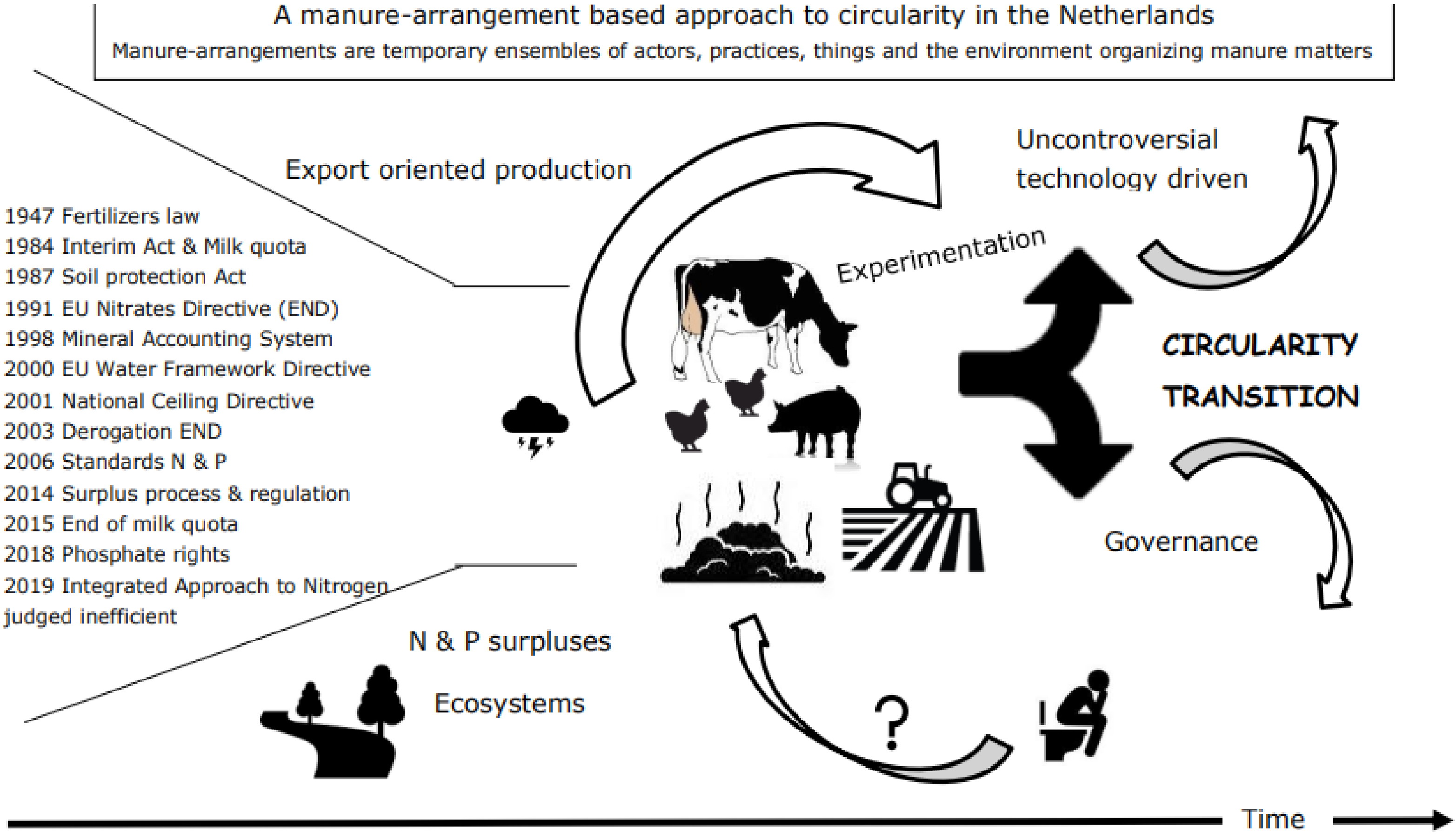

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Report 1366

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A manure-arrangement based approach to circularity in the Netherlands - Perspective

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Samenvatting NL: *Mest is een belangrijk element in de transitie naar een kringloop landbouw en maatschappij. Er zijn landen en gebieden waar mest echter controversie veroorzaakt vanwege het intensieve karakter van de veehouderij en milieuproblemen. In deze gebieden kan mest een remmend effect op de transitie hebben. In dit rapport wordt een mest-arrangement benadering toegepast om de rol van mest in de transitie in Nederland te bestuderen. Mest-arrangementen zijn tijdelijke ensembles van actoren, praktijken, dingen (bijv. technologie) en het milieu die mest gerelateerde aspecten organiseren. Dit verkennende onderzoek vat het belangrijkste beleid en regelgeving rondom mest in Nederland samen. We stellen dat het huidige beleid en andere structuren, tot op zekere hoogte, de ruimte voor het experimenteren met circulaire praktijken belemmeren. Vervolgens wordt gereflecteerd op de contradicties van de huidige implementatie van circulariteit binnen een groei- en export-georiënteerde economie. Tenslotte kijken we ook, vanuit een mestarrangement benadering, naar de opvallende afwezigheid van menselijke 'mest' en mineralen in de kringlooptransitie.*

Summary UK: *Manure is an important element in the transition towards a circular agriculture and society. However, in certain regions of the world with intensive forms of livestock production manure generates some environmental challenges and controversies which might hinder the transition. In this report we deploy a manure-arrangement approach to explore the role of manure in the circularity transition that is currently being organized in the Netherlands.* Manure-arrangements *are temporary ensembles of actors, practices, things (e.g. technology) and the environment organizing manure matters. In this exploratory research, we summarize key policies regulating Dutch manure. We argue that current policy and other structures hinder, to a certain extent, the space for experimentation and expansion of circular practices. Then, we elaborate on some tensions that emerge by applying the concept of circularity in a growth and globally oriented economy. Finally, from a manure-arrangement perspective, we also address the question regarding human excreta as a missing element in the transition towards more circular livestock and agricultural practices.*

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1 Introduction

Manure produced by livestock has been a source of minerals and of organic matter since the early days of agriculture (Jones, 2012). It was just in the eighteenth and nineteenth century that experimentation, production and application of chemical fertilizers started (ibid.), and it was recently, during the so-called Green Revolution in the 1950s and 1960s of the past century, when chemical fertilizers were globally adopted to become now one of the most common fertilization-practices in the industrialized world.[1] Criticisms and doubts about the sustainability of this practice and a focus on concepts such as circularity have induced renewed attention of policymakers and practitioners to organic fertilizers including manure. Besides, research reports positive results for the application of organic fertilizers regarding yields (particularly in combination with reduced percentages of inorganic fertilizers), nitrogen (N) use efficiency, soil organic matter and soil microbial activity (Kuzyakov et al., 2000; Hua et al., 2020; Ye et al. 2020).

Circularity is becoming a key policy objective in the EU (e.g., EC, 2015; EC 2018), the overall goal is to close material circles to protect the environment without losing economic prosperity. Moreover, manure is currently taking an important position in the discourses and practices aimed at elaborating and implementing the principle of circularity. Our focus here is on manure within the growth-oriented Dutch agriculture. In line with other EU countries, the Ministry of Agriculture, Nature and Food Quality of the Netherlands has developed a vision aimed at reshaping the Dutch agricultural sector into a 'world leader in circular agriculture.' In this vision we can read the following:

> 'Soil management works towards applying processed animal manure while steadily reducing artificial fertilisers. That way arable land and pastures receive high-quality organic fertiliser based on crop residues or manure. This will ensure that the currently still significant role for artificial fertiliser keeps diminishing. Putting an end to the use of artificial fertiliser based on scarce fossil raw materials (phosphate, potassium, natural gas) will also further reduce greenhouse gas emissions from the production of artificial fertiliser.'[2]

Manure, however, has also become a controversial issue, particularly in regions with intensive livestock production (Åkerman et al., 2020), such as the Netherlands. Actual conventional practices regarding manure might make of it a problem and a barrier for the transition rather than a pivotal material for soil restoration and fertilization. The export oriented and economically (and in terms of feed-conversion efficiency) successful Dutch livestock production generates a manure surplus which is beyond the sustainable boundaries of local ecosystems (Bos et al., 2013; Schoumans et al., 2019; see here Section 3.1) and, therefore, policy and regulatory frameworks have been built to minimize negative environmental effects. In this context, traditional structures, regulatory frameworks, and practices co-exist with emerging initiatives which are currently giving form to the circularity-concept within the livestock and agriculture domains.

In this report we elaborate on the concept of manure-arrangements for gaining a better understanding of current sociological dynamics and tensions concerning the role of manure in the transition towards more circular agricultural practices. The next section elaborates on the manure-arrangements approach. Then we elaborate some relevant topics which characterize how manure-arrangements are shaped and shape the circularity transition in the Netherlands: First (Section 3.1), we provide an overview of the main policies, from the 1950s until now, concerning manure and elaborate on how they influence the transition. Second (Section 3.2), we reflect on how current manure-arrangements organized around policies and other specific local structures and aspects influence the creation of space for experimentation with circularity. Third (Section 3.3), we elaborate on some tensions that arise when the circularity concept is implemented within the growth and export oriented Dutch livestock and agricultural context and economy. Finally (Section 3.4),

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[1] The FAO reports that the highest nitrogen inputs per cropland area were computed for Egypt (367 kg N/ha), Netherlands (243 kg N/ha), and China (220 kg N/ha). http://www.fao.org/economic/ess/environment/data/mineral-and-chemical-fertilizers/en/ (accessed June 2020).

[2] https://www.government.nl/ministries/ministry-of-agriculture-nature-and-food-quality/documents/policy-notes/2018/11/19/vision-ministry-of-agriculture-nature-and-food-quality---english (accessed January 2021).

we address a topic that is currently neglected, i.e., human excreta as a potential source of nitrogen (N) and phosphorus (P) and organic matter, and therefore, a missing element of current manure-arrangements within this agricultural context. We close the report (Section 4) with a reflection on the role of these arrangements within the transition towards circular and sustainable practices.

2 A manure-arrangements based approach

The circularity transition needs to be meaningful for different stakeholders at the same time that it provides ecological solutions for the environment. Here, we aim to explore how manure-arrangements are organized within the Dutch context and what is the role of manure in the transition. Manure-arrangements as a conceptual approach is a specific application of policy-arrangements (Arts et al., 2000; Arts & van Tatenhove, 2004; Arts et al., 2006) including materiality. Arts et al. (2006) defined policy arrangements 'as the temporary stabilization of the content and organisation of a policy domain.' By definition these arrangements take a multi-level character and are created in the interaction between actors and policies and structures and change. Manure-arrangements, particularly in the Dutch context, are closely related to governance. While governing, e.g. by means of EU directives (see below), implies top-down management through governmental organizations and law, governance highlights a multitude of networks of, and relations among stakeholders engaged in practice. The concept of governance is widely used in political and social sciences to capture the way in which a specific policy domain or issue of general/public interest, such as the environment, energy, or agriculture, is organized and managed (Kooiman, 2003; Arnouts et al., 2012). Governmental and non-governmental organisations are usually involved in governance-arrangements (Arts & van Tatenhove, 2004; Arts et al., 2006).

More specifically, in this study we approach manure from a co-production and science and technology studies perspective. In this way we not only look into some governance aspects, but also into some material elements of organizing manure and agricultural matters as well as circularity (Law & Mol, 2008; Åkerman et al., 2020). Manure-arrangements are here defined, therefore, as temporary ensembles of actors, practices (including doings, rules and meanings), things (e.g. technology) and the environment organizing manure matters. Subsequently, 'manure' is here understood as a multi-factorial (material and social) issue in which stakeholders are involved at different levels and at a particular moment in history.

From our manure-arrangement approach manure is not only the excreta of husbandry animals, but it is understood as a coproduction of animals in interaction with ecosystems and social systems. Manure (and this integral approach) is a relevant link to organize sustainable biogeochemical cycles and, therefore, an important element within the circularity transition. Ruminants, for instance, eat grass and other type of plants that also grow in relative unfertile regions and which humans are unable to digest. Moreover, they transform them into highly valuable human-edible proteins such as milk or meat, and the fertilizer manure – as well as into mechanical and thermal energy and greenhouse gasses, of course. Furthermore, manure is also a political issue, particularly in regions with a high density of farm animals. For example, because of its contribution to climate change (Gerber et al., 2013; Reisinger & Clark, 2017) or because of ammonia emissions and subsequent nitrogen deposition that threatens biodiversity (Stevens et al. 2010; Guthrie et al., 2018).

Therefore, regarding manure, change is required at different levels to enable a transition towards more circular practices. Technical innovations (in the fields of, e.g., bio-digestion or composting), farm system innovations, new rules and perceptions, market innovations and scientific knowledge are all required. Regarding knowledge, Schoumans et al. (2019) argue that a better understanding of the interaction between manure (and other organic fertilizers), soil, productivity and risk is required to be able to quantify the economic value of manure in the transition. Moreover, changes at the policy level and new governance-arrangements are also required, partially induced by requirements from national and EU directives. E.g., in the Dutch context, changes are required to meet the 'Nitrates Directive' (Council Directive 91/676/EEC) that aims to reduce and prevent water pollution caused by nitrates run-offs from agricultural sources (e.g., manure). The Nitrates Directive forms an integral part of the Water Framework Directive (WFD) and is one of the key instruments in the protection of waters against agricultural pressures in the EU. Currently, the Netherlands does not meet the requirements of these directives.

Our understanding of governance-arrangements builds thus on the fields of science and technology studies and the sociology of knowledge (Latour, 2005; Yearly, 2005). It is, moreover, inspired by the concepts of practice (Bourdieu, 1977) including materiality (Shove et al., 2012; Arts et al., 2014) and the duality of structure (Giddens, 1984) that shows that social institutions and rules both influence and are influenced (produced and reproduced) by actors. The approach builds also on the language of co-production (Jasanoff, 2004), meaning that social, technological and environmental factors, elements and structures interact, influence and shape each other in time.

This science and technology type of approach suggests, to a certain extent, a relevancy symmetry among the material and social elements, in their interaction on practice. However, here, we have not conducted natural science research neither we make quantifications concerning biological, chemical and other natural science type of analyses, these are beyond the scope of this research. We, nevertheless, refer to this type of data/literature when required.

Methodological notes

This exploratory research focuses on some policy, material, governance and sociological aspects of manure-arrangements within the circularity transition in the Dutch context. We have conducted a desk research to, for instance, highlight how manure has been regulated in the last decades in the Netherlands, or to refer to the N and P balance of the country. Thirteen interviews with experts and livestock farmers have been conducted.[3] Some of these interviews were conducted in the 'experimental regions' which are supported (since the fall of 2019) by the Dutch Ministry of Agriculture, Nature and Food Quality, an in which physical and legal space for experimentation is created to give form to circularity (De Haas et al., 2021). Tests and pilots are conducted in these regions, for instance, with 'new' crops, environmentally friendly livestock housing systems, citizens and farmers cooperation to monitor air pollution, new sources of organic matter such as plant residual flows from natural, municipal or roads areas, etc.[4] This experimental regions are:

- Agro-proeftuin de Peel[5]: It focuses on the production of alternative-protein, fodder and biomass; soil health and low emissions livestock housing.
- Mineral Valley Twente[6]: Regional food production chain, manure, soil and water quality.
- Agro-innovatieregio Achterhoek: Promoting innovations in the agricultural sector and nature inclusive agriculture.
- Akkerbouw Flevoland: Precision agriculture and healthy soils.
- Agro-agenda Noord-Nederland[7]: Sustainable dairy production, smart farming, and biomass.

These experimental regions are, from the governmental perspective, also seen as a policy experiment to find out which legal barriers encounter circularity experiments. One of the authors of this report is involved in the regular meetings that are organized between ministry officials and managers of the circularity programs in these regions. Moreover, the authors of this report are currently involved in other projects in which manure, livestock and circularity play a central role.[8] Currently, there is a lively dynamic going on around circularity in the Netherlands and experiments and reflection are organized on this topic in which the authors actively participate. Therefore, here, we build also in this type of knowledge and expertise.

[3] Some relevant questions and topics that we have discussed with stakeholders and that guides our analysis are, for instance: How is manure defined/seen by stakeholders? And this in relation to ecosystems. How is manure regulated? E.g., through law and rules in the conventional livestock sectors or through experimental regions. What stakeholders (networks) are involved? What practices characterize the manure arrangement? E.g., socio-technological practices concerning storage, processing, application, and management. Or general questions regarding their vision of circularity and how their practices reflect this understanding.

[4] https://www.platformkringlooplandbouw.nl/ (accessed November 2020).

[5] https://www.agroproeftuindepeel.nl/ (accessed January 2021).

[6] https://mineralvalley.nl/ (accessed January 2021).

[7] https://www.agroagendann.nl/ (accessed January 2021).

[8] For example, the project 'connected circularity' (www.wur.nl/en/Research-Results/Research-programmes/Research-investment-programmes/Connected-circularity.htm, accessed January 2021); Policy-supporting research on climate change ('Climate Envelope'), or on antimicrobial resistance in a circular livestock production (Puente-Rodríguez et al., 2019).

3 The role of manure-arrangements in the transition towards circularity

In this section we elaborate on some relevant aspects regarding the role of manure in the transition towards more circular agricultural practices in the Netherlands. First, we elaborate on the evolution of manure volumes and policies since the 1950s until now. Second, we reflect on how manure-arrangements organized around these policies and material aspects together with other specific local characteristics and structures influence the creation of space for experimenting with circularity. Third, we elaborate on the question: towards which type of circularity-endpoint is the Dutch transition moving? Finally, we argue that human excreta are a missing element of current manure-arrangements within the domain of agriculture.

3.1 Made in Holland – policy, volumes and nutrient aspects of the arrangement

In the Netherlands, there are millions of farm animals producing millions of kilograms of manure. In 2019 it was estimated that there were more than 100 million chickens producing around 1.266 million kilograms of manure, about 12.3 million pigs excreting about 10,000 million kg, approx. 4 million cattle producing approximately 60,737 million kg manure, 918,000 sheep, 968,000 ducks for slaughter, 632,000 turkeys, more than 600,000 goats, 336,000 rabbits and about 90,000 horses and ponies (CBS Statline). It is estimated that, in 2019, in total 74,602 million kg of manure were produced in the Netherlands (see table 1).

Table 1 *Historical perspective of Dutch manure production (Source CBS Statline June 2020[9]).*

Year	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	**2010**	**2016**	**2017**	**2018**	**2019**
Million kg	49,019	60,696	68,192	85,634	87,445	75,558	72,172	78,211	77,878	75,180	74,602

More than half of the total area and two thirds of the land area of the Netherlands is used for agriculture and horticulture.[10] This area is, nevertheless, not enough for safely 'digesting' the manure produced (see Fig.1). Dutch government and the European parliament have developed policies to avoid soils, ground- and surface waters pollution.

3.1.1 Chronological overview of (recent) Dutch (and European) manure policies and regulations

- 1947 - Fertilizers law (from the Dutch, Meststoffenwet): Regulation of transport or sale of fertilizers.[11]
- 1967 - Nuisance act (from the Dutch, Hinderwet): Permanent manure storage required to get a livestock farm permit (Brussaard & Grossman, 1990).
- 1984 -Interim Act limiting pig and poultry production. Prohibition on the building an expansion of pig and poultry barns in some regions in the Netherlands. Farmers in those sectors owned usually little agricultural land (van Eerdt et al., 2005; Willems & van Grinsven, 2011, Leenstra et al., 2014-2019).
- 1984 - Milk quota imposed from the EU: It affected the Dairy sector limiting the production of milk, and of manure.
- 1987 - Fertilizers Act and Soil protection Act, organizing the manure production rights (since 1996, it is the national implementation of the EU Nitrates Directive) and 1987-88 controlling the (seasonal) timing and method for the application of manure. The application standards focused on phosphate (P205) quantities as this, apparently, is easier estimable than N (van Eerdt et al., 2005).

[9] https://opendata.cbs.nl/statline/#/CBS/en/dataset/83981ENG/table?ts=1604318026244 (accessed November 2020).
[10] https://www.clo.nl/indicatoren/nl2119-agrarisch-grondgebruik- (accessed November 2020).
[11] https://wetten.overheid.nl/BWBR0002028/1967-08-09 (accessed November 2020).

- 1991 - European Nitrates Directive (END): Prevent pollution of (vulnerable) ground and surface areas as well as coastal areas because of the N-agricultural sources. The END forced EU countries to designate regions vulnerable to nutrient pollution. The Netherlands chose to apply it to the whole territory. The objective was to search for an agricultural N input-output balance, imposing a restriction in its application, meaning, a maximum of 170 kg N per ha per year (van Eerdt et al., 2005; Leenstra et al., 2014-2019). At that time, and if applied (see here below) to livestock production in the Netherlands, it could have meant a serious reduction of livestock volume. Here is where a farm mineral-balance approach came in.
- 1998 - Mineral Accounting System (MINAS) (to enforce EU Nitrates Directive): Regulates nutrient (phosphorus and nitrogen) balance between inputs (animal feed and fertilizers) and outputs (manure, crops and livestock products) per hectare at the farm level, imposing a tax to farms that exceeded a demarcated limit (Oenema & Roest, 1998; Ondersteijn et al., 2002; van Eerdt et al., 2005).
- 2000 - European Water Framework Directive (WFD). The European Nitrates Directive is an integral element of the WFD, and it is aimed at protecting surface and groundwater from agricultural practices.
- 2001 - National Ceiling Directive (NCD) to reduce ammonia emissions. Reduction of ammonia emissions from housing, storage and application of manure. It defined emission ceilings for the European countries (van Grinsven et al., 2016).[12]
- 2003 - Derogation of restrictions under the European Nitrates Directive. The Dutch successfully asked for a derogation of these ceilings and were allowed to apply 250 kg N per ha per year on grassland (instead of 170 kg N ha/year) due to a claimed high N uptake and long growing seasons of Dutch grasslands (Ondersteijn et al., 2002; van Grinsven et al., 2016).
- 2006 - Application standards for N and P (replacing MINAS) which included strict (stricter than other European countries) statutory levels of N in manure.
- 2014 - A fraction of the manure surplus produced on a farm must be processed (Leenstra et al., 2014-2019; van Grinsven et al., 2016) making of manure (surplus) a costly item for farmers. Since 2014 Dutch government sharpened manure regulation through, e.g., mandatory independent sampling of solid manure, enforcement of the use of GPS equipment in manure transport vehicles. This to avoid fraudulent practices which, nevertheless, occur.[13]
- From 2015 on, the EU, because of the poor water quality, asked the Dutch government to increase grassland to 80% of agricultural land and to reduce N application to a maximum of 230 kg N ha/year (for sand and losses areas) (van Grinsven et al., 2016).
- 2015 - End of the European milk quota system, because of which some, within the Dairy sector, intensified their farms before the expiration. The government reacted with conditions concerning P within the WFD.
- (First of January) 2018 - Phosphate rights for dairy farmers where given to dairy farms according to the number of cattle present in the farm on the first of January. P-rights can be traded. However, in each transaction 10% of the rights is withdrawn from the market by the government (Neeteson, 2000).
- In May 2019 the Dutch Council of State (highest administrative court) judged the Integrated Approach to Nitrogen (PAS) as inefficient to reduce the national emissions of nitrogen oxides and ammonia under the levels required by the European directive. The PAS started on July 2015 and it was imposed for the implementation of the European Habitat Directive while, at the same time, facilitating economic development. Farms expansion's permits, but also permits for infrastructures or housing were stopped. It followed a massive protest of farmer groups who brought their tractors, literally, to the doors of the regional and national institutions. The mass media labels the current situation as 'the nitrogen crisis.'

From a policy perspective, one could argue that, in the last decades, the manure-arrangement is evolving from a regulation of volumes (of animals, of transportation, or of milk) and a kind of consensus regarding the need of high livestock productivity towards a regulation of an unstable balance (mineral unbalance) and of the conditions regulating practices. At the same time that governmental agencies (including the new EU-actor) seem to be forced to, gradually, make more explicit nature-protectionist rules.

[12] See (van Grinsven et al., 2016) to gain a better understanding of the overlap between the EU nutrient directives (END, WFD and NCD).

[13] The Dutch quality newspaper NRC has been an important source to bring those practices into the public and policy attention www.nrc.nl/dossier/mestfraude/ (accessed September 2020).

Moreover, despite European and national regulations to reduce manure-N discharges, the concentration of N in rivers (Bouwman et al., 2017; Metson et al., 2020), for instance, has not been significantly reduced. Bouwman et al. (2017) argue that this is because of the historical large N surpluses accumulated. Of course, other sources of N and P such as human diets and waste management play an important role here. Moreover, although manure is a valuable element to close circles between and within agricultural and food systems, the combination of an increase in the usage of phosphorus fertilizer and of livestock production 'has fundamentally altered the global P cycle' (MacDonald et al., 2011) as agricultural 'landscapes have a nutrient memory' (Bouwman et al., 2017). Globally, it is estimated that the anthropogenic nutrient flows have exceeded the planetary boundaries (Steffen et al., 2015). Some landscapes are experiencing a shortage of nutrients while other regions in the world produce more manure than can be utilized. The Netherlands is such a case. It is estimated that there is a P surplus of 8 kg/ha/year and a N surplus of 131 kg/ha/year (Leenstra et al., 2014-2019); see Figure 1. Moreover, in 2020, according to the Dutch government, the two main sources of nitrogen into the agriculture were concentrates (415 million kilogram) and synthetic fertilizers (220 million kilograms), causing a 307 million kilograms nitrogen surplus [14].

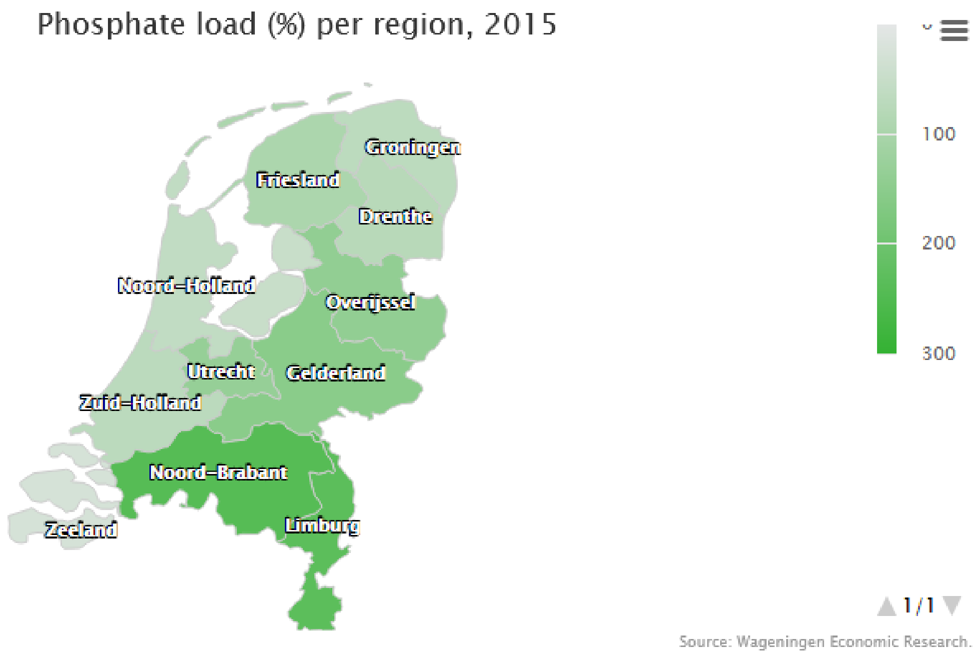

Figure 1 *Ratio (%) between production and allowed placement of phosphate per Dutch province.15*

It is estimated that about 60% of the manure production in two Dutch provinces cannot be applied within the provincial borders. In three other provinces approximately 30% of the manure produced must be applied outside their borders. Except for one (Zeeland), in all the other Dutch provinces there are municipalities with manure surpluses.[16] Thus, despite policy and regulatory efforts and frameworks we can conclude that the Netherlands struggles to assimilate its manure.

3.2 Current arrangements and change

After World War II, policies aimed at increasing and make more efficient the production of agricultural and livestock commodities have been escorted, as we have just seen, by policies for avoiding environmental pollution caused by, among others, an imbalance between input and output of nutrients, i.e., manure. Manure practices and arrangements have shaped (and have been shaped by) policies, ecosystems (e.g., soil acidification, or eutrophication of water systems) and landscapes. These manure-arrangements are also

[14] www.cbs.nl/ nl-nl/nieuws/2022/04/stikstofoverschot-landbouw-in-2020-iets-toegenomen (accessed January 2022).

[15] Meaning that if the ratio is in one province below 100% then it is, in theory, possible to apply manure from other provinces and if it is above 100% then part of the produced manure must be used outside the provincial borders. Figure source: www.agrimatie.nl/ThemaResultaat.aspx?subpubID=2232&themaID=2282&indicatorID=6621 (accessed January 2021). Note that this figure does not visualize the Caribbean municipalities of the country.

[16] www.agrimatie.nl/ThemaResultaat.aspx?subpubID=2232&themaID=2282&indicatorID=6621 (accessed January 2021).

shaping the space and paths towards circular practices. We focus now on the experimental regions (see Section 2). In these regions tests and pilots are conducted with 'new' crops, environmentally friendly livestock housing systems, participatory air pollution monitoring, etc

The current departmentalization and decentralization of the government is here an issue. For instance, the Ministry of Agriculture, Nature and Food Quality is the one that has formulated the circularity vision and facilitates the experimental regions, but the Ministry of Infrastructure and Water Management is the one that arranges the permits concerning livestock housing and, therefore, manure management systems. Farmers and stakeholders are encouraged to conduct experiments in the 'circularity experimental regions,' for which permits, and exceptions might be required. This is a complex and time-consuming process. Moreover, at the end of the day the permit is approved by a local alderman/woman who is enforced to follow, and who is accountable for, the current national and European regulations. So, if something goes wrong in the experiment both the farmer and alderman/woman will be judged, logically, according to the current legislation (program manager of an experimental region, personal communications, September and October 2020). The decentralization of the government through ministries, provinces, water boards, and municipalities as well as the current regulations might hinder or delay innovation (personal communications, September and November 2020).

Furthermore, note that the political and social climate regarding livestock and agricultural production in the Netherlands is highly polarized – manure is one of the controversial issues. The experimental regions evolve in this context. At one side of the continuum we find a hardcore group of farmers and agriculturally related organizations, at the other side a hardcore group of social organizations and local residents (alderman, personal communication, September 2020). The two ends have become experts, finding their way to research, media and policy. In addition, they are very successful in mobilizing followers. The center of this continuum is less active, so these two extremes determine the atmosphere of the discussions and point to two contradictory dots on the horizon. Trust in each other, in policy, in farmers, in research, etc. and an integrated way of thinking and acting will become essential for the experimental regions as well as for accelerating the circular agriculture transition.

In the Netherlands, there are many farmers (e.g., Remeker, Het Kwatrijn, etc.), small-scale initiatives (e.g., Kringloopboeren, Herenboeren, etc.), regional initiatives (e.g. Agroproeftuin de Peel, Mineral Valley Twente, etc.), and policies (e.g., Ministry's circularity vision) which are giving form to the circularity transition in a small-win manner (Weick, 1984; Termeer & Dewulf, 2018;Termeer & Metze, 2019). I.e., these initiatives pose provocative ambitions and try to achieve change by the cumulative effect on sustainability that they produce through small steps. In the experimental regions different experiments are organized by a diverse set of stakeholders to, e.g., reduce ammonia and greenhouse gas emissions from barns. However, the recent history of Dutch manure, (nutrients) policies and practices are now, in a way, blocking the way forward of circularity practices and initiatives.

For instance, an initiative that might want to introduce (a couple of) cows for closing nutrient cycles and produce organic matter within a farm or in an urban area must have phosphate-rights, which if you are not a livestock producer might be difficult to obtain. Or, if you have certain rights for housing finishing pigs, you cannot experiment with sows and piglets (or with cows) to develop integral production systems. Or, if your dairy housing system consists of a barn with a slatted floor and a manure pit underneath (approx. 80% of Dutch dairy farms), it will become difficult to get a permission for experimenting with other forms of manure management such as working with two fractions. Working with two fraction is interesting as a nitrogen-rich liquid fraction can be used for fertilizing grassland, while the more solid fraction is rich in phosphate and organic matter and can be employed for fertilizing arable fields and for soil management/restoration. This practice is expected to improve the use of nutrients and facilitate the replacement of synthetically created fertilizers (van Middelkoop & Holshof, 2017). Note that the reserves of rock phosphate are finite (Dawson & Hilton, 2011; Geisseler et al. 2018) and that the production of nitrogen is energy-intensive (Dawson & Hilton, 2011, Trimmer & Guest, 2018). A practitioner of one circularity experimental area (personal communication, August 2020) argued that experiments in the arable land domain are, so far, easier to be organized than livestock related ones because the later are time consuming regarding permits, as manure is strictly regulated.

These experiments with technology-based manure management systems (e.g. floors, robots, manure removal and fraction separation techniques, storages, biodigesters, etc.) seem to be mainly driven by the need to comply with the policy objectives to reduce ammonia emissions rather than with circularity objectives. Consequently, these manure management systems are experienced by farmers as added costs in the production process. And if new business models are developed in these experiments we see that many of the products emerging could be characterized so far as niche products (e.g., old crop varieties, expensive meats, etc.), or products from experimental systems that has not yet been optimized such as agroforestry, intercropping, etc. Farmers and experts argue that it is very difficult for this circularity-products to compete with the current commercial (cheap and good quality) agricultural products.

The Dutch government is investing in circularity and enabling spaces for experimentation. However, current manure-arrangements are still shaped on the style and content of policies and practices of the last decades. One could argue that there is a focus on technology driven solutions, high expectations regarding the capacity of the sector itself to change, and an unwillingness to intervene in the production volume. In this context, scaling up pilots and experiments is still a big challenge. Some experts (van Grinsven et al., 2016)[17] and practitioners claim that goal-oriented (instead of measure-oriented) policies regarding nitrogen and phosphate could trigger innovation and improve emission's target achievement. For instance, currently specific measures and housing systems has a officially recognized ammonia emission factor. Therefore, a farmer who installs an air scrubber at his/her pig farm might obtain a production permit as this system is able to reduce around 90% of the ammonia emissions. However, this does not guarantee that the air scrubber device is switched on. Focusing in objectives, such as avoiding biodiversity loses through ammonia emission reduction, might also help the organization of policies and practices that stimulate the awareness of environmental and ecological challenges and risks. Monetary revalorization or forms of compensation to value nature (degrowth), circular food and other agricultural products and practices might be as well required.
Another important issue is, however, the envision of futures: towards which end are we moving? Which circularity-goal do we exactly want to achieve?

3.3 Circularity as a moving target between local-global cycles

The experimental regions are aimed at facilitating the circular transition. This section elaborates on the way in which the concept of circularity is implemented within the Dutch livestock and agricultural context. We elaborate on the concept itself and on some tensions that emerge in the application of this concept in a global oriented (agriculture and) economy.

The concept of circularity has evolved from a natural resources perspective for circumventing trade-offs and reduce/avoid waste (Fidelis et al., 2019; Sachs et al., 2019) towards a more policy driven, holistic and broad approach aimed at reaching higher levels of sustainability.[18] Currently, it is very common to read the term of circular economy or circular agriculture in scientific and policy papers (de Boer & van Ittersum, 2018; EC, 2015; EC, 2018; Moraga et al., 2019; Ploegmakers et al., 2020). The Ellen McArthur foundation defines circularity according to the following principles: Designing waste and pollution out of the system in a process of decoupling economic activities and welfare from finite resources, keeping products and materials in use, and regenerating natural systems. The foundation argues that '*Transitioning to a circular economy does not only amount to adjustments aimed at reducing the negative impacts of the linear economy. Rather, it represents a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits.*'[19]

As the concept of circularity evolves and expands, the discursive pathways are diverging (Calisto Friant et al., 2020; Ploegmakers et al., 2020). Different stakeholders are articulating different circularity discourses and practices, therefore, shaping different futures. Some argue that principles such as degrowth (Kallis et al., 2018; Calisto Friant et al., 2020), for instance, are also relevant for circularity. Degrowth highlights the need to decouple economic growth from nature depletion. This issue is barely addressed by the

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[17] Personal communications, September & October 2020.
[18] For a more systematic historical perspective of the concept of circularity see (Calisto Friant et al., 2020).
[19] https://www.ellenmacarthurfoundation.org/circular-economy/concept (accessed December 2019)

government's circularity vision or within the experiments conducted in the experimental regions. It is as if economic growth is seen as a prerequisite to characterise successful experiments. These experiments usually deploy practices and discourses which are science and technology driven and focused on optimization of (production and waste) resources management type of principles. Moreover, these activities are conducted against the background of ecological principles such as safeguard the health of agroecosystems, efficient use of biomass, recycling, etc. We are in the initial steps of the transition, but a more integral approach regarding principles and practices might be required.

One could argue that an important approach to manure from a circularity perspective might focus on the requirements and demands of ecosystems and of end-users of manure, e.g., crop farmers, and from there on redesign the manure production-treatment chain. However, in our exploration of initiatives in the experimental regions we still see some disconnections between livestock initiatives and crop production. The intensive and monoculture (also mono-livestock) production systems are strictly regulated as we have seen (Section 3.1), this makes it difficult for actors to cross sector boundaries. For instance, within the livestock domain, experiments are conducted in barns with systems for separating manure's thick and thin fractions to reduce emissions and to improve mineral application. As aforementioned, these principles and practices could speed up chemical fertilizer replacement. But then, in many of these initiatives there are no specific agreements organized with potential purchasers of these separated manure's flows, which means that they are sometimes brought together again within the barn. It is argued that farmers want to see if/how these systems work (personal communication, October 2020). However, the motivation right now for experimentation with these (separation) systems might be more related to the policy requirements for reducing ammonia emissions from barns than with circularity ambitions. Of course, reducing ammonia emissions contributes to one of the principles of circularity, i.e., safeguard the health of ecosystems. One wonders, however, whether this is enough to (or aimed at) create a circularity future. More integral approaches might strengthen and provide coherence to the transition. Meaning, in this example, that livestock-manure experiments, from their initial stages, ought to be designed in collaboration with, e.g., arable land farmers or other initiatives that can use these manure streams.

Global oriented agriculture
One of the most fundamental questions for the Dutch agriculture and livestock production sectors is whether the current vision and facilitation role of the government and the production and market oriented initiatives will be able to decouple economic growth from 'finite resources' (in the Ellen McArthur foundation's words) and ecological degradation. Does an export-oriented economy fit circularity? Please note that the Netherlands was, in 2020, still the World's second (behind the USA) largest exporter of agricultural products, with an estimated value of agricultural goods of 94.5 billion euros in 2019, and 95.6 in 2020.[20] Livestock products are produced mainly for international markets with an export value in 2020 of, e.g., meat 8.7 billion euros and dairy and eggs 8.3 billion (see Figure 2).

[20] https://www.cbs.nl/en-gb/news/2020/03/agricultural-exports-hit-record-level (accessed November 2020). https://www.cbs.nl/nl-nl/nieuws/2021/03/landbouwexport-blijft-op-de-been (accessed January 2021)

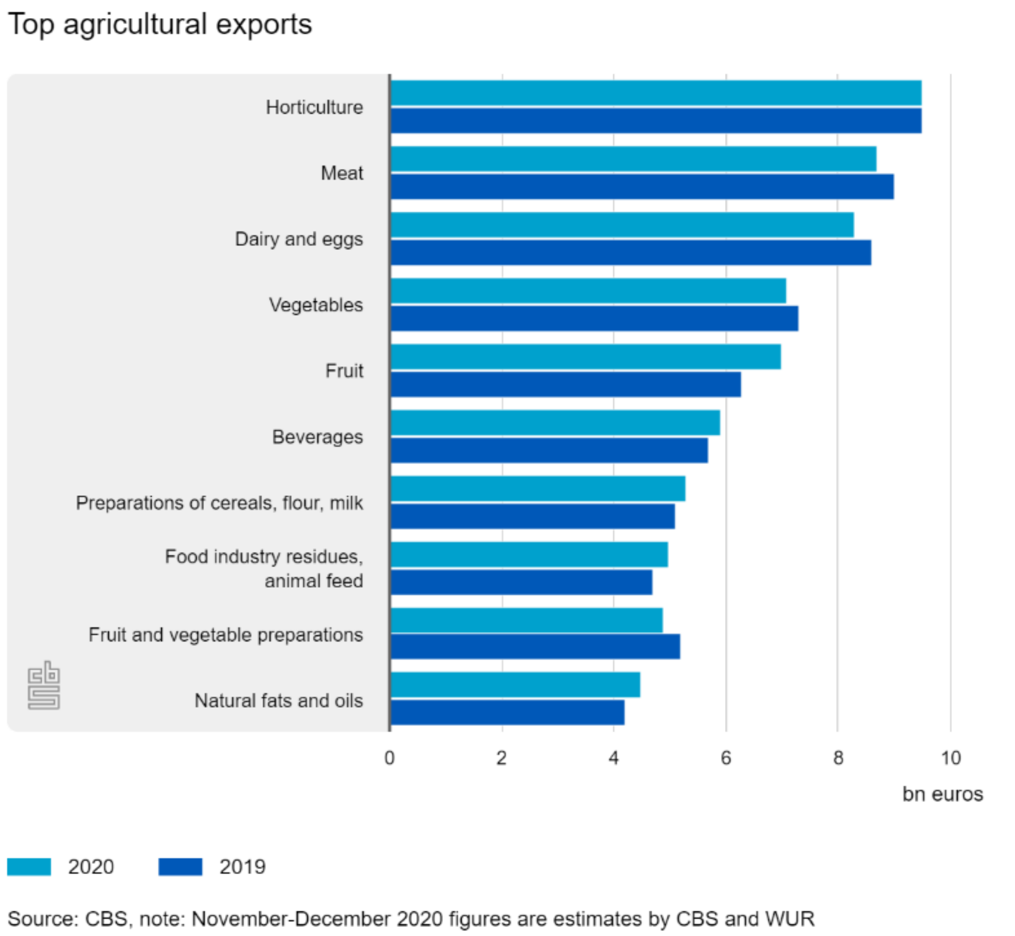

Figure 2 *Export value (bn euros) of agricultural goods, 2019-20. Based on estimates.*[21]

Note that, e.g., animal feed must be imported to support these livestock productivity activities, at the same time that feed is processed and exported (See Figure 2). Recently, the World Wide Fund for Nature has published a report which estimates that over 43 million hectares have been deforested between 2004 and 2017 being one of the drivers of this development the expansion of commercial agriculture (Pacheco et al., 2021). At the same time, it is claimed that, since 2006, the implementation of the Soy Moratorium has been effective in reducing the deforestation within the Amazonas, but it might have increased pressure elsewhere and, in some places, the deforestation occurred before 2006 (ibid.). In this regard, the Netherlands is the largest importer of soy in the EU and the largest importer of Brazil's soy (see Figure 3) and one of the world larger importers of this commodity. The Netherlands imported a total of 3.5 bn kg of soybeans in 2010, 4.4 bn kg in 2015, 4.3 bn kg in 2018 and 4.1 in 2019.[22] Of course, many efforts are currently made to, e.g., import the, so called, responsible certified soy[23] to feed animals. However, de Boer and van Ittersum (2018, p. 10) argue that 'footprints of foods from animal sources do not address feed-food competition (i.e. competition for biomass or natural resources between production of feed for livestock and food for humans)'. Moreover, they also argue that livestock breeding and feeding practices ought to orient itself towards efficiently and exclusively converting humanly non-edible biomass, in particular, of those locally available (ibid.; see also Puente-Rodríguez et al., 2022).

[21] https://www.cbs.nl/nl-nl/nieuws/2021/03/landbouwexport-blijft-op-de-been (accessed January 2021). The same source explains that 'Export of goods produced in the Netherlands as well as foreign-produced goods which are exported after significant processing, considering the extent to which the product's HS Code has been adjusted. Re-exports (of goods without any significant processing) and domestic goods exports combined constitute the aggregate Dutch export figures.' https://www.cbs.nl/en-gb/news/2020/03/agricultural-exports-hit-record-level (accessed January 2021)

[22] https://www.cbs.nl/en-gb/news/2020/40/soybean-imports-from-brazil-up-by-40-percent (accessed January 2021).

[23] https://responsiblesoy.org/?lang=en (accessed January 2021).

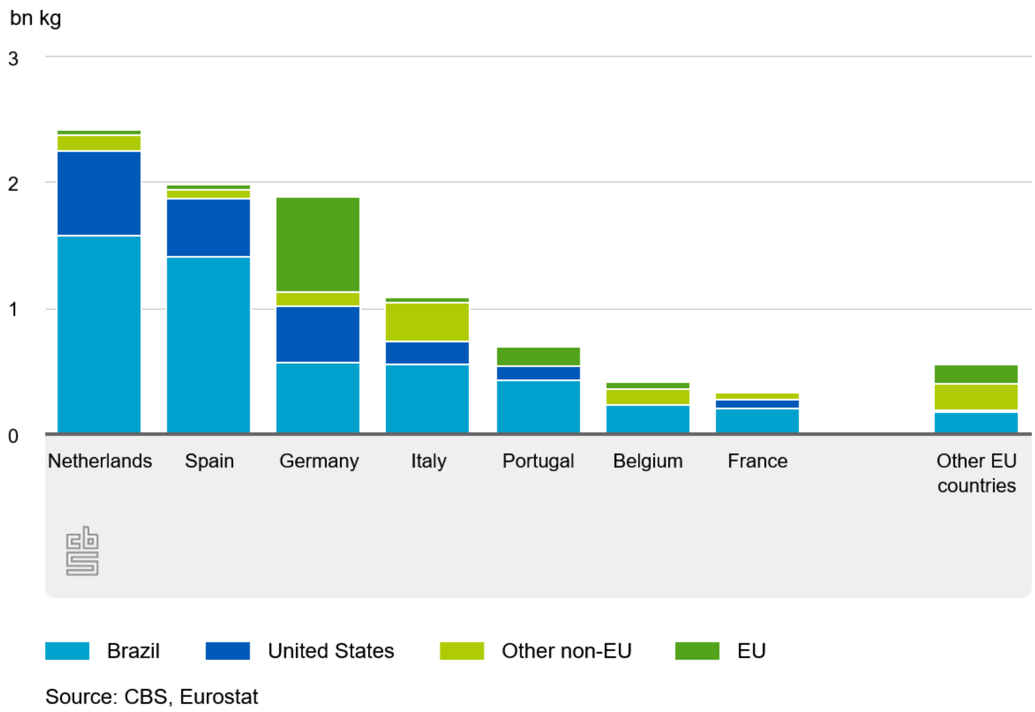

Figure 3 *EU soybean imports (bn kg) by origin, first half of 2020.*[24]

In the experimental regions, efforts are being conducted to find ways of closing 'small cycles' at the farm or local level, while the Dutch trade and agricultural sectors are important players in the 'global cycles.' More reflection-, research-, civil society-, productive- and policy-initiatives should be organized around these tensions between scales, biogeochemical cycles and economic and social welfare.

At the local level

As we have argued before, at the local level many livestock farmers and stakeholders still seem to think and work according to the current parameters, optimizing the current production system, e.g., by maintaining current practices while trying to reduce the ammonia emissions. This mainly concerns a 'technical' optimization, and it is commonly organized around new housing systems, end of the pipe techniques (e.g., air scrubbers), or feed measures. The same seems to apply to many farm advisors who are trained traditionally and of course have their own commercial interests (personal communication, November 2020).

In this global/local context, one might argue that, currently, there is an uncontroversial, prosaic[25] and technology driven circularity future proposed which is also supportive of ecological principles at the local scale, and which, moreover, does not define a clear way forward. A positive and interesting aspect of this diffuse stipple at the horizon, however, is that it currently creates space for a governance rather than a government approach. In the experimental regions, for instance, bottom-up (research) questions and initiatives emerging from farmers are prioritized and facilitated (personal communications, September, October). A facilitation team, in the different experimental regions, searches for knowledge partners (research institutes, universities or advisers), addresses eventual permit and legal issues and takes care of the communication of the projects' evolution and results. Those are interesting forms of transdisciplinarity and post-normal science (Funtowicz & Ravetz, 1993) type of research. An illustration thereof is the 'smart village Sint Anthonis.' Here, a group of livestock producers work together with local residents and researchers on a measuring system (sensors and data analysis) to 24/7 monitor the emissions of particulate matter in the municipality.[26] Or other initiatives, in which conservationist organizations, in collaboration with farmers, civil servants, composting companies, researchers and other stakeholders, use biomass emerging

[24] https://www.cbs.nl/en-gb/news/2020/03/agricultural-exports-hit-record-level (accessed January 2021).

[25] Prosaic as defined by Dryzek, *prosaic alternatives* assume the 'political-economic chessboard set by industrial society as pretty much given'. Dryzek argue that another discursive dimension regarding environmental problems are *imaginative alternatives* which 'seek to redefine the chessboard' (Dryzek, 1997, page 13).

[26] https://www.agroproeftuindepeel.nl/projecten/meetnetwerk-sint-anthonis (accessed November 2020).

from natural protected areas to restore and improve agricultural soils by increasing organic matter.[27] Or the so-called living lab 'digestate for a healthy soil', in which the effect of applying digestate on the soil is being investigated in a number of test fields.[28] Digestate is the material that remains after manure anaerobic digestion aimed at producing biogas. These collaborative practices are promising in a polarized context and suggest a need for clarifying the (circular or otherwise) future of Dutch livestock-agriculture functions and production.

Circularity is a multifaceted and, therefore, difficult to operationalize concept. Some tensions emerge by applying this concept in global oriented economies. The choice of circularity as the core of a new agricultural policy fits well the Dutch tradition of resolving conflicts not by choosing sides, but by introducing more complexity. This is in line with the so-called Dutch 'polder model' which is organized around a rational recognition of social diversity for reclaiming land from the water to organize a wealthy and densely populated society in a coastal lowland and delta area. A case in point is the knowledge-based trial-and-error approach in the experimental regions that is conducted by multi-stakeholder networks.

3.4 Missing links – the human factor

Despite the surplus of minerals that are usually produced in regions and countries such as the Netherlands with a high livestock and human density, one could argue that a manure-arrangement approach and a circular food system should encompass human excreta as well. This would imply radical new practices that also involve consumers and cities and the like (Trimmer & Guest, 2018; Moya et al., 2019). Manure, including human excreta, could help replacing synthetic produced fertilizers which are produced from non-renewable sources (e.g., phosphate rock) or in an energy intensive way (e.g. ammonia fertilizer) (Metson et al., 2016; Trimmer & Guest, 2018). At the same time the literature reports that the anthropogenic nutrient flows have surpassed the planetary boundaries (Steffen et al., 2015) which force us to, for instance, recycling strategies. In this section we reflect on this neglected issue within the circular transition in agriculture and in some critical issues concerning the application of manure such as the pollution of ecosystems or the propagation of antimicrobial resistance.

Manure-arrangements are specific ways to deal with faeces and urine based on specific and dominant ideas of its meaning at a specific point in history, e.g., manure as 'waste', as 'valuable fertilizer', 'soil enrichment', 'whitener' or even 'medicine'. Manure-arrangements are as old as human agriculture and have shaped local societies and landscapes for centuries. When asked how he defines manure, an expert involved in an experimental region answered (October 2020) that manure is, of course, a policy controversial issue, but it is, actually, the excrement of animals. To which one could add, animals, including human beings.

In the past, manure-arrangements concerned also human excreta. See, for instance, the value of urine in Roman cities as a fulling agent, fertilizer and medicine (Bradley, 2002; Keenan-Jones, 2004; Witty, 2016). Moreover, in China there is a millennia-long experience with treating human excrements, governed by strict procedures to guarantee hygiene and safety for enabling an efficient use of this source of minerals and organic matter within agricultural practices (King & Leeflang, 2011). King and Leeflang in the book 'Four thousand years of circular agriculture' (in Dutch, ibid.) claim that it was due to Chinese farmer's knowledge, expertise and discipline that they were able, still at the beginning of the twentieth century, to close the biogeochemical cycles by hygienically collect and composting human excrements before applying it into the fields.

The cities in the pre-industrial Europe also provided urban fertilizer to agricultural areas. The Flanders region, for instance, was importing human excreta from Amsterdam in the Middle Ages. Poo was processed, together with other organic waste, into compost (Daru, 1999). Still in the beginning of the nineteenth century poo

[27] Due to climate change severe periods of droughts are affecting the Netherlands, being southern and eastern regions more affected than the rest and causing an economic damage, challenging the water availability and quality as well as the soils (Buitink et al., 2020; Philip et al., 2020). Agricultural stakeholders are deploying initiatives to increase the organic matter in the soil as strategy to palliate drought.

[28] https://www.twente.com/en/global-goals/7-affordable-and-clean-energy/farmers-from-noord-deurningen-find-a-solution-for-nitrogen-problems (accessed December 2020)

was collected in the Dutch cities by tenants with their cars. In the course of the nineteenth century cultural and hygienic standards together with the new role of the government made this system obsolete and a centralized system of organic matter management (including sewerage) was gradually organized (ibid.). Afterwards the use of human excreta was banned for agricultural usage. In the nineties the Netherlands banned even the use of sludge on farmlands.

We have seen that efforts are now started to organise sustainable biogeochemical cycles at the livestock/ agricultural level. However, the minerals and organic matter flows of human beings are not yet considered in the agricultural Dutch transition. Remember that the Netherlands has a high population density, meaning a relative huge potential of manure. However, human manure is still treated as 'waste,' 'pollutant' and, therefore treated in water waste treatment plants. High-tech approaches to recover nitrogen and phosphorus from human excreta are already being organized (Trimmer & Guest 2018). The promotion of circular practices has raised also relevant questions concerning 'safety' and 'pollution' by the application of manure.

Critical remarks

Manure from animals can become a source of antimicrobial resistance (AMR) and of residues of antibiotics and other antimicrobial agents and medicines (Lahr et al., 2019; Puente-Rodríguez et al., 2019). Moreover, and concerning human (used) medicines, a recent study estimated that around 33,000 people died in the EU in 2015 (Cassini et al., 2018) and around 700,000 deaths occur per year worldwide (O'Neill, 2016; MacFadden et al., 2018) due to AMR. However, the use of antimicrobials in the Dutch livestock sector has been sharply (approx. 70%) reduced in the last decade (SDa, 2020) which might make of the Netherlands an appropriate place for experimentation and research on circularity and, e.g., the accumulation of AMR or medicine residues in the environment.

The use of manure (including human) for fertilization or the use of wastewater for irrigation, are important practices for circularity. However, medicine residues (Lahr et al., 2019) and antimicrobial resistance can reach the environment via manure and can enter the food chain via this route. This can occur through fresh fruit and vegetables, for example (van Overbeek et al., 2014). It has also recently been shown that residues of antimicrobials accumulate in soils and on tomatoes irrigated with wastewater (Christou et al., 2017; Umweltbundesamt, 2018).

Manure can also be a source of pathogens. Manure treatment measures and techniques before application could palliate their propagation or the propagation of AMR and other sources of pollution. The efficiency thereof to neutralize these infectious and antimicrobial agents is not yet fully developed (Hoeksma et al., 2016; van Epps & Blaney, 2016). Moreover, knowledge about these routes and aspect such as the persistency of these agents and germs in the environment, or even the 'cleaning capacity' of different types of soils is in its infancy and should be extensively studied and monitored and eventually regulated within the transition. Beyond this warnings, the extent to which human diet and excreta influence N and P (un)balance (Cease et al., 2015) and how it can be currently used as a source of fertilization and organic matter within agriculture is also worth exploring, or even a prerequisite if we are serious about manure-arrangements in the circularity transition.

4 Closing remarks – a transition in its early adolescence puzzled by manure

In this report we have explored the role of manure-arrangements in the transition towards a circular agriculture in the Netherlands. Manure-arrangements evolve in time according to socioecological factors and are formed by practices, habitus, technologies, emissions (e.g., greenhouse gasses, odour or ammonia), discourses, and policies (laws, rules, or the legally organized exceptions to these laws, etc.) organized around manure.

In the current Dutch context, one can argue that the dominant manure-arrangement makes of manure a problem because of the surpluses of N and P and, therefore, the impossibility to apply it on the local, regional and even national available rural land. Moreover, most farmers manage manure as slurry (i.e., the mixture of faeces and urine) which is kept in the farms until the spring when the slurry is injected into the soil. Intensive (pigs and poultry) and other large-scale livestock farms are forced to pay for transport and application elsewhere in the Netherlands or to treat/process manure surpluses through, among other techniques, bio-digestion, composting or drying and sanitizing before they can sale/export it. As we have argued, in the Netherlands, this arrangement has been organized, starting after the Second World War, by organizing intensive and industrialized forms of livestock production, in combination with an export orientation. At the same time, regulatory frameworks regarding manure have been developed to palliate the negative ecological consequences that this entails.

Section 3.1 summarizes the most relevant policies and regulations in the Netherlands since the 1950s concerning manure. Despite these policies and regulations, the literature reports N and P surpluses, which currently influence the available space for deploying circularity practices and initiatives. Policies, markets, and practices form the structures within which circularity practices have to emerge and evolve. Monoculture or single-animal farms with specific sector/farm regulations and practices and strict manure management systems are the norm. Circularity implies a conscious connection between ecosystems and agriculture (and society), implying also the multiple connections between the different production sectors.

In the Dutch experimental regions, we see initiatives that try to transversally connect different production and social sectors and domains (De Haas et al., 2021). For instance (see Section 3.2), transdisciplinary research practices are conducted to monitor air quality, or to collect/treat biomass to restore and improve arable soils for addressing (climate change and the subsequent) drought affecting these regions. Or other initiatives in which specific fertilizing products from livestock farming such as the digestate are tested on fields. This approach in which different actors and domains are integrated has the potency to accelerate the transition towards a circular agriculture. In this sense, manure can play an important role as a connecting-element between livestock farming and arable farming and horticulture (and even, management of nature protected areas). At this moment, however, these initiatives are relatively small-scale and have an experimental status. For a more integrated approach, it might be necessary to upscale experiments to larger areas and domains of circularity to consciously design circularity into the food systems while, at the same time, linking it with other domains such as water and drought management, biodiversity, the energy transition, fair revenue models, or decoupling monetary profit from the weakening of nature.

Despite the efforts made, the Dutch economy, of which agriculture is part, mainly relies on unsustainable production and consumption practices that damage finite resources, produce emissions and climate change and that endanger economic, environmental and, therefore, social welfare. In this context, the government has defined a vision for the future of agriculture around the concept of circularity. However, it is still ill-defined at what scale circular agriculture should operate (global, European, national, regional, or local) or which nutrient cycles (finite resources) it should contain. Governmental agencies and actors have, in this regard, two main roles, namely: regulation and facilitation. On the one side, they have the democratic duty of monitoring these and other livestock and agricultural developments and enforce current national and European regulations, as well as meeting the international agreements concerning, trade, biodiversity or climate change. On the other hand, they have a facilitatory role for further specifying the design of circular agriculture and setting recognizable and realistic (sub)goals, and by creating 'legal spaces' for experimentation when required. The experimental regions play currently this facilitator and dynamization role in the Netherlands. From a policy perspective, governmental organizations test current policies and regulations in these experimental regions to find out which legal barriers do entrepreneurs encounter as they develop circular practices. Afterwards, most probably, national (and probably also European) policies will be transformed for enabling that innovations (crops, technologies, practices, etc.) leave the experimental and niche level and, expand and become common practices.

From a manure-arrangement perspective one could argue that the circularity transition is in its early adolescence. Thereby, the vision and the recent impulse to this transition is mainly channelled by a minister (ministry) who has been politically elected in democratic elections and which, therefore, might eventually change. Whether circularity is to get traction and, from a manure-perspective, reach its adulthood in the Netherlands (and elsewhere, see e.g., Velenturf et al., 2018, Åkerman et al., 2020) depends among other factors on the formulation of long(er) term policies. On the long term, the government has to answer the question of whether an export-oriented livestock production is compatible with circularity. This depends, among others, on the scale on which circular agriculture will be defined and, therefore, the entities involved. If it is on a global scale and export oriented, then stakeholders in the livestock domain will most probably be forced to invest, develop and implement a lot of technology at the farm level to avoid losses and emissions and to meet national, European and international objectives and agreements regarding N, P, water quality and greenhouse gas emissions. If it is at a much smaller scale (regional or even European) a serious vision and analysis will be required regarding the role of animals, the specific need and characteristics of manure as source of fertilization and organic matter and the needs and limits of ecosystems. Most probably, no straightforward answer to this question will be articulated in the short term, but discussions regarding the role and volume of farm animals will certainly be part of it in the Netherlands. A long-term perspective generates a policy stable and predictable landscape in which investments and (circular or otherwise) business models and practices are enabled. It might also enable a sustainable link with the European Union Circular Economy Strategy or more challenging objectives as formulating a decarbonizing agenda.

A clear definition regarding where we are moving to is important indeed. For this, stakeholders usually argue that we need a government that formulates clearly and unambiguously what circular agriculture is about and facilitates the circularity transition. However, we argue that, in the Netherlands, the uncontroversial discourse and promoted practices also offer interesting opportunities to develop a governance rather than a government type of approach. From this point of view, circularity might evolve more consistently as farmers, companies, research institutes and advisers, non- and governmental organizations are the ones that are giving form and content to circularity on practice. Finally, from a manure-arrangement approach perspective and to be able to replace synthetic fertilizers, one cannot deny human excreta as a pivotal source of minerals and organic matter in the transition towards circularity.

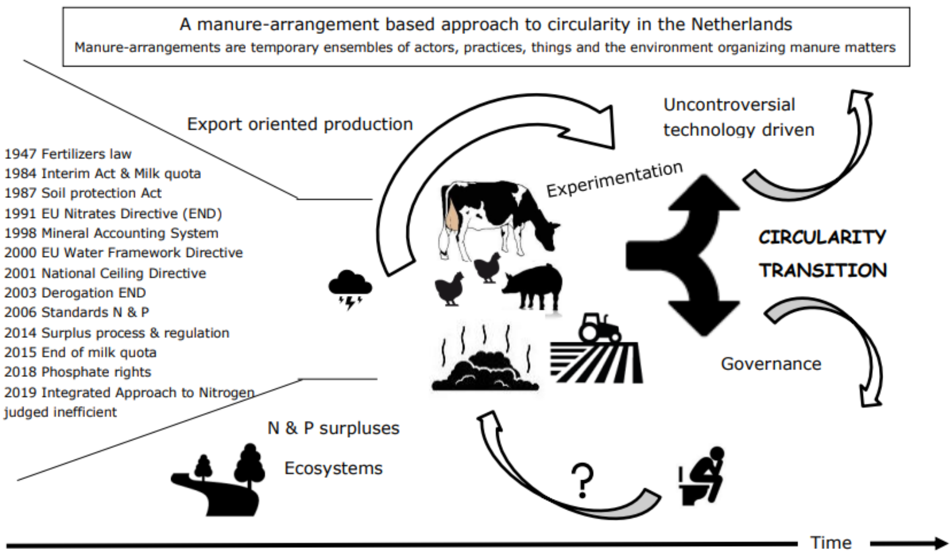

Figure 4   *Report's graphical abstract.*

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