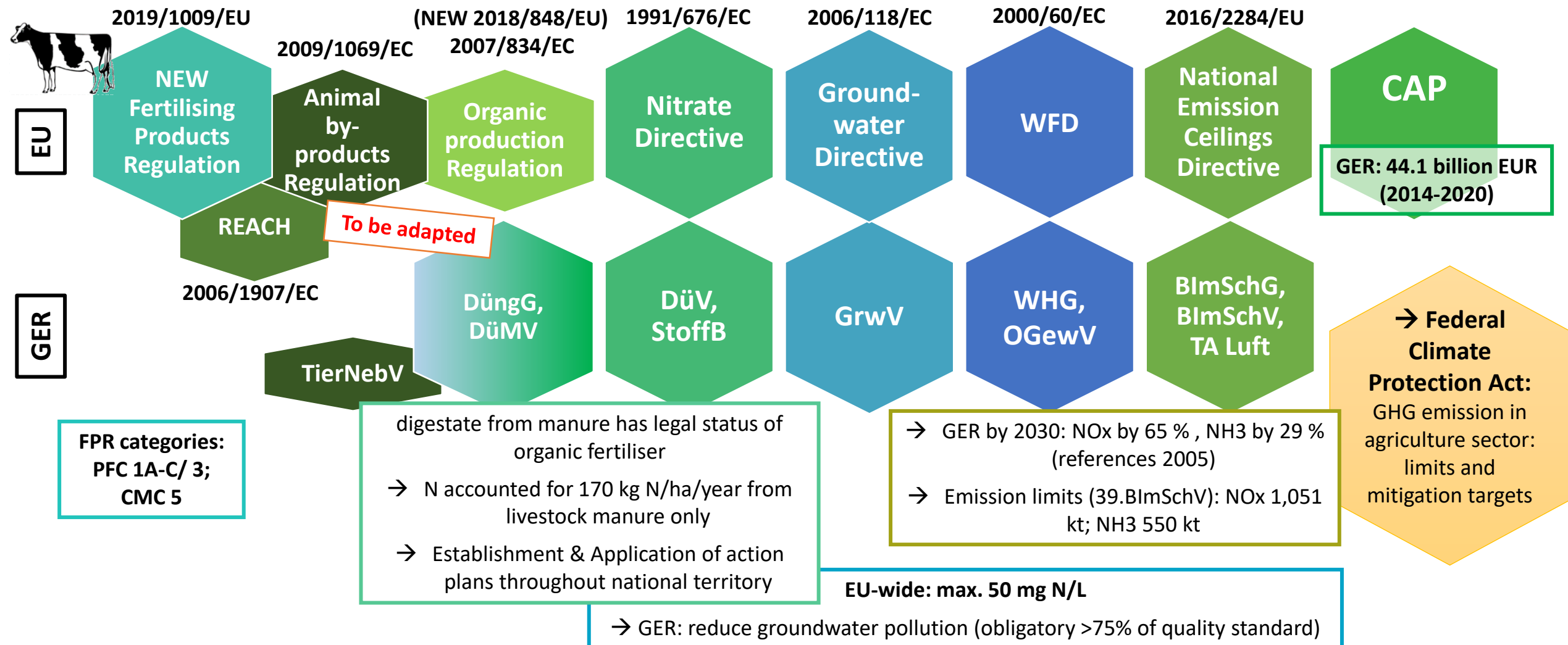
Analysis of possible contaminants

Environmental Policy

Case study Brandenburg, Germany



Horizon 2020 European Union
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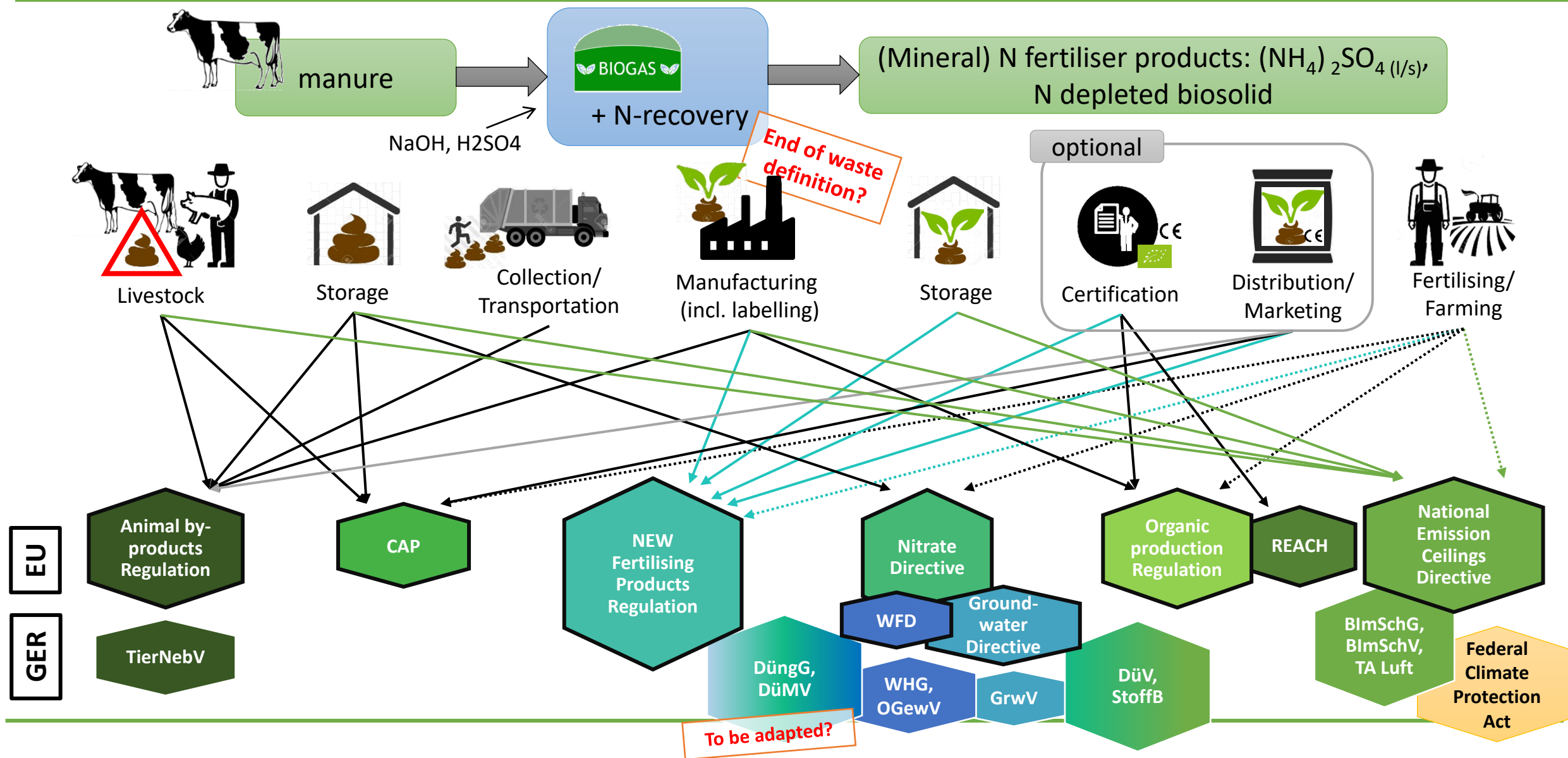


Environmental Policy

Case study Brandenburg, Germany



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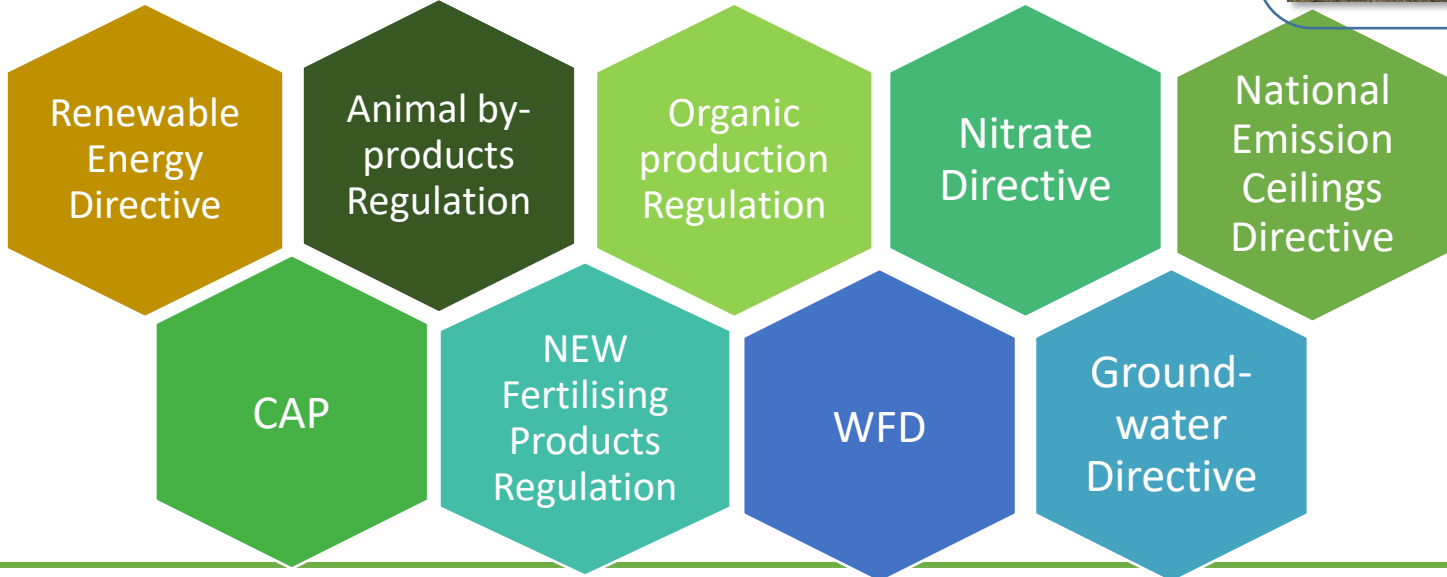
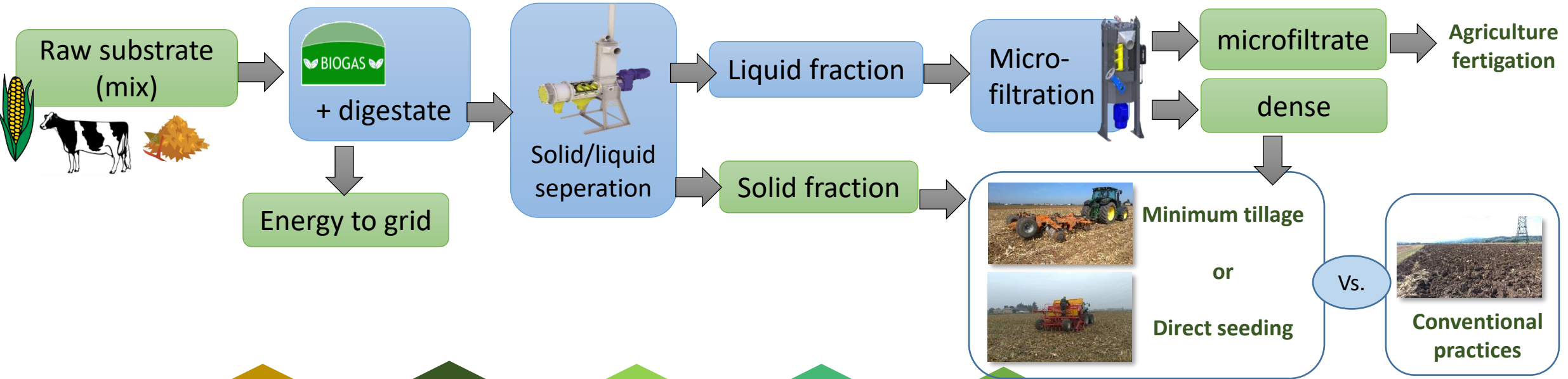


Environmental Policy

Case study Emilia-Romagna, Italy



Horizon 2020 European Union
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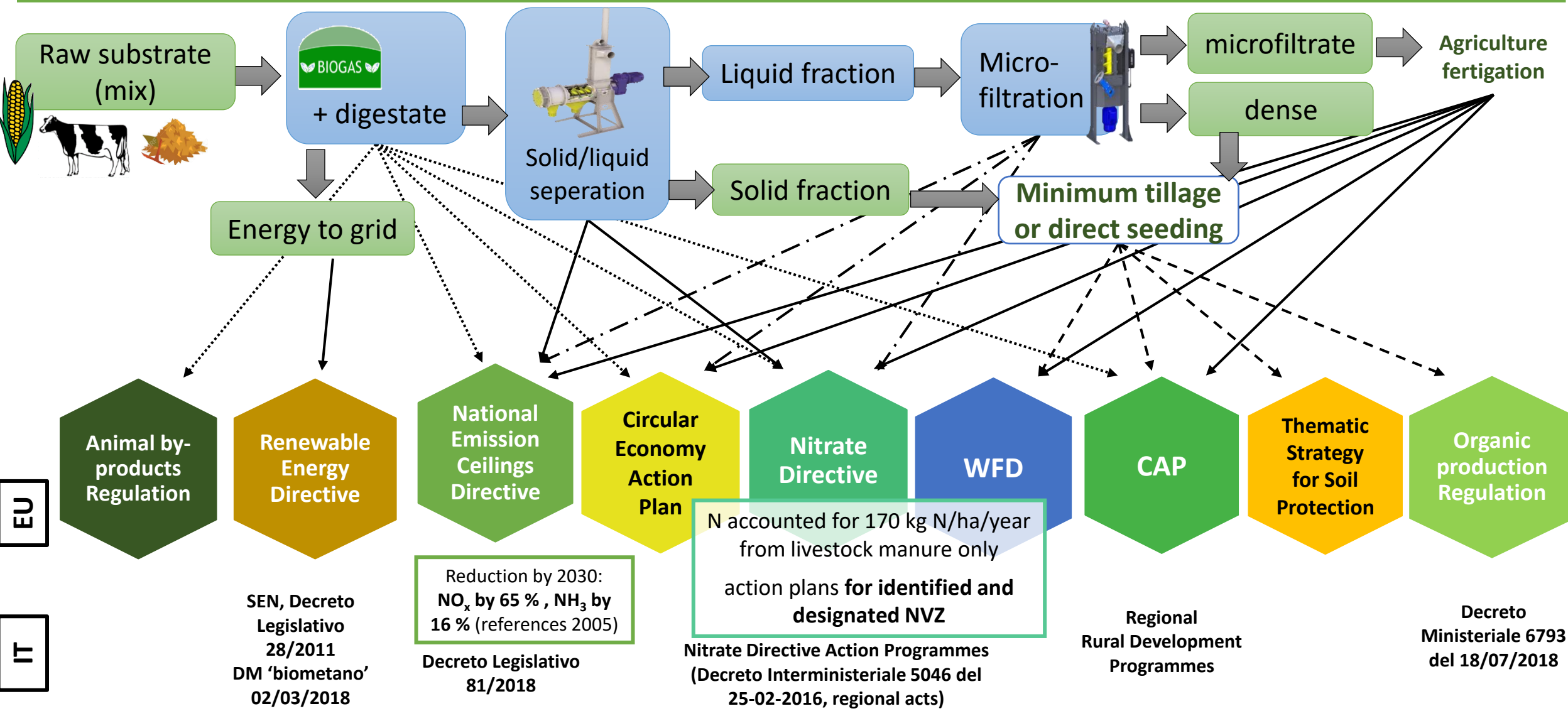


Environmental Policy

Case study Emilia-Romagna, Italy



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N accounted for 170 kg N/ha/year from livestock manure only
action plans for identified and designated NVZ

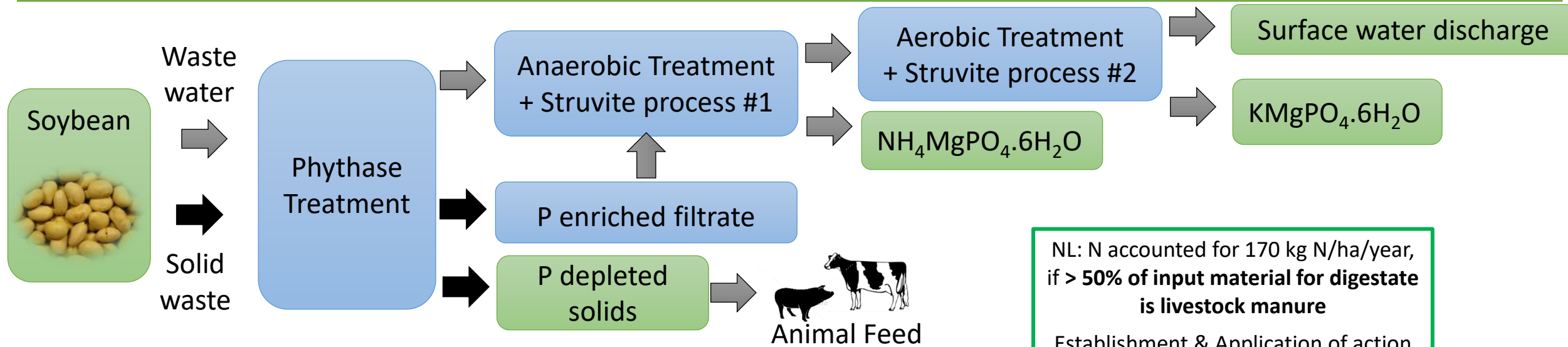
Reduction by 2030:
NO_x by 65 %, NH₃ by 16 % (references 2005)

Environmental Policy

Case study Gelderland, NL



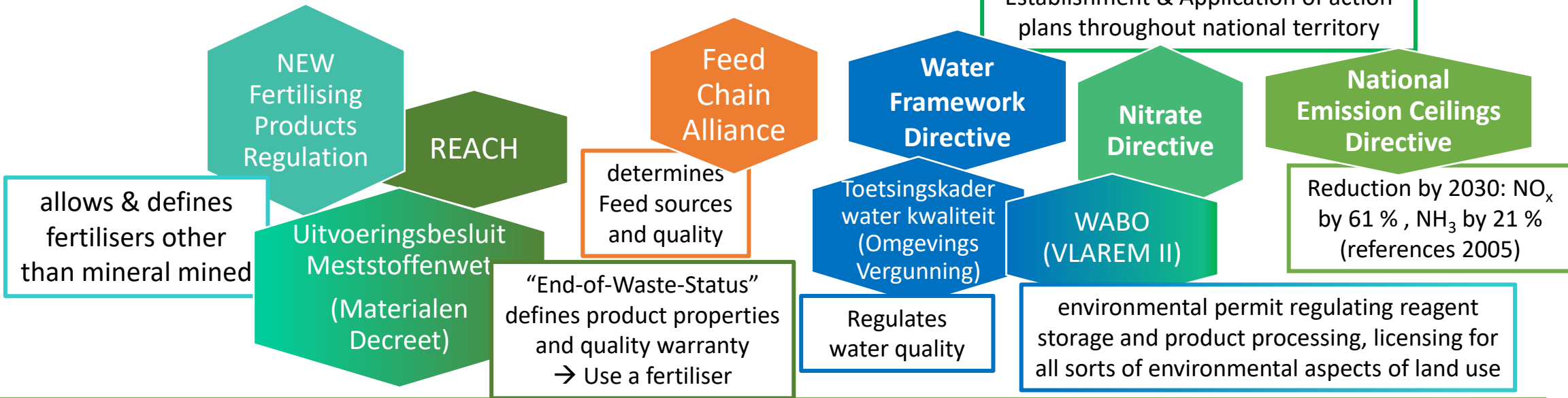
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NL: N accounted for 170 kg N/ha/year, if > 50% of input material for digestate is livestock manure
Establishment & Application of action plans throughout national territory

EU

NL (BE)*



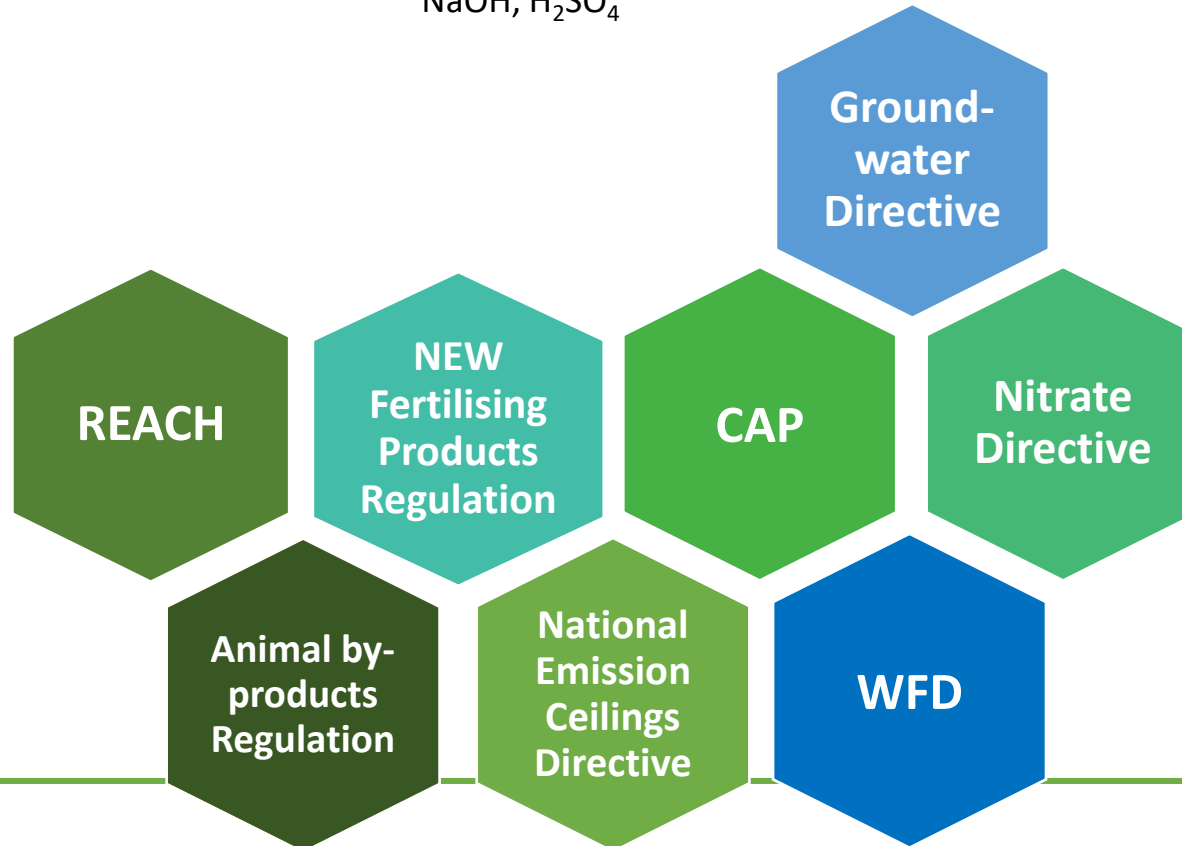
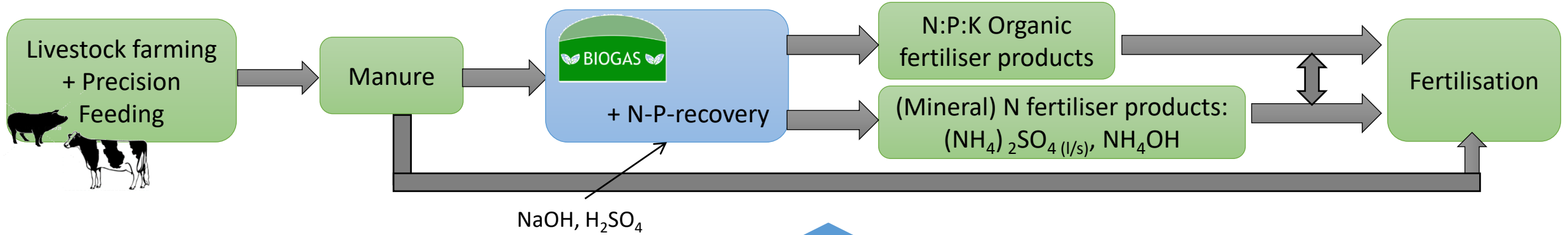
*(struvite production occurs in Belgium, fertiliser application in the Netherlands)

Environmental Policy

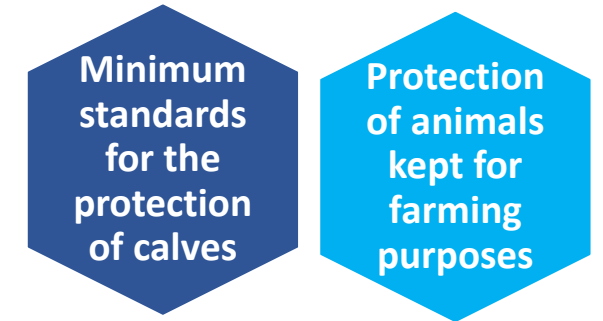
Case study of Catalonia, Spain



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→ To be considered but not within project's scope

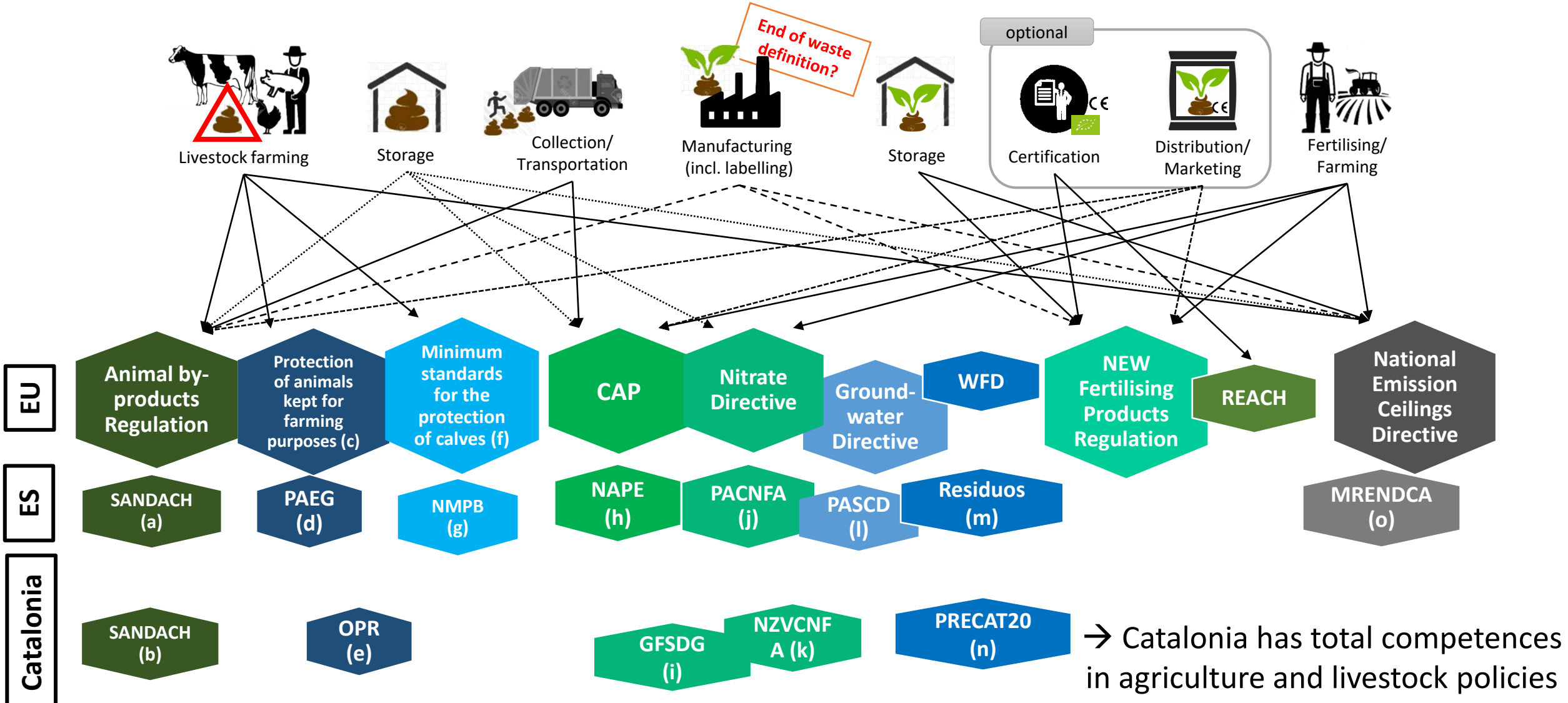


Environmental Policy

Case study of Catalonia, Spain



Horizon 2020 European Union Funding for Research and Innovation (773649)

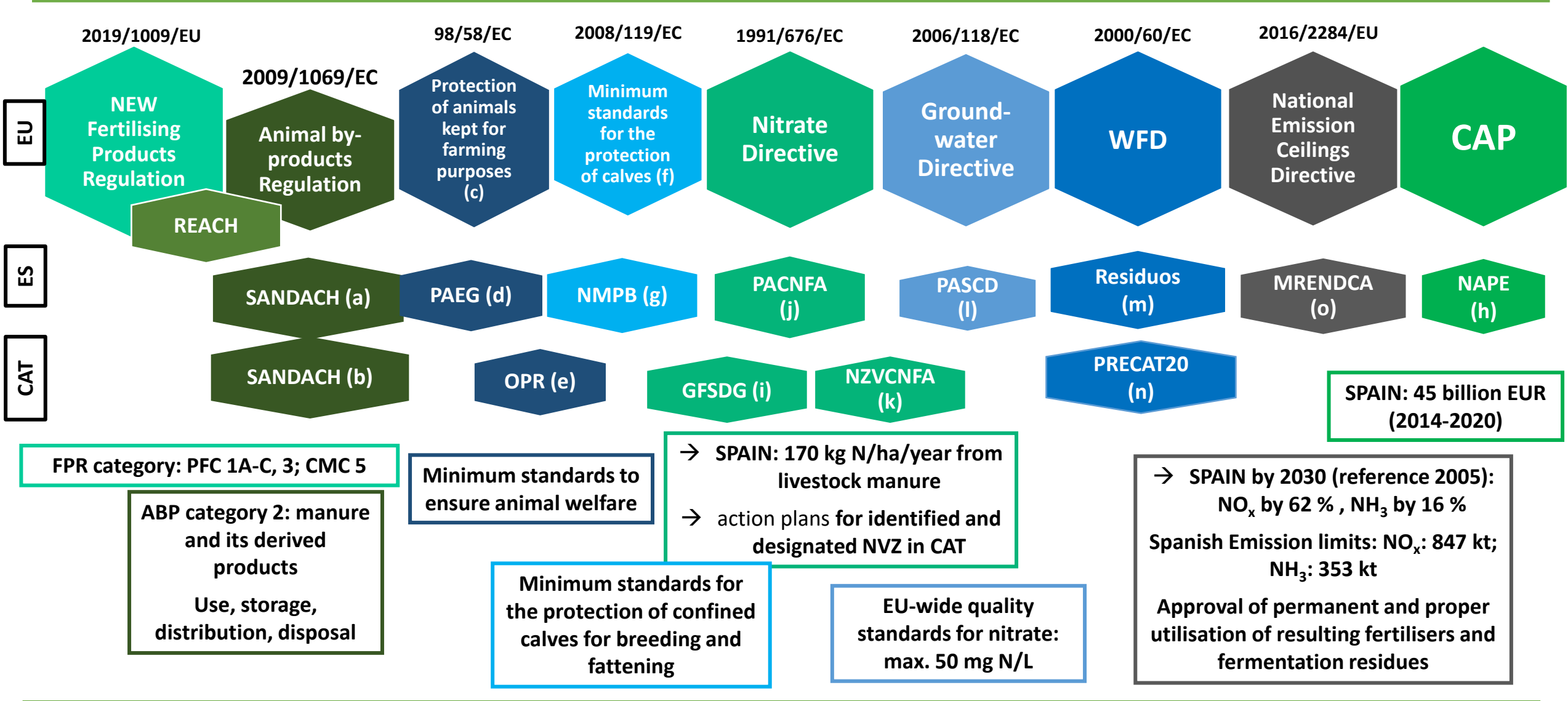


Environmental Policy

Case study of Catalonia, Spain



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Project Number:
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77364
CIRCULAR AGRONOMICS
D5.3. Environmental Policy Analysis

ANNEX II



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Policy Group

Environmental policy analysis

D5.3

lead: SOGESCA,
KWB



1. main policy obstacles



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Related to ...

Product quality/definition:

- End of waste status of product obtained/Digestate is not considered a commercial fertiliser
- Different (= less stringent) legal requirements compared to classic fertilizer
- Public acceptance

Market:

- Negotiate a higher price with the dairy factory
- placing the product in the food retail market, getting access to marked for fertilizer
- set proper marketing activities for the product to be recognized
- General public acceptance of the obtained product

Application/technology:

- Restrictions in Nitrate directive on fertilisation periods
- Too long periods to obtain licenses for implementing a new technology/treatment
- lack of real incentives for the optimized use of digestate
- lack of equipment for conservation agriculture, in particular no till seeders (policy hasn't yet pushed hard enough in this direction)
- Getting construction permit
- limits for proper dosage of acid whey to the field;
- product registration for soil placement
- acid whey storage

→ Obstacles quite case study specific

→ commercial fertilisers more attractive by law and market (legal requirements, application, price,...)

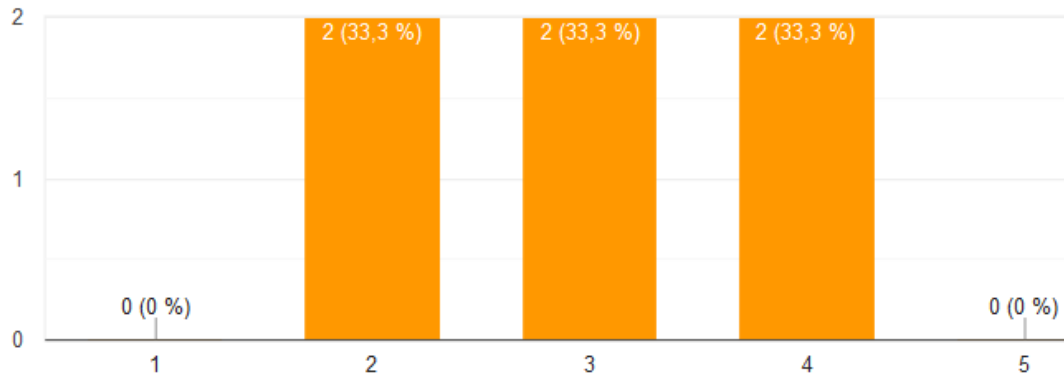
2-4. Legislation (1: not at all – 5: very much)



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Funding for Research and
Innovation (773649)

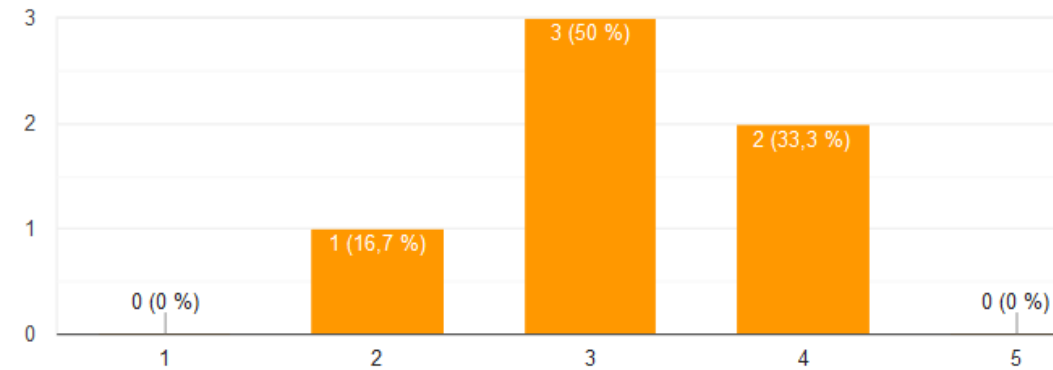
2. Legislation is not always clear to me and I have difficulties in understanding (e.g. definition of waste and by-product, definition of organic fertilizer).

6 Antworten



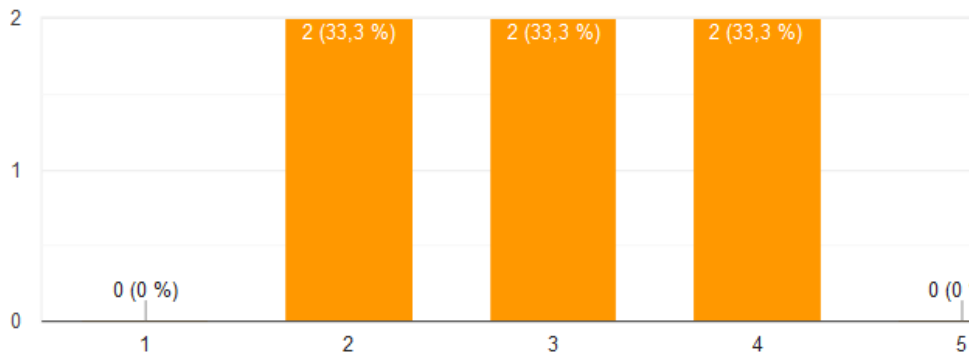
3. How strong is the political commitment on EU level according to Circular Economy solutions in Agriculture?

6 Antworten



4. I think there is a lack of incentives to support sustainable agricultural practices.

6 Antworten



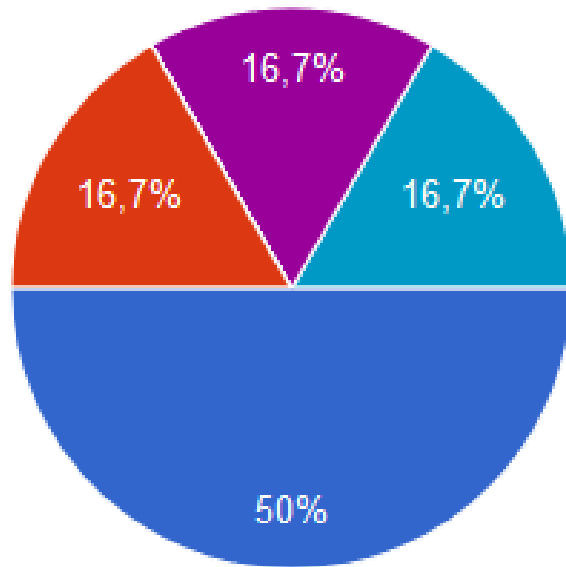
→ If yes: what incentives do you think are weak?

- **Circular Economy:** reuse, recycle of residues & recovery of nutrients, renewable energy use in Spanish farming sector, few positive incentives like support of nutrient recycling
- **R&D support:** demonstration + market replicable studies, innovative machineries + equipments
- **Acceptance:** general information for main public
- **Financial support:** small farmers face uncertain future, no security

5. Main problems related to policy amendment



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- Too long agreement process
- Reluctance to revise existing legislations / resistance to change
- Implementing the new regulations
- Assuming that the status quo is OK
- Focussing on different goals (others than related to sustainable agriculture)
- strong agricultural lobby and agricultural industry fighting against...

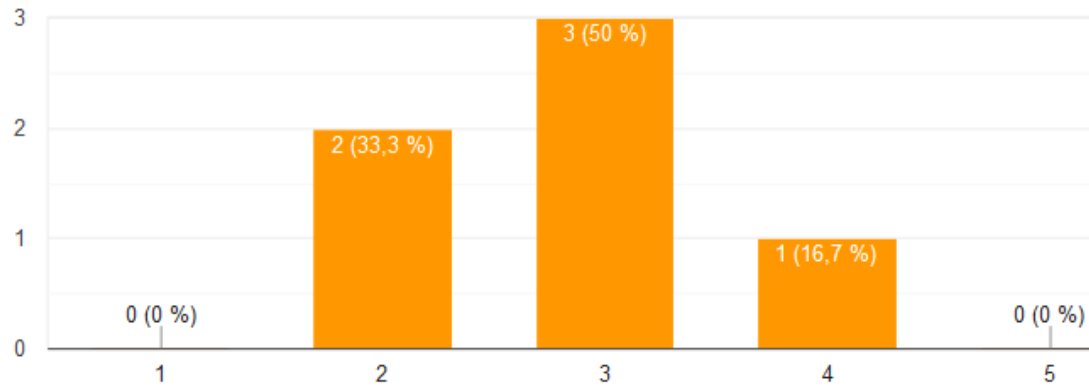
6. Legislation reliability (1: not at all – 5: very much)



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6. Do you experience frequent and sudden legislative changes, which lead to insecurities for farmers in planning their agricultural activities?

6 Antworten



→ If yes: greatest challenges

- annulment of the milk- and sugar quota system
- Lack of **knowledge**: no expert about legislation
- Lack of **security**: Spanish livestock-farming sector strongly influenced by changes in Spanish renewable energies legislation: Farmers would invest more money in environmental sustainable facilities and procedures in case of a clear and secure legislation frame (EU policies should better protect the agricultural sector and give it legal security)
- **Quality**: parameters based on **detection limits** not on actual environmental effect, change of fertiliser regulations

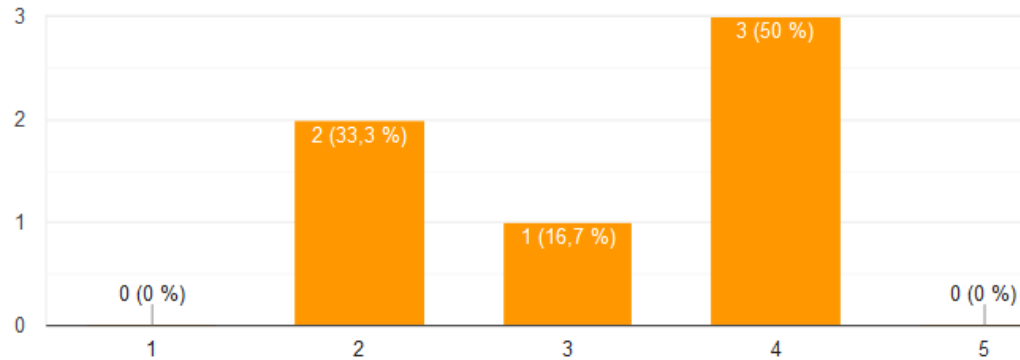
7. National legislation (1: not at all – 5: very much)



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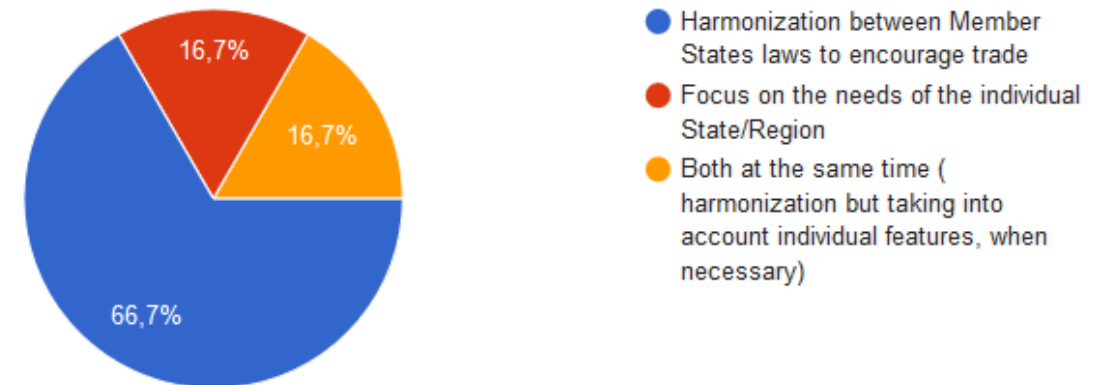
7. Do differences between the national laws of the European states cause difficulty, e.g. in trading?

6 Antworten



In your opinion, which aspect is the more important one?

6 Antworten



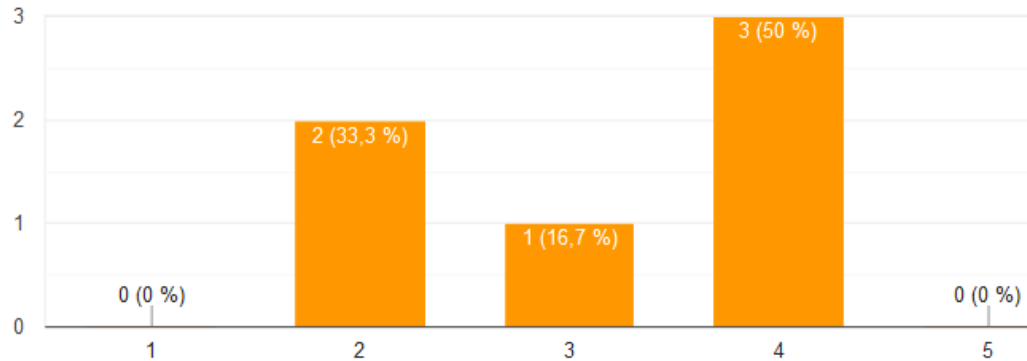
7. Legislation reliability (1: not at all – 5: very much)



Horizon 2020 European Union
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Innovation (773649)

7. How much does a lack of collaboration between different institutions or stakeholders (e.g. policy-makers and practitioners) prevent a more efficient implementation of circular economy solutions?

6 Antworten



- What do you think is the main communication lack and by whom?
- food retail **market** does not communicate the products benefits in a satisfying way
 - **policy makers** not familiar with practical issues, farmers tend to look at their specific interest, Successful demonstration studies, Legal versus **science**
 - policy-makers do not account real needs of the sector (commonly strongly influenced by countries economy, budget allocations, political agreements or pressures from other industrial and political sectors)
 - recycling still seen as "dirty" (slogan "no dirt on our fields"), **Farmers unions and especially organic farming** does not accept "dirty" products. It must be communicated that there is no dirt in nature.

8. crucial cooperations...



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... for developing circular economy-friendly policies

- farmers - dairy factories - food retail market
- research centres - agricultural advisors and associations - policy makers
- effective stakeholder chain that answers needs of every member of a chain
- Financial incentives for recovered products
- all stakeholders within the chain, as “living-lab” in which all links represented (providing evidence-based recommendations from the different points of view, needs and experiences)
- consumers – farmers: Consumers have to tell what product and process quality they want and what farmers should listen and communicate the options present.

- Crucial cooperations depend on comprehensive approaches:
- Communication (policy, science, practitioners and consumers)
 - Market supply and demand
 - Financial incentives

ANNEX III

Case study	Type of stakeholder	Stakeholder	Role	Interest/Influence
GER	Policy makers	Elected decision makers of government	representing the will of voters	responsible for restricting environmental harm but fear too strict measures that could hinder economy
GER	National agencies	agricultural/ environmental agency	representing the legal position	ensuring farmers follow the law
GER	NGOs/Associations	environmental NGO	representing special interest group	changing fertilisation practice
GER	Institutions/ Research	IASP -International Association of Science Parks and Areas of Innovation	representing the scientific view	changing the world for the better
GER	Agricultural suppliers and services	Fertiliser sales	representing an economical group	making money
GER	Farmers	Farmer next door	producing food and energy with land and environment	surviving economically
IT	Policy makers	Italian Ministry of Agriculture, Emilia-Romagna region	issue laws and regulations in the agricultural sector	influences the development of the agricultural sector. Interested in the innovation developed in the case study
IT	National agencies	ISPRA - Italian Institute for Environmental Protection and Research (and the regional Arpae)	environmental monitoring and accounting also in the agricultural sector	influences the policy makers. Interested in the innovation developed in the case study
IT	NGOs/Associations	Farmers Associations (Coldiretti, Confagricoltura, CIA), citizens' committees (sometimes)	represent the interests of their farmer associates, of a group of citizens (committees)	interested in agricultural policy, try to influence it
IT	Institutions/ Research	Universities, Research Centres	develop innovation, in some cases in consultation with the agricultural sector	interested in agricultural policy development/implementation, sometimes influence them

IT	Agricultural suppliers and services	agricultural materials and equipment dealers, technical assistance	interested in the spread of their technical proposals	interested in agricultural policy, try to influence it. Some are very interested in the innovation developed in the case study
IT	Farmers	many different	crops, livestock, bioenergy	Some are very interested in the innovation developed in the case study
AT	Policy makers	Federal Ministry of Agriculture, Regions and Tourism		regional value creation: lowering import dependency; support for small-scaled Austrian agriculture
AT	National agencies	Biosphärenpark Lungau	National Park	Sustainable development of the Lungau region
AT	NGOs/Associations	Chamber of Agriculture	farmers lobby	more consumer appreciation of Austrian agricultural products and reasonable prices; reduce food imports and thus the displacement of Austrian agricultural products by introducing a better designation of origin for agricultural products
AT	Institutions/ Research	AREC	Scientific institute and advice centre for farmers	Generation of agricultural expertise and transfer of this knowledge to both policy makers and farmers
AT	Agricultural suppliers and services	Dairy factory	intermediary between farmers and the food retailing industry	Buys products from the farmers and wants the products to be placed in the supermarkets of the food retail.
AT	Farmers		Producers	Wants to sell products for an adequate price.
AT	Private firms	Food retail industry (Spar, Rewe, etc.)		Wants to maximize returns of their limited shelf space in their supermarkets. When two products compete for shelf space, the less profitable product is removed from the range.
NL	Policy makers	The ministry of agriculture (LNV)	Ministry of Agriculture	Strong influence on agricultural issues nationally
NL	National agencies	NWO https://www.nwo.nl/en - Netherlands Organisation for Scientific Research	national funding agency, The Dutch Research	NWO facilitates excellent, curiosity-driven disciplinary, interdisciplinary and multidisciplinary research.

			Council (NWO)	
NL	NGOs/Associations	nutrient platform (https://www.nutrientplatform.org/en/about-nutrient-platform/)		cross-sectoral network of Dutch organizations that believe in a pragmatic approach towards nutrient scarcity.
NL	NGOs/Associations	https://www.wur.nl/en/Research-Results/Projects-and-programmes/Scientific-Committee-on-Nutrient-Management-Policy/Scientific-Committee-on-Nutrient-Management-Policy.htm		
NL	Institutions/ Research	Wageningen University	Academia and Research	National research
NL	Institutions/ Research	Wageningen Research	Research	
NL	Institutions/ Research	Louis Bolk Institute (organic)	Research	
NL	Institutions/ Research	Nutrient Management Institute	Research	
NL	Agricultural suppliers and services	Dutch mineral fertiliser association (Meststoffennederland): https://www.meststoffennederland.nl/ See their statement on circular agriculture (in Dutch) https://www.meststoffennederland.nl/over-meststoffen-nederland/over-meststoffen-nederland		
NL	Agricultural suppliers and services	ICL fertiliser company	Supplier	
NL	Agricultural suppliers and services	https://www.agrocares.com/en	Testing and advice	
NL	Farmers	Farmers organization LTO	Union/co-operative	Strong influence on agricultural issues nationally
ES	Policy makers	Ministerio de Agricultura, Pesca y Alimentación	Spanish Ministry of agriculture, livestock, fisheries and food	Proposal and implementation of the Spanish Government policies regarding agricultural, livestock and fishing resources, agri-food industry, rural development and food.

ES	Policy makers	Departament d'Agricultura, Ramaderia, Pesca i Alimentació (Catalan Ministry of agriculture, livestock, fisheries and food)	Oficina de fertilització i tractament de dejeccions ramaderes: Catalan fertilisation and manure treatment agency	Legislation, advice and support on fertilisation and manure management and treatment
ES	Policy makers	Departament de Territori i Sostenibilitat (Catalan Ministry of Territory and Sustainability)	Agència Catalana de l'Aigua (ACA): Catalan water agency	Legislation, advice and support on water management, treatment and distribution
			Agència de Residus de Catalunya (ARC): Catalan waste agency	Legislation, advice and support on waste management and treatment
			Direcció General de Qualitat Ambiental i Canvi Climàtic: Catalan pollution and climate change agency	Legislation, advice and support on air quality, pollution and climate change
ES	Associations/non-profit organisations	Asociación nacional de fabricantes de fertilizantes (ANFFE)	Fertiliser manufacturers association	Encouragement quality fertilisation and sustainable productive agriculture
ES	Associations/non-profit organisations	Asociación de jóvenes agricultores (ASAJA)	Farmers association	Standing up for young Spanish crop and livestock farmers rights
ES	Associations/non-profit organisations	Asociación española de fabricantes de agronutrientes (www.aefa-agronutrientes.org)	Agro-nutrient manufacturers association	Contribution to the development and expansion of the agricultural sector. Support to agricultural nutrition
ES	Associations/non-profit organisations	Red española de compostaje (REC, www.recompostaje.com)	Scientific network	Sustainable management of organic waste, treatment and application
ES	Associations/non-profit organisations	Asociación Española de Productores de Vacuno de Carne (ASOPROVAC)	Spanish livestock farming association	Advice to beef cattle farmers
ES	Associations/non-profit organisations	Confederación de Asociaciones de Frisona Española (CONAFE)	Spanish livestock	Development of programs aimed to the improvement

			farming federation	and selection of the Friesian breed
ES	Associations/non-profit organisations	Federación Española de Industrias de la Alimentación y Bebidas (FIAB)	Spanish food and beverage industry federation	Standing up of the interests of the food and beverage sector
ES	Associations/non-profit organisations	Asociación Nacional de Especialistas en Medicina Bovina de España (ANEMBE)	Spanish Veterinarian professional association	Veterinarian with an interest in dairy and fattening cattle, created with the aim of promoting the exchange of knowledge, providing continuous training and dialogue forum
ES	Associations/non-profit organisations	Organización interprofesional láctea (INLAC)	Organisation of producers and processors of cow, sheep and goat milk	Representative of the common interests of the Spanish producers and processors of cow, sheep and goat milk
ES	Associations/non-profit organisations	Federació de Cooperatives Agràries de Catalunya (FCAC)	Farming federation (associations group)	Representation and defense of Catalan agricultural cooperative movement in order to strengthen economic and social activity of the sector
ES	Associations/non-profit organisations	Associació de Productors de Conreus Extensius de Girona	Farming association	Advice to farmers
ES	Associations/non-profit organisations	Federación Frisona de Catalunya (FEFRIC)	Catalan livestock farming federation	Jointly dairy control of Catalan Friesian cow sector based on a own joint infrastructure
ES	Associations/non-profit organisations	Joves agricultors i Ramaders de Catalunya (JARC)	Farmers association	Standing up for young Catalan crop and livestock farmers rights
ES	Associations/non-profit organisations	Unió de Pagesos de Catalunya (UP)	Farmers association	Standing up for Catalan crop and livestock farmers rights
ES	Farming cooperatives/farmers	Cooperativas Lácteas Unidas (FEIRACO / CLUN)	Farming cooperative	Advice, Joint farm management, agricultural products suppliers
ES	Farming cooperatives/farmers	Cooperativa de ganaderos de Asturias (ASCOL)	Farming cooperative	Advice, Joint farm management, agricultural products suppliers
ES	Farming cooperatives/farmers	Agrupació de Cooperatives de les Terres de Lleida (ACTEL)	Farming cooperative	Advice, Joint farm management, agricultural products suppliers
ES	Farming cooperatives/farmers	Cooperativa d'Ivars d'Urgell	Farming cooperative	Advice, Joint farm management, agricultural products suppliers
ES	Farming cooperatives/farmers	Grup Cooperativa d'Artesa de Segre	Farming cooperative	Advice, Joint farm management, agricultural products suppliers

ES	Farming cooperatives/farmers	Grup Vall Companys	Farming cooperative	Advice, Joint farm management, agricultural products suppliers
ES	Farming cooperatives/farmers	Cooperativa Agropequària de Guissona (CAG)	Farming cooperative	Advice, Joint farm management, agricultural products suppliers
ES	Farming cooperatives/farmers	Cooperativa Plana de Vic	Farming cooperative	Advice, Joint farm management, agricultural products suppliers
ES	Farming cooperatives/farmers	Cooperativa Agrària de Torelló	Farming cooperative	Advice, Joint farm management, agricultural products suppliers
ES	Farming cooperatives/farmers	Cooperativa Agrària de Banyoles	Farming cooperative	Advice, Joint farm management, agricultural products suppliers
ES	Farming cooperatives/farmers	Agrària del Vallès	Farming cooperative	Advice, Joint farm management, agricultural products suppliers
ES	Farming cooperatives/farmers	Granges Terragrisa	Pig farming	Investor on sustainable manure management and treatment
ES	Farming cooperatives/farmers	Porgaporcs S.L.	Pig farming	Investor on sustainable manure management and treatment
ES	Farming cooperatives/farmers	Mas Bes S.L.	Dairy farming	Investor on sustainable manure management and treatment
ES	Institutions/ Research	SERIDA	Asturian institute for agri-food research	Contribution to the modernization and improvement of the capacities of the agri-food sector by fomenting and carrying out technological research and development
ES	Institutions/ Research	IRTA	Catalan institute for agri-food research	Contribution to the modernization and improvement of the capacities of the agri-food sector by fomenting and carrying out technological research and development
ES	Institutions/ Research	CIAM	Galician institute for agri-food research	Contribution to the modernization and improvement of the capacities of the agri-food sector by fomenting and carrying out technological research and development

ES	Institutions/ Research	NEIKER	Basque institute for agri-food research	Contribution to the modernization and improvement of the capacities of the agri-food sector by fomenting and carrying out technological research and development
ES	Institutions/ Research	INTIA	Navarre institute for agri-food research	Contribution to the modernization and improvement of the capacities of the agri-food sector by fomenting and carrying out technological research and development
ES	Private Companies	Tecnozoo	Technology manufacturer and supplier	Technology development for dairy sector
ES	Private Companies	AlfaLaval	Technology manufacturer and supplier	Technology development for waste treatment
ES	Private Companies	Hipra	Sanitary products manufacturer and supplier	Scientific support to animal health, vaccine development
ES	Private Companies	GEA	Technology manufacturer and supplier	Technology development for waste treatment
ES	Private Companies	Zoetis	Sanitary products manufacturer and supplier	Scientific support to animal health, vaccine development
ES	National agencies	The Spanish Research Council (CSIC)		
CZ	Policy makers	Ministry of Agriculture	Governmental institution	No/Yes
CZ		Ministry of Environment of the Czech Republic	Governmental institution	No/Yes
CZ	National agencies	Central Institute for Supervising and Testing in Agriculture	Agency	Yes/Small
CZ		Environmental State Fund of the Czech Republic	Agency	No/Small
CZ	NGOs/Associations	Czech-Slovak Dairy Union	Agency	No/Yes
CZ		Zera, a.s.	Agency	No/None
CZ		INCIEN, a.s.	Agency	Yes/Small
CZ		The Association of the Private Farming of the Czech Republic	Agency	No/None
CZ		Agricultural Association of the Czech republic	Agency	No/None

CZ		Food Processing Chamber of the Czech Republic	NGO	No/None
CZ	Institutions/ Research	Mendel University Brno,	Research	None/Opinion makers
CZ		University of Chemical Technology Prague, Department of Dairy, Fat and Cosmetics	Research	None/Opinion makers
CZ		University of Veterinary and Pharmaceutical Sciences Brno, Faculty of Veterinary Hygiene and Ecology	Research	None/Opinion makers
CZ		University of South Bohemia in České Budějovice, Faculty of Agriculture	Research	None/Opinion makers
CZ		Czech University of Life Sciences, Faculty of Agrobiological Sciences, Faculty of Agrobiological Sciences, Faculty of Natural Resources, Praha	Research	None/Opinion makers
CZ		Czech Academy of Sciences	Research	None/Opinion makers
CZ		Research Institute for Fodder Crops, Ltd. Troubsko	Research	None/Opinion makers
CZ		Crop Research Institute	Research	None/Opinion makers
CZ		Research Institute of Agricultural Engineering	Research	None/Opinion makers
CZ		Research Dairy Institute	Research	None/Opinion makers
CZ	Agricultural suppliers and services			
CZ	Farmers	Agritec	Company	No/None
CZ		Agrofert Holding	Main company in the whole field, owner of all big companies	Maybe/big
CZ		BONAGRO, a.s.	Company	No/Small
CZ	Acid whey producers	MADETA, a.s.	Company	Yes/Big
CZ		OLMA, a.s.	Company	No/Big
CZ		Choceňská mlékárna	Company	No/Average
CZ		MoraviaLacto	Company	Yes/Average
CZ		Polabské mlékárny	Company	No/Average
CZ		Groupe Lactalis	Company	No/Average
CZ		Fromageries Bel	Company	No/Average
CZ	Acid whey re-processors	All-impex	business company	No/None
CZ		MEGA, a.s.	business company	Yes/Average

CZ		Membrain	business company	Yes/Average
CZ	Fertilising companies	Agrofert, a.s.	Main company in the whole field, owner of all big companies	Maybe/Big
CZ		ELITA semenářská, a.s	business company	No/Small
CZ		Fertistav, spol. s r.o.	business company	No/Small
CZ		ChemapAgro	business company	No/Small
CZ		Lovochemie, a.s.	Important company	No/Average
CZ		YARA Agri, Česká republika	Important company	Maybe/Average
CZ		Fosfa, a.s.	Important company	Maybe/Average
CZ		Ecolab	Important company	No/Small
CZ		Agro CS	Important company	No/Small