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ABSTRACT

Nitrogen (N) provides the agriculture industry with a wicked problem: it is an essential nutrient for efficient crop production, but N losses from agricultural production can harm both the stability of the environment and the health of humans. To limit this, targeted N regulation at the ID15 (1500 ha) level is slowly becoming a reality for farmers and authorities in Denmark. This paper explores the formulation of value propositions connected to developed technologies and concepts for retention mapping at the field level for more detailed targeted regulation. We explore all this through a comprehensive longitudinal ethnographic case study over a period of three years. We use the value proposition canvas to make sense of the viewpoints of the involved stakeholder groups. Our empirical setting is a large-scale research project in Denmark, a country that has high environmental goals regarding nitrogen loading. The publicly funded project involved a multitude of stakeholders, ranging from industry consultants, regulators, farmers and researchers from several disciplines. Important for our study is the fact that much of Denmark's regulation is based on a consensus-driven approach. Thus, it provides a compelling setting for exploring the creation of value propositions through multisector stakeholder engagement. Our findings indicate that, while there is a general movement towards targeted N regulation due to an advancement of knowledge, the practical side of its implementation is less straightforward. Here, stakeholder-formulated value propositions can facilitate this process, not only being connected to the measurement technology, but also relying on a link to a regulatory transformation.

1. Introduction

Denmark is considered an agricultural "superpower" according to The Economist (Schumpeter, 2014) and the World Economic Forum, and its food production is very specialized, technology-driven, and centered on innovative thinking. As such, 2/3 of Denmark's total landmass is occupied by agricultural production and the production feeds a population that is three times the size of the Danish population. In line with the European Union's targets, Denmark has made ambitious commitments to reduce both environmental pollution and climatic impact by 2030 and 2050. One such commitment is to ensure the reduction of nitrogen pollution in groundwater and surface waters, and coastal near-marine areas as described in the EU Water Framework Directive (Directive2000/60/EC).

The use of nitrogen (N) is one of the most important food production nutrients because crops rely on it to grow efficiently. However, globally nearly half of all N applied to cropland is lost to nature through leaching or ammonia emissions (Lassaletta et al., 2014; Sutton et al., 2011). This causes a severe downside as N is leached from the agricultural fields to the aquatic environment and pollutes groundwater and the marine environment contaminating drinking water which has very adverse human health effects (Schullehner and Hansen, 2014; Schullehner et al., 2018). Although Denmark has increased the nitrogen use efficiency of agriculture since a trend reversal in the mid 1980'es (Hansen et al., 2017; Dalgaard et al., 2014), this situation has forced regulators to strengthen N's management and restrict its uses on agricultural croplands (Bowles et al., 2018; Zhang et al., 2015). With the attention on N pollution related to the environment and health-related problems, also

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other European countries have seen an acceleration in regulation that aims to protect nature and the environment and encourage sustainable initiatives that motivate businesses to enact such a sustainable transition.

In this paper, we explore how the creation of value propositions connected to the highly regulated agriculture industry can manifest itself through multisector-stakeholder engagement that balances the needs of industry and society, thus potentially benefitting all involved parties. Value propositions are formulations that organizations use in defining or outlining the underlying impact that a product or a service has on its end-users. According to Osterwalder et al. (2014), the definition of a value proposition is that it: "*Describes the benefits customers can expect from products and services*" (p. 6). In that sense, if a product or service creates value through, e.g. increased benefits or reduction of costs, then the value propositions are likely to generate among the end-users a willingness to pay for that product or service. In the above exemplification, no regulatory intervention affecting the end-user's decision to purchase the good or service would be required. In that sense, it is driven by market demand structures, which are well known within the economic literature as there are no negative side effects assumed. However, relating to the agriculture industry and farming sector some goods and services are tightly regulated by law in some countries (i.e. the use of pesticides or N fertilizers) due to the potential side effects on the environment. When the state regulates in such a fashion it can be done through a command and control governance structure (Blohmke et al., 2016). Under such conditions, formulated value propositions might only be beneficial for the society at large and thus additional values might not be utilized to their fullest as the negative side effects have to be included to find the social optimum (Grinsven et al., 2013). Therefore, when considering the implementation of technologies and concepts that aim to alter the regulatory framework, the articulation of stakeholders' formulated value propositions adds a holistic perspective that will inform the final formulation of the regulation. In some cases, it is fairly easy to articulate the value propositions that the technology adds to society and at times with rather small costs. In other words, technology might sometimes be required for the regulation to reach its maximum potential. A recent example of such a situation is represented by the use of the so-called "corona passes" across many European countries. Such electronic passes are provided by governments and allow for and nurture more economic activity during the COVID-19 pandemic. Hence, governments and state agencies rely on such technologies to achieve societal goals. The point is when addressing more sustainable technologies connected to regulation studies point towards barriers that may hinder possible commercialization and particularly that policy-makers need financial assistance provided by the state (i.e. Li et al., 2019). Also, there are known paradoxes related to the commercialization of sustainability innovation which is connected to downstream activities. When regulation is complex and stringent it becomes a problem for the technologies' price performance, i.e. commercialization of applications that provide societal value might be obstructed, as the overall cost is too high for a niche market to cover (Hall et al., 2018). We argue that a value proposition can assist in paving the way for a more dynamic regulation, which could include possibilities of collective actions, thus easing out known pitfalls for technology implementation and finding a solution for potential commercialization. Indeed, end-users might not directly see the economic need for the technology provided, but within a regulatory framework, its value becomes more evident. Arguably, end-users might speculate or expect the regulator to invest in the required infrastructure, making the widespread adoption of a technology possible and representing an economic gain for society. Hence, this article concludes that it is arguable that the developed technology is only likely to be implemented if embraced and supported by regulators.

Based on the informative value that the value propositions can have on the final formulation of the regulatory framework, we seek to explore the following question: *How can newly developed, scientifically advanced technologies and concepts for nitrogen retention mapping on the field level be introduced in the market?* In answering this question, we aim to address some central topics related to the research-based development and implementation of sustainable products and services. Connected to this, we also outline the role of institutions that formulate and govern the legislation for sustainability actions and its actors within agricultural production. In doing this we explore how stakeholder engagement facilitates the formulation of value propositions to guide a new nitrogen paradigm both in the practical and legislative implementation.

Denmark is moving towards targeted regulations of N use in agriculture. The movement towards targeted N regulation aims at maintaining high agricultural production and still limiting the environmental impact on the aquatic environment. The notion of robust and less robust areas has been discussed since 2008 in farming circles. There has also been a fear that differentiating the soils into robust and not robust would mean that some farmers might lose out. This was also the conclusion of the Ministry of Environment Pilot project, and so the Farmers Union changed their approach so that targeted regulation would only be a good idea if no farmers would lose out. (Ogstrup et al., 2016). This led to the requirement in the Agricultural and Food Package that the targeted regulation (at the catchment level) would be followed by compensation for the measures (catch crops) implemented. This would also help in case the data behind the targeting approach seemed uncertain or even unfair (Jacobsen et al., 2017).

The overall idea for targeted regulation builds on the premise that by targeting single fields, the effect of individual measures per field will be higher than the average of a catchment. Targeted N regulation aims to delineate robust fields (with low N losses and high N retention capacity of the subsurface) which can have a higher N application rate with higher yields from more vulnerable fields (with high N losses and a low N retention capacity of the subsurface), which have a lower N application rate. Prior research indicates that an economic gain of 20–26% can be achieved by moving to a more targeted approach (Jacobsen and Hansen, 2016).

As Denmark is currently changing its regulatory paradigm for N use, it presents an interesting case to explore for the questions; however, it also allows us to more specifically investigate the underlying mechanism to the question on market introduction as elaborated in the next sections. The change in regulation requires a more detailed estimation of nitrogen retention at the catchment or the field level, which can be a challenge. This implies a better understanding of the variation in the hydrogeological structures and denitrification zones in the subsurface under the individual fields to be able to model the water flow and nitrogen retention.

Various suggestions for a sustainable governance model should be subjected to various outcome/scenario analyses to ensure the best solution for all stakeholders. Therefore, we also ask: *How can value propositions be formulated in connection with a new technology-driven concept to inform a novel model for targeted nitrogen regulation*? In asking this question we explore how value propositions can provide a feasible direction for countries that want to change or adopt a sustainable legislated agricultural production.

The vision of the MapField project is to develop innovative environmental technologies and concepts useable for more targeted environmental regulation of nitrogen management in agriculture, and the project is a continuation of the rOpen projekt (Christiansen et al. 2021). It has therefore been a process that was initiated to potentially give the scientific foundation for the political proposition regarding targeted regulation which was established in 2013 by the Nature and Agricultural Commission. The knowledge gained in the MapField project will contribute to the implementation of the political vision of more targeted N regulations of Danish agriculture introduced in the Food and Agricultural Package which can be further developed (in more detail) with the MapField approach.

This study explores value propositions as an important tool for legislative implementation. In doing so, we showcase how the value proposition framework is not only useful for new product development but can also be extended into, and add value to, the process of formulation of new regulation and governance structures for sustainable change in society. Overall, the purpose of this technology is to drive a change in nitrogen fertilization and management that are related to the current way of food production. Therefore, from an academic perspective, this movement in the mapping of N is in itself a novelty in science, as it broadly aims to determine the nitrogen reduction in the subsurface under individual fields (Hansen et al., 2021b). In this process of pushing the technology, the project researchers have noticeably been publishing their findings in various scientific outlets. Some of the important topics connected to the Mapfield project is e.g. assessing complex subsurface redox structures connected to the sustainable development of agriculture and the environment (Hansen et al., 2021a) and investigating fast machine learning-based models on ground-based time-domain electromagnetic data (Bording et al., 2021) and 3D hydrogeochemistry models of nitrate transport and fate in a glacial sediment catchment (Kim et al., 2021). On top of the scientific push, the MapField consortium also aimed to investigate how possible regulatory implementation could be done. With this in mind, this study of MapField has important learnings for countries in need to move towards a lower nitrogen impact on the aquatic environment, e.g., countries within the EU concerning the Water Framework Directive. In that process, it is important to create a common ground that allows for stakeholders to actively engage with each other. However, a more detailed N retention mapping with a higher resolution also implies higher levels of uncertainty. Creating an understanding of the background of this uncertainty through stakeholder engagement is paramount as it will facilitate both farmers' and agencies' acceptance, thus limiting a potential pushback and rejection of the technology.

In section 2 the theoretical framework and the triple helix framework is described in more detail. The following section described the data collection and data analysis used to link the qualitative data to the structure presented in section 2. This provides together the foundation for the results presented in section 4. Here there is a focus on the individual dimensions linked to the process of creation of value propositions for the different stakeholders. The paper finishes in sections 5 and 6 with the discussion and conclusion respectively, looking at implications for both technology developers and from a policymaker perspective.

2. Theoretical framework

2.1. The triple helix framework of innovation

The triple helix framework outlines the fact that universities can play an enhanced role in nationwide innovation. The framework aims to ensure that knowledge and opinions from stakeholders from three important sectors, the industry, the research institutions, and the government, are key drivers for innovation (Etzkowitz and Leydesdorff, 2000; Ranga and Etzkowitz, 2013). A very important distinction for the triple helix framework is that it is a nonlinear model for innovation. In that sense, it allows for interactions between the three actors to nurture a research push. Also, it has been argued that the inclusion of stakeholders assists in the legitimization of future science and its integration into society (Etzkowitz and Leydesdorff, 2000). The framework has also been suggested as a model for sustainable growth (Cancino et al., 2018). In doing so, sustainable growth and technological innovation create value in three dominant forms, (1) environmental value which relates to: Renewable resources, low emissions, low waste, biodiversity, and pollution prevention (air, water, land). The (2) social value promotes equality and diversity, well-being, community development, secure livelihood, labor standards, health & safety. Lastly, value drivers of (3) economic value: profit, return on investments, financial resilience, long-term viability, and business stability (Cancino et al., 2018, p.32).

The collaboration between the triple helix actors is mobilized through stakeholder engagement also deemed as multisector stakeholder engagement. The engagement among stakeholders is central for large-scale societal projects. The engagement of multiple internal and external stakeholders across sectors and the project investigator team has been identified as a defining condition for the success of large projects (i.e. Lam et al., 2011). Being only one of the key stakeholders, scientists are very dependent on other stakeholders, like farmers or industry agents (end-users) in this case, to actively engage in such projects to succeed (Bahadorestani et al., 2020). However, such stakeholder engagement is not trivial to facilitate nor to motivate, and if failed, there are risks that it may hinder the dissemination of the project's results in the end and the uptake of the technology or idea (Eyiah-Botwe et al., 2016).

Here, the triple helix framework for technology innovation (Etzkowitz and Leydesdorff, 2000) offers an adequate analytical lens to study the interactions between stakeholders. The reason for this is that the triple helix framework suggests that technology innovation and implementation on a national level is best done when active engagement between these three prominent actors occurs. In that sense, all actors in the triple helix need to be present and engaging with each other to ensure the best outcome to a societal problem, i.e. changing legislation to embrace new technology. One of the core advantages of using this as an analytical lens in this study is that the triple helix, just like stakeholder engagement, relies on social responsibility among the actors representing the three sectors to be truly effective. This implies that stakeholders can distance themselves from a very central focal point of 'what is in it for me?' Social responsibility is an ethical framework where individual actors collaborate to create benefits for society at large (cf. Fischer, 2004). Regarding governance for sustainability change, the triple helix model has been suggested as a theoretical lens to capture national sustainable transition (Scalia et al., 2018).

2.2. Value propositions for sustainable solutions and governance

Both theoretically and practically the term "value proposition" is predominantly referring to bundles of products and services offered to customers to satisfy their needs and to create value for them. The value created can be in its practical use or can have symbolically perceived value (Freudenreich et al., 2020). Endogenous to this framework is a segmentation process, as the value proposition asks, "what are we offering to whom?". This furthermore builds on three underlying categories, firstly (1), target segments: "which customers do we choose to serve and which of their needs do we seek to address?". Secondly (2), product or service offering: "what are we offering customers to satisfy their needs?", and lastly (3), the revenue model, "how are we compensated for our offering?" (Kiron et al., 2013, p. 70).

However, when expanding to value propositions for sustainable products and services, as these do not *per se* aim to generate benefits for companies but rather aim to create benefits for society, you need to include a holistic approach (Baldassarre et al., 2017). For instance, they show how this could be done in connection with "providing an alternative energy awareness program to corporate clients who want to reduce energy consumption in their office buildings with a cost-effective solution" (Baldassarre et al., 2017, p.178). This also includes situations where the current costs are reduced due to regulation. Traditionally, sustainable value propositions relate to topics like maximizing material and energy efficiency, creating value from waste, encouraging sufficiency, and re-purpose the business for society/environment. This list is not exhaustive and is adapted from the paper by Lenssen et al. (2013).

Researchers have indicated that sustainable value propositions differ from traditional company value propositions. Namely, it is a value proposition that allows multiple-stakeholder value creation by considering the needs of not only customers, but also includes shareholders, suppliers, and partners as well as the environment and society (Donaldson and Preston, 1995; Lenssen et al., 2013; Tyl et al., 2015). Conceptualizing a sustainable value proposition is a critical task in sustainable business models because it requires understanding and managing several needs and objectives across multiple stakeholders to create shared value (Allee, 2000; Bocken et al., 2014; Kramer and Porter, 2011). Furthermore, essential for sustainable value propositions is a holistic view of the value proposition. This assists in outlining both the benefits and the costs connected to the implementation of the sustainable product or service not only for the target group but also for a broader range of stakeholders, including investors and shareholders, employees, suppliers, the environment, and society (Lenssen et al., 2013). The value proposition canvas (VPC) (Osterwalder et al., 2014) provides an excellent tool to ensure that both "pains" and "gains" connected to the implementation of a regulation inflicting technology are captured. However, regulation of a product or a service is considered a national intervention. This intervention through regulation is often articulated in a governance model by which the market actors operate.

The notion of governance model refers to how states govern their network and markets through the allocation of resources. In doing so, governance frequently involves networks, rules, steering, order, control, corporate governance, governing, and authority. As such, governance has been defined as "the action or manner of governing – that is, of directing, guiding, or regulating individuals, organizations, or nations in conduct or actions" (Lynn Jr, 2010, p. 671). A governance model has been defined as an articulated system consistent with formal and informal rules (Gubitta and Gianecchini, 2002). Therefore, governance models will define the market's scope and limitations for the firms within the targeted industry. This essentially implies that the regulatory nature of the governance model and its guiding fundamentals, value drivers for the industry, are embedded therein. Thus, an important role of the governance model is that it is implicitly defining the underlying options for the business models for the industry. Hence, a governance model serves as a platform that articulates what the stakeholders can and cannot do within the specific regulatory framework.

The governance model is the framework that depicts how the governance is then practically executed, i.e. by a flexible balancing act of resource allocations and agile/dynamic legislation. To ensure that governance models are adequate and flexible it is argued that governance and democracy can work better when citizens are consistently engaged and consulted in the process through public dialogs and debates, hence multisector stakeholder engagement (Bang, 2004; Bevir, 2006, 2010; Catlaw and Jordan, 2009; Wallington and Lawrence, 2008). Put in another way, the latter refers to the involvement of relevant stakeholders that are either impacted by or influencing the regulatory framework in the articulation of the governance model.

Therefore, we argue that the articulation of the governance model should be built on the underlying (sustainable) value propositions. Furthermore, the proposed model must be evaluated and tested thoroughly to capture the industry impact before being implemented (Podesta et al., 2013). A central notion connected to governance models and sustainable production is that many countries still rely on 'technology push' nurtured by research (Tukker and Butter, 2007), rather than market pull. Therefore, understanding the connection between governance, multisector stakeholders and value propositions identification is important for exploring the implementation of the MapField technologies and concept.

3. Methodology

3.1. Data collection

In total, we include data in various forms to ensure the creation process. These data consist of observations, ethnographical interviews which are informed by the participatory observations, technology documents, meeting observation and participation, emails, surveys, and workshops. Data about the MapField development were collected by combining different sources, including semi-structured interviews with various project stakeholders, direct observations, and archival and documental analyses to triangulate data and verify results. The data collection was carried out between 2019 and 2021. Table 1 below outlines an overview of the data collection process of this study. Our inclusion criteria for the data collection were from the early stage of the project very broad. We therefore initially included a wide range of project documents, however, afterward, we excluded meeting notes, documents, and reports that consisted of purely technical content and had no relevance for articulations of value propositions, the implication for implementation, or connected stakeholder engagement. An example of exclusion would be a detailed scientific note on how MapField changed the analysis of glacial movement in Denmark during the last ice age. This account has value in itself, but it does not concern our focal point of interest. Throughout the project, we actively participated in meetings that would add to our understanding regarding value propositions, and stakeholder engagement at an organizational level. That is, we did not observe or partake in the planning of stakeholder engagement at the micro-level, i.e. between the local advisor and the farmer. Instead, we took notes on this progress and interviewed both researchers and industry agents that were part of organizing this process. The observations, notes, and doings by the project members guided our initial interview guide and surveys. We conducted ethnographical interviews (Spradley, 1980) articulated around the various aspect of observation connected to the development and implementation of the MapField technology and the evolution over the years. Particular attention was paid to exploring the motivations of the choices made by the multisector stakeholders to trace the influence of different stakeholder comments. We conducted a purposeful sampling regarding the interviewees, as we wanted our informants to be able to elaborate independently on the benefits and problems for implementing this new N retention measurement. The selection of interviewees was driven by an ongoing evaluation of internal and external actors in terms of interest and influence in the project and its outcomes. Given this purposeful sampling, our informants can be considered experts within the fields. The interviewed farmers volunteered, however, as a condition to be selected, their farms had to own at least one field in the MapField test area and their field needed to be mapped. Concerning the interviews, they lasted between one and 2 h and were recorded and transcribed. All our data transcripts were thematically coded in Nvivo. Fig. 1 below depicts some of the major events throughout the development and implementation process of MapField. We created a survey for one of the workshops to validate our initial observations. In the survey, we presented our large pool of stakeholders and asked the participants to rate influence and interests. At the same time, we asked them to provide at least three benefits and three hurdles for the implementation or commercialization of MapField. Lastly, we asked the survey participants to evaluate four different implementation scenarios that we had created in terms of feasibility and likelihood. The result of the survey data assisted us to better identify the technology's usability (value), potential hurdles (pains), stakeholder depths, and lastly, potential implementation possibilities. Participants in the meetings varied, as for the work package leaders' meeting, it was mainly WP leaders plus a handful of project researchers, roughly 10–12 in total. Meeting with stakeholders ranged from 10 to 50 depending on the context and aim of the meeting, and included higher-level public servants from the municipalities, regions, and the environmental agency, industry advisers and consultants, and a broad range of scholars from geochemistry, geophysics, and agro-ecology. The costing group which we facilitated also included the PI, and two other work package leaders. Table 1 outlines the data that all these above-mentioned accounts enabled us to collect.

3.2. Data analysis

Our coding guide follows a thematic coding principle with room for exploration within each of the themes. Thematic analysis often relies on pre-set themes that are included before the coding. In that sense, the researcher already from the start includes predefined theoretical topics in the interview guide – to ensure that the research question and aim will be answered; in a sense, we relied on an open yet structured question

Table 1
Overview of data collection.

Source	Activity	Description	Amount	Documents	Value drivers
Participatory meetings	Work package leader meetings	Monthly meetings where progress and bottlenecks were outlined for all the work package leaders	20+ meetings with observations and notes	About 100 pages of handwritten notes + official meeting minutes and other documents	Drives common understanding among the project work package leaders on what the concept can do and not do. Furthermore, realignment of expectations and access to cropland test sites
Engagement in meetings	Internal stakeholder workshop	Presentation and discussion of the concept and its possibilities related to nitrogen management, regulation, and mapping	10 meetings with a presence from all work package, presenting findings and progress	12 pages of meeting notes included debates and question the various methods in play + official meeting minutes	Provided key insights into what work is being done in the various work packages, and the discussion fostered a dialog around the actual benefits of using the concept
	Large stakeholder workshop	Findings presented for possible end-users, suggesting different avenues for where and how the concept can be used	Several meetings with end-user stakeholders. Structured meeting notes from the meetings, plus follow up interview with the project investigator	Presentations plus 8 pages of discussant notes + official meeting minutes	Through iteration of dialogs with the stakeholders and by presenting the newest results of the models - both the project and the ministry started to align on very apparent uses of the technology. Driving a translation mechanism between the scientist, social scientist, and lawmaker
Initiated meetings	Costing group	The costing group had the primary role of calculating the expected cost of the concept	8 meetings with notes plus various calculations and suggestions to the cost structure and potential value drivers to sustain the cost drivers	30 pages of notes including possible gains for making the initial investment	Stepwise solution for mapping cost, particularly useful for mapping catchment with known high uncertainty for N retention. Also provided a solid platform for articulating and formalizing the value propositions and hypothetical scenarios
	Global impact case	An internal team with a clear focus on creating a global impact case for MapField	5 meetings	20 pages of notes	MapField as a concept is a direct fit into one of the pillars of the 4R framework for applying fertilizer. This will have an impact on both developed and developing countries designing their N management program going forward
Interviews	Internal stakeholders	Interviews were collected among different high-level agents. These include environmental agency officers, industry-leading figures, work package leaders, and the project principal investigator	5 high-level stakeholders	35 pages of transcriptions	What are the value drivers in the concept and how should they be implemented? What are the major benefits and costs of the MapField concept? Where is the value created and where are the major hurdles connected to the implementation?
	External stakeholders	Interviews with the external stakeholders were primarily done with farmers	6 farmers	20 pages of transcriptions	The interviews guide a lot of the dialogs in e.g. the costing meeting and were useful in arguments for the gains and pains of the farmers. Cemented that farmers had particular benefit from the technology
Survey data[a]	Internal stakeholders	Project internal survey	17 informants		
Documentations, reports, and email correspondences	Participation in the coordination of project internal activities and development of various reportings	Development of leaflet, historical accounts, the creation of a priority tool, problem-solving activities	200+ emails, 25+ documents	17 completed surveys	Informs the different activities such as scenarios and uses of the concept. Internally perceived understanding of the technology. Who did they see as external stakeholders?

[a] A detailed account of the questionnaire and its underlying theoretical perspectives is provided in Appendix A.

guide. To ensure that we capture all aspects of our rich data we try to remain abductive in the thematic coding, as we would like emerging themes to flourish as well. Regarding our codebook, we organized codes inspired by the Gioia methodology (Gioia et al., 2012). This allowed us, in iterations, to navigate between emerging themes of codes in the data, and at the same time to consult the literature on these and how they relate to our predefined theoretical themes. This approach ensures that emerging codes and themes are placed within the appropriate theoretical dimension. This iterative coding also allows us to go back and forth and, if needed, reposition a code according to known theoretical dimensions. Furthermore, it allows us to account for codes that might belong to more than one theme or dimension, and in that way, we get a better understanding of the potential cross-connections between the codes and themes/dimensions.

One example of this is the second order theme of “pilot project”, which consists of codes related to the project partners and stakeholders debating and suggesting a future series of pilot areas for more in-depth testing. In the next case, it is a “real” world area. This theme was initially placed under two dimensions, opportunities and implementation. Thematic coding allows us to emphasize the context of the code. As for the pilot project themes, it is clear that they are needed as they help to ensure proper implementation of the legal framework that utilized the

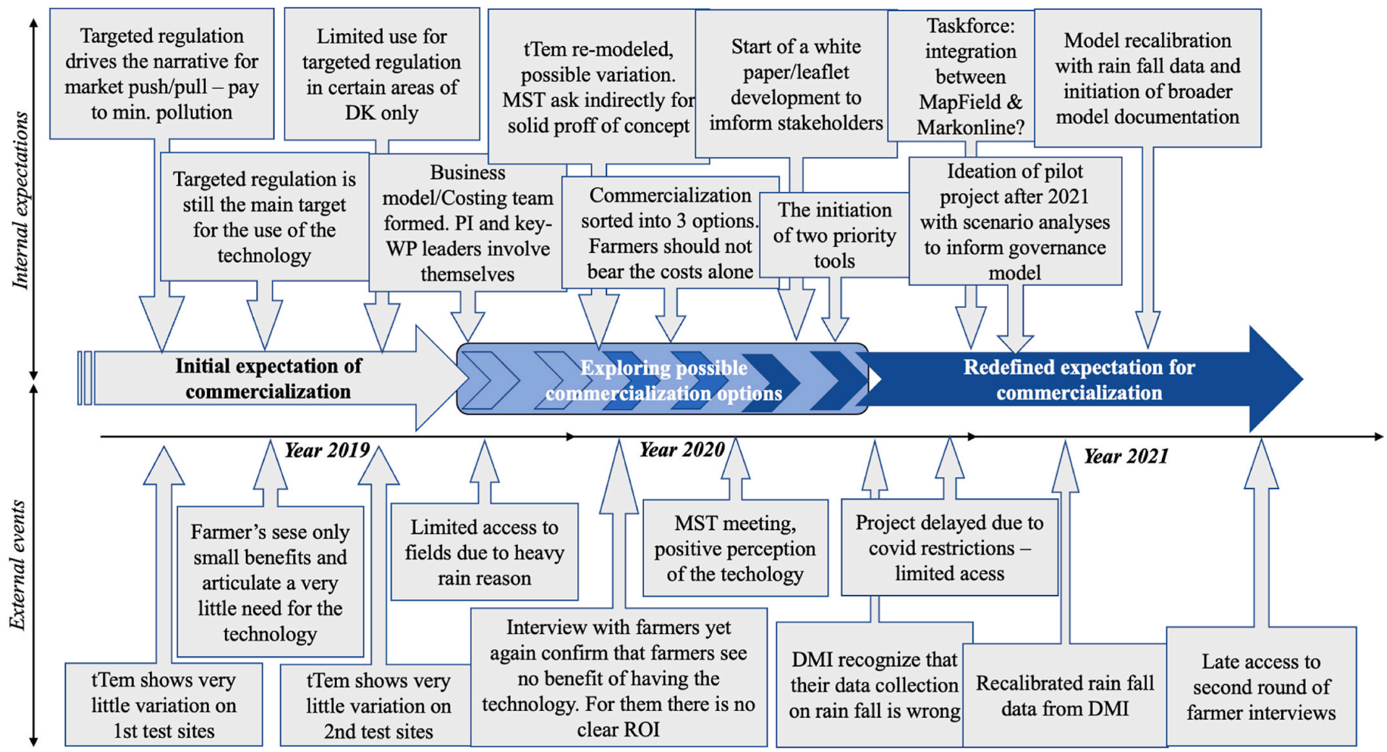

Fig. 1. Timeline with the most significant events during the project leading to a shift in perception.

potential of the technology. With the value proposition canvas (Osterwalder et al., 2014) being an integrated part of our research approach and design (e.g. it informs our interview guides and coding process of all data), we also coded our data accordingly. Therefore, we do consider 1st order codes to be antecedences of value proposition into the aggregated themes. As such, the 'technology and knowledge development' dimension in the coding tree is informed by multiple 2nd order themes and these are generated from the 1st order codes. Fig. 2 showcases this process of coding for a small part of our data analysis.

For example, the theme 'outlining model limitations' consists of a range of 1st order codes. With VPC in mind and grounded in the pains and gains thinking, one such 1st order code is 'research publication is good validation', which is a recurring observation and statement throughout the data, in meetings, interviews, and written materials circulated within the project. The object and gain are clear, the peer-review process of research publication is understood as a validation (gain) of the knowledge created and provides a solid foundation for value creation as the technology, the empirical data, and the research methodology connected to it. A second key reason is that publications are often required deliverables in the grand project. However, a successful publication still represents the acceptance of knowledge development and is to be considered as value creation. Another important connection to this theme is the debate, understanding, and use of redox data. With several accounts, the 'redox refinement' code under the same 2nd order theme is grounded in gains thinking as with the development of knowledge the technology mapping tool becomes more specific in what it can do and cannot do. The guiding principle above is used throughout our entire coding of 1st order codes and connected 2nd order themes. We extended our coding with the use of parent and child codes on larger 2nd order themes.

The same pattern is seen in the 'multi-stakeholder engagement' dimension as 1st order codes like 'exploring the opportunities for targeted regulation' relate to solid gains. With the knowledge expansion on the topic, the state decision-maker can listen to experts on the subject and compare different viewpoints. During the coding, it was simultaneously connected to the exploration of the technology on how it could be executed and implemented. Lastly, the 'cost and value drivers are very well connected to the VPC and need very little explanation. All in all, these dimensions and themes provide a theoretical opportunity to outline why the VPC can be a suitable framework in building sustainable governance models within agricultural production as they are built upon inputs from all essential stakeholders.

Overall, the concept of value proposition connected to the MapField technology is omnipresent. The farming industry will receive gains from adopting the technology in terms of better production opportunities on robust croplands and better strategic use of catch crops or set-a-side. However, value propositions are twofold, as we have also identified pains connected to the implementation of the MapField technology. As such, regulatory administration has to be considered as being cost-effective. Therefore, agencies and ministries have to justify the cost of using the technology. This is why the cost work package looks at both the gain from implementation and the costs of the mapping. The mapping can be both better and cheaper. Allowing more of the processes to be automated will reduce costs and time. Complex data and mappings of subsurface geological and redox structures are costly and this causes one implementation obstacle. The mapping intensity of the catchment is not yet refined and this is a problem as a certain amount of the area needs to be mapped for the hydrological model with N transport to run.

The industry most impacted is the farming industry, as the implementation of a field-to-field targeted regulation will result in some farmers experiencing further reduction requirements if their fields have low retention. Meanwhile, others or even neighboring farmers may not experience reduction requirements as their fields might be robust with levels of retention. Given this, there are clear-cut pains and gains with the introduction of the MapField concept. Firstly, the pains are largely considered to impact more locally on the micro-level (at the farm), and the value proposition analysis indicates that many gains are merely societal and impact regionally (e.g. at a distant bay area). Value propositions connected to introducing the new mapping concept provide a strong base to inform and formulate a governance model that benefits all parties. It depicts who will gain and who will bear the pains. The current legislation provides no incentive for farmers to invest in the MapField

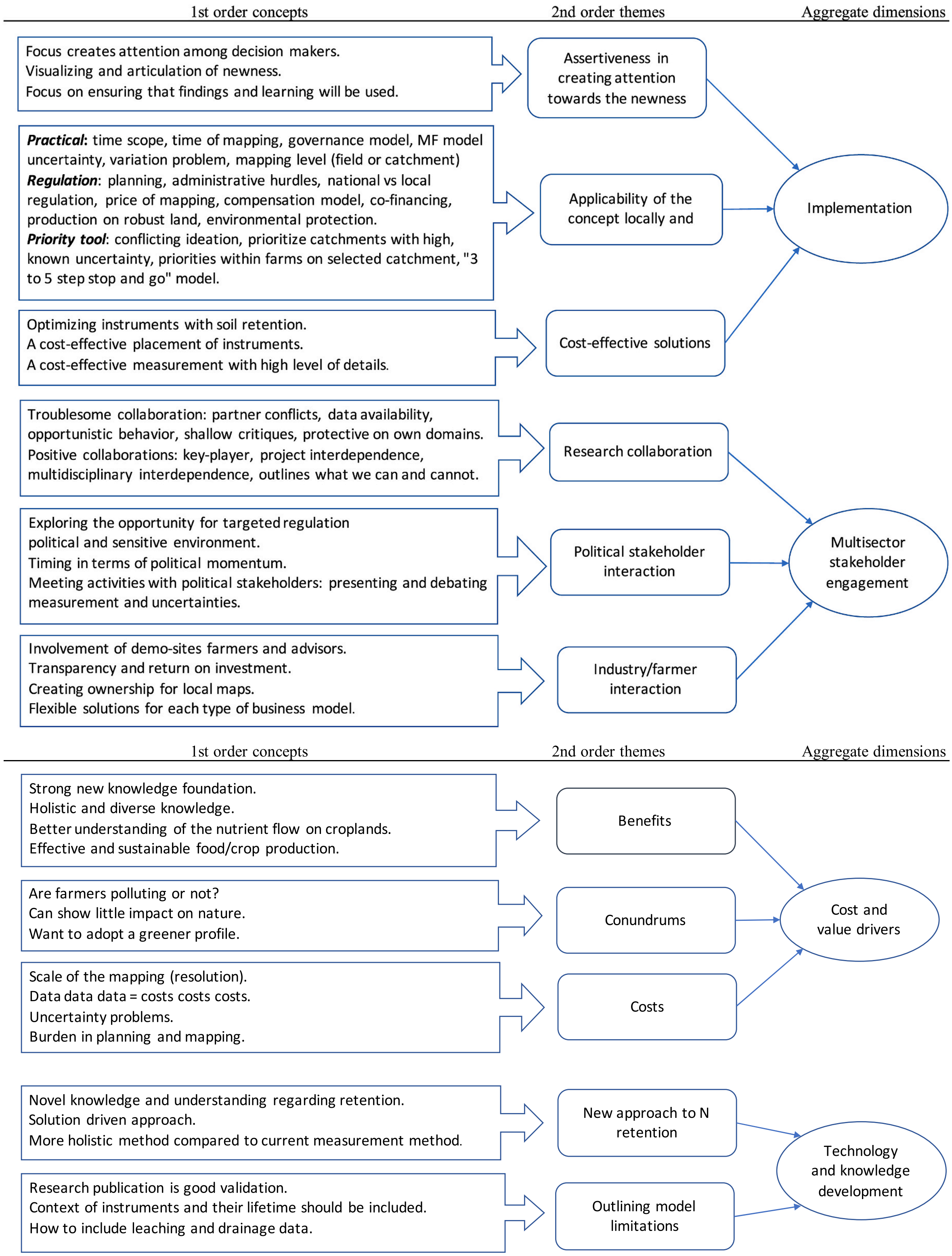

Fig. 2. Examples of the coding process.

mappings. Thus, the implementation is very dependent on the acceptance of any new introductions of mapping measures to inform and guide new regulations. Therefore, well-formulated VPs and documentation go hand in hand when new technologies are introduced to a heavily regulated industry.

4. Findings from the MapField case

4.1. The evolution and ideation of value proposition through stakeholder engagement

In the following, we analyze the evolution of the value proposition among the stakeholders in MapField in connection with the four categories identified to be important for the creation of value propositions through engaging all stakeholders that are part of the triple helix framework. Table 2 below outlines the activities performed by the multisector stakeholders that were part of the project.

In our analysis, we find that some (pre)conditions are necessary for a first interest from farmers, state, or regulators. There needs to be variation in the subsurface composition and the field-to-field scale N retention maps but also a regulatory requirement for N reduction to the aquatic environment. Under such conditions, a potential lift of current reduction requirements due to actual retention being higher than expected might create the necessary stimulus for farmers to engage and invest in the mappings. By doing so, farmers could demonstrate that some areas have much higher retention than currently considered. Nevertheless, the potential appetite towards such investments is lowered by the high degrees of uncertainty related to the mapping outcomes; this will be highlighted in the next sections. Hence, a potential investment is also subject to a high degree of risk. However, the potential barrier is the current Danish legislation, which is the N losses requirements at the ID15 catchment level (1500 ha) which does not currently include field-to-field regulation. Therefore, it would be necessary to regulate whether a farmer would be required to use the new knowledge gained from a mapping, even if its results show lower levels of retentions.

4.1.1. Multisector stakeholder engagement

In exploring the value propositions of service and technology that will drive a paradigm shift among lawmakers, stakeholder engagement becomes important. The reason for this is manyfold, and there is a historic element in which there is long-term collaboration but also severe disagreements amongst key stakeholders. The agricultural sector in this case needs to balance a wicked problem and a broad range of input through multisector stakeholder engagement is needed to ensure that all benefits and costs are identified. As this is deemed important for several reasons, we explore its importance in developing value propositions. Therefore, the multi-stakeholder engagement included a broad account of activities from small to large meetings with both internal and external stakeholders, email correspondence between researchers and developers, interviews, and observations. Here, we also capture if tensions arise or how positive feedback resonates in the project team. Developing novel knowledge for mapping and measuring nitrogen retention does spark an intense debate between different researchers. The tension was accounted for in several ways, and coded from meetings, where the critique was pointing toward the limitation of the data included in the models. For outside stakeholders, these academic debates seemed harsh and only stalled the process of knowledge creation. A head of office from an industry collaborator described the debates in the following way:

> *"problem occurs if they are not trying to meet and create common knowledge and merge the strength of different perspectives. You can nearly feel the tension at times because they believe very much in their model".*

While debates are good and strengthen the overall outcome of the project, the academic debates were perceived negatively by the collaborator who elaborated on this, *"The reason I see it as a negative, is because I think those discussions seem very tough on them"*. Researchers and scientists are easily motivated and they engage rather actively when it comes to concept feedback. The industry collaborators also see strengths and benefits from the new perspective as it changes the current world views in the nitrogen debate. "*I see it as a strength that we mobilize geoscience and geophysics as it is kind of "a bull in a China shop" – it stirs up things and reshuffles them"*. The scientists are of a different opinion than the industry collaborator, and the Management team has this view on the academic debate:

> *"It is a common thing here (in Denmark), that if one group has been advising the authorities, then it will find it troublesome that a new group*

Table 2
Data foundation and sources of information.

Internal Stakeholders	Description (concerning MapField, e.g. take the examples mentioned later in here) and Expertise	Example of Activities (include this in the description perhaps?)	Artifact and Tools
Geus	Hydrological modelling and survey. Geus is leading the MapField project and has a primary role in modelling the water flow	Developing the overall concept of MapField, by incorporating the hydrological modelling based on results from borehole surveys in combination with the AGS software	Gantt charts; redox mapping; hydrogeological maps
Department of Geoscience, AU	Doing geological modelling and developing tTem testing equipment	Performing geophysical modelling based on scanning (tTem) material from croplands	tTem scans; retention maps of Loop areas; development of tMAG
Department of Agroecology, AU	Crop and root zone expertise, with a comprehensive understanding of nitrogen use and misuse (management), a part of the AU agro science center FOULUM	Theorizing on the nitrogen management option, by synthesizing the result from the geophysical and hydrological models	Identification of the riparian zone
Department of Engineering	Data modelling and advanced machine learning	Running computational algorithms	Programming of deep learning tool on the results of the tTEM and tMAG
Aarhus GeoSoftware (AGS)	Developing the software for the measurement used in the tTem and have expertise in hydrogeophysical software	Developing the software used in the tTem in which they also implement GIS to assist with the final modelling (geological information system)	Updated software packages for TEM
Niras	Consulting engineering firm	Niras will be performing tests of the near-final MapField concept technology	Provide a clear map of where the technology can be used and not. This will guide many decisions in the final phase of the project
Seges	The agricultural sector's own knowledge and innovation center	Organisation of facilitation workshops in the local catchment for the farmers, to engage them. Seges also sets up interviews with the farmers and other agro-industrial actors	Document on the identification of area with nitrogen uncertainty retention
Department of food and resource economics, KU	Economic impact analysis of policy changes	Doing economic calculations, stakeholder engagement by presenting and debating the results with the farmers	Interview transcription; interview guide; economical calculation
Department of Management, AU	Business models possibilities. Stakeholder and market analysis	Perform stakeholder analysis and assist in defining value proposition through stakeholder engagement actions	Policy brief/leaflet; value proposition; stakeholder maps; market analysis
The Danish Environmental Protection Agency (MST)	Enforcement of the legislation, a political body that monitors the activities and impacts the use that nitrogen has on the environment	Participate in meetings with the project, where they outline current problems in the monitoring of nitrogen leach and allowances	

enters and tries to defend its position. But I think this is a very common thing in Denmark – simply because we are such a small country, some researchers tend to believe that we got patents in the areas that we have historically been advising on. Because of Denmark's size, we as scientists are not used to competition like they are in the US or Germany".

Even though the "newcomers" are not getting a warm welcome, everybody knows that this is a good thing in ensuring that science will always challenge our ways of doing things. A member of the management team continued, "*A new group entering the field is frowned upon, sort of, but it is healthy when this is happening*". This viewpoint is shared among the industry collaborators who can see clear benefits if researchers choose to collaborate:

"I am not part of these "disputes" – I can see clear benefits from both models, and the DK model has some really good elements, but it needs to be challenged as it should include more perspectives".

The inclusion and engagement of stakeholders drive the underlying perception of how to utilize the concept as they debate possible avenues of implementation over time. As researchers have often described, the initial idea acts as a 'research push', but what is key here is the engagement and formulation among all stakeholders of cost and value drivers for the potential technology as it evolves. This dialog is slow but steadily changes the perception, and this is also about understanding where the benefits are and that some businesses might suffer. An industry agent stated the following:

"We are currently having a national N model and that one has many good things in it, and is an important step towards targeted regulation, but by bringing in new scientific elements from geoscience, we are now moving even closer to it, by bringing their knowledge to bear."

During a meeting, it was stressed by agricultural researchers and agents that more documentation was needed: one thing was written scientific papers, but they were not good for the industry. There is a clear element of debating that the gains in doing targeted regulation with precision mapping are great, but that it will cause some farmers to suffer greatly and this acceptance takes time:

"The agricultural industry has to find their position here, too, because as we observe over time, they realize that some of their members will gain from this, however some members will lose."

When the farmers who are the directly impacted stakeholders were asked about the dynamic or enhanced targeted regulation, they had various concerns, but none of them were nervous about potentially lowering their nitrogen allowances or input. The farmers commented in the following way:

"I am not concerned about it being regulated using a more targeted approach in future. Actually, I do speak in favor of it as I find that it is doable – as I do crop for yield, not for high protein!" (Arable farmer).

"I would not like to do split field, as it makes our crop rotation and fertilizing too administrative and planning heavy. I would be much more in favor of taking out of production land with low N retention since I need robust lands for my high protein crop production" (Pig farmer).

The multisector stakeholder engagement dimensions are well-connected to all the aspects of the MapField concept, given that it is central for both the development of MapField and the implementation process and those connected hurdles related to an immediate adoption of the technology. The latter can be partly related to MapField being the third in a line of projects that make use of stakeholder engagement to facilitate the research and development phases of this technology (see Nygaard et al., 2021). In the next section, we will investigate the details of these implementation obstacles.

4.1.2. The balance between solving problems and creating new hurdles with implementation

Implementation is a natural conversation between all stakeholders when it comes to the MapField use and service. In that sense, the topics of data and documentation are often argued as an important element to inform the various stakeholders. One often debated topic was an extension to more pilot projects, that is a scenario-based project which will build upon the technology developed in MapField. This move was needed to collect more extensive data and provide better documentation. These pilot projects also need to include a comprehensive scenario analysis. Among the multiple stakeholders, this is seen as the next logical step – merely because it will assist in resolving some uncertainties that are not currently considered in the framework. This came up in various ways and during a project preparation meeting, one of the lead scientists outlined the three steps or tracks needed to advance the project outcome in a future pilot scheme which was, "*We need to develop a knowledge track, a legal track, and an implementation track"*. The idea of a pilot project is similarly mentioned in various meetings, and as part of the implementation that is being debated. During a meeting between scientists and regulators, a government official described the pilot steps as being a bit different: "*From my perspective, we have three important steps; one is technical knowledge, the next step is planning and the final step is administrative regulation".*

This is required to give them an understanding of how and when the approach can be used. The hope is that it can be used on individual farms, but this is not the case as the hydrological model requires data from the whole hydrological catchment for calibration of boundary conditions. Therefore, scientists recommend a catchment scale ID15 or 1500 ha as the minimum mapping area.

The consensus is that a pilot project will provide a holistic and better foundation to inform the regulation. Another important topic here, which also connects to both multisector stakeholder engagement and technology & knowledge development, is model and data transparency. Indeed, it is of key importance for all stakeholders to understand the value of the MapField concept. Most importantly, the pilot project themes are very closely connected to the themes of regulatory and practical implementation.

Under the implementation, we also included 'assertiveness to creating attention' among decision-makers. This topic also connects well with the theme of creating new knowledge. It relates to the responsibility of the project to inform the decision-makers that new and novel insights to how the measurement and connected regulation can now be done differently. The management team elaborated in the following way, "*In a sense, we use a lot of time in making our results and findings visible, we do this by continuing to articulate what we are doing and present it to the ministries and agencies*". However, from a researcher's perspective, this activity makes sense, as a member of the management team further argued, *"We as researchers need to ensure that the knowledge generated in rOpen and MapField will be put into action and used, otherwise it would be a waste of resources*". Therefore, there is a large focus on creating attention among the decision-makers from the entire project team. One of the main reasons for this was outlined during a briefing meeting by a work package leader, *"we need to figure out how we can get the authorities to look in our direction … (..).. it does not help us that they are not using our tool*". The latter part of the quote refers to the national N retention model used by authorities that is managed and developed by another research unit, but within the same institutions.

The implementation of a novel N retention concept cannot be discussed without also including the notion of a price tag. Therefore, price and pricing as a theme are included and captured within various accounts. These accounts arise from meetings in the "costing group", debates on price in larger meetings, over interviews, and also from our survey data. The theme of the price is well connected to the theme of cost-effectiveness. With the increasing interest from policy-makers, more cost/price awareness has arisen in the meetings with stakeholders outside of the project team. The policy-makers have made the project team aware that pricing is crucial. The projects before MapField were drawing attention to lower cost and uncertainty levels. Similarly, these themes were a major concern since the beginning of MapField. A government official expressed it like this, "*by a quick calculation, this very quickly becomes expensive*" and during the interview with a management team member, "*the ministry has concerns about the price tag*". This is because the ministry aims to do a full mapping as the present maps, whereas the notion in the project was to focus the effort on the areas where the effect of the mapping is the largest. This also led to the need for a prioritization tool to find out where the need was the largest. This follows from the notion that the ministry thinks in terms of a full mapping of Denmark which in terms collides with the positions of the project participants, who do not see the need for such a national map. It was concluded before MapField was implemented that this new tool should be used to identify where the need is largest. A related issue regarding pricing is to put the right commercial price on a research project where side activities and investigations are carried out.

As cost-effective regulation is vital for implementation in Denmark, the project team has a natural focus on this, and therefore as a response to the "critique", they are innovating and trying new and more time-effective mapping procedures. A management team member elaborated, "***We are now testing if we can do the mapping with a larger distance and get the same results? We do this, as we hear some stakeholders say that this is currently too expensive. But it is hard for us to say what the price is going to be in the end. We might not be anywhere near the market price now***".

To capture a key problem connected to the stakeholder creation of value proposition it is clear that some benefits and costs are either connected to the industry, the authorities, the researchers, and the society. In Table 3, we have summed up the large categories of pains and gains for each of the groups. That is identifying value propositions for the mapping technology as a standalone commodity and the case if MapField is implemented as a means to inform future targeted nitrogen regulation. As the overall vision of the mapping tool is to inform possible targeted regulation, we find it necessary to include value propositions connected to both the technology itself but also to the regulation that it may inform. The reason for this is that if it is not done in such a way, important value propositions that are key value drivers for tools connected to targeted regulation would not have been identified. In line with what Nygaard et al. (2021) describe, both stakeholder engagement and the identification of hurdles for implementation are important for the ongoing development of the MapField concept. In the next section, we will outline aspects of technology development and the two dimensions above that affect it.

4.1.3. Technology and knowledge development – MapField

This dimension is aggregated from seven major themes. It refers to the entire chronological development of the technology, exploring what it can do and cannot do. An overview of references to MapField concept's progress over time can also be found in Hansen et al. (2019) and more background about its as a decision tool is described in Frederiksen et al. (2020).

A key driver that connects well with the benefits is that all created knowledge needs to be published in scientific journals before findings can be disclosed to the public. Furthermore, the publication is part of the concept communication agenda, and the principal investigator stresses this every time a public announcement needs to be made. Hence, to legitimize their contents, public announcements from the project are based on knowledge from peer-reviewed publications. The latter was a key requirement from the funding body. During a work package leader meeting, it was discussed if newsfeed or dissemination externally should come after a scientific publication. The fact that the knowledge community accepts the new knowledge is leveraged by the project team.

Multisector stakeholder engagement is a very vital part of this process, as the stakeholders get to express their needs and concerns related to the preliminary findings. And it speaks into the refinement of the technologies' boundary condition and provides a clear practical perspective. As an industry agent said:

> *"I am quite sure that in the long run, MapField is a benefit. In the shorter run, there are some discrepancies regarding the approach to doing this, between the different camps of researchers. The current model vs the new model discussions is time-consuming, but this is also the strength of a research project – when opinions are challenged or changed".*

During the bigger presentations facilitated by the agencies and ministries, the different "groups" of researchers (note that groups refer to: those researchers currently informing the agency and the researchers within the MapField project) are between themselves firstly debating the findings, and the public servants are often having follow-up questions to this. In that sense, natural scientist has much focus on the flows of water and retention of N in the geological layers, and the value they outline can be perceived as pure knowledge gains that are disconnected from what farmers perceive as benefits. This is indeed a clear way for the government to get the best out of the research communities. It follows well with the notion that the government is exploring the options to do better and more precise regulation of N in the farming industry.

As mentioned in the sections above, there is a movement towards more targeted regulation in Denmark (Environmental Protection Agency, 2017). In doing this, it is important to outline the different levels regarding targeted regulation in Denmark. Firstly, there is the level of details regarding retention (catchment or, id15), secondly, levels of details regarding reduction requirements (national, catchment, or id15), and lastly, levels of details regarding the effect of measures (national or soil type/livestock intensity). In this, the first steps have been taken during 2019–2021 to make it more targeted, and the state is now in the process of deciding the next step. Due to this process, the researchers currently servicing the authorities are invited to debate the technology with the ministry and MapField. This, in a sense, has a dual purpose. Firstly, the ministry is using academics to debate between the two camps of academics, and from this debate, they can infer where the boundaries and concerns are connected to the development of MapField. Connected to this, the ministry also keeps asking about one of their main concerns, namely if MapField can assist in resolving current uncertainties concerning the current reduction calculations and provide benefits to the ministry in the form of improved modelling. Secondly, the debate provides the ministry with a good platform to compare the current with the new concept. There is no doubt about the novelty that MapField brings to the field, and, although the ministry seems quite impressed, it is still investigating other options. This bridges the cost-effective solution and the one regulation conundrum which we will come back to in the section here below.

As outlined by one of the lead scientists in several meetings, with the use of the technology going forward in Denmark we will have the ability to determine subsurface N retention on a field-to-field basis. Connected to its implementation mentioned in the section above, the three tracks should also be developed to leverage new knowledge, regulative hurdles, and capacity allocation during implementation. These three tracks aim to ensure that new data, knowledge, and documentation are presented transparently before being implemented into the concept. This is an extension of the future pilot project ideas seen in the implementation section above.

The development of the technology and the refinement hereof is crucial in order to reach the central argument of the vision, and the project leaders actively coordinate activities among their broad range of partners. For instance, a partner within advisory and engineering was asked to perform the test of the hydrological models' boundary conditions. We captured many events like this, and the findings are twofold as there are two benefits from this. Firstly, the utilization of diverse knowledge by involving partners, so stakeholder engagement emerges through this action. However, by pushing assignment and value creation onto the partners, the technology push becomes a compiled push from the project stakeholders. In doing so, the project leader tries to change

Table 3
Gains and pains by the adoption of the technology by itself and using it to inform targeted regulation.

	Industry		State		Research		Society	
	Gains	Pains	Gains	Pains	Gains	Pains	Gains	Pains
MapField technology concept	Farmers can choose to map their field for more in-depth knowledge Advisors can use it strategically for collective actions Can be embedded in the "field-online" tool Better use of catchment crops tTem requires no heavy equipment	Costly without a "stop or go" version Single farmers in catchments are not enough Needs to be done as collective groups Co-financing structures must be formulated Drilling requires heavy equipment	Provide a new perspective on N retention Advance the knowledge on soil retention and on what constitutes robust crop production land Provide new knowledge to the targeted regulation debate Can resolve the problem with uncertainty related to current mapping measurement	Cost per. hectare pr. year is high The time (length of mapping Denmark) Can only be done in the current period of the year	New measurement and model to explain advanced geological structure in crop production land Advancing the understanding of redox zones and then the turnover of nitrogen A better understanding of leaching A model that includes archival data and combines it with current data	A rather large area is needed for the modelling to run efficiently Needs bulks of data to run effectively Processing time and estimation time are long The model is still in the testing phase The inclusion of data is time-costly Access to fields is restricted	Knowledge about how the geology impacts the cropland production Competition on knowledge domains If farmers do use it and at the same time do better use of catchment crops: there are local environmental gains A concept that is ready for larger testing	If not used, possible ineffective use of cropland Time and funding in keeping advancing the knowledge in the area
Targeted regulation	Nationally and locally going towards a more efficient production on robust land Strategic use of catchment crops to acquire reductions Ease reduction requirements on robust land - securing high yields	Fragile production land might be needed to take out or receive increased reduction requirements Financing of the concept of each catchment Some farmers will have no interest in investing in this technology as they might know the outcome while others have high incentives	Provide a tool that ensures reaching the targeted environmental and climatic goals With low uncertainties, it justifies for a new and different regulation Ensures no use of less effective catchment crop of fragile cropland and vice versa	The planning and administration of doing the targeted regulation requires large changes What area is needed to be outlined as targeted - the field, the catchments, or something in between? One regulation nationally makes it costly and a long process Financing is a problem	Advising and collaborating with state and industry on the topic Access to data going forward Ensuring that the outcome of the funding is put to use	Access to farms Data from other research groups	Enhanced the surface water protection from excessive nitrogen pollution A healthier aqua environment and nature No nitrogen exposure to humans using the nature	Society will bear the cost largely

the perception that this is just a research push.

4.1.4. Cost, value drivers, and governance models

The MapField vision is built on a strong set of value drivers that depict clear national benefits from the development of the concept. This overarching theme manifests itself throughout the various activities in the project. Moreover, benefits from utilizing the technology are also found at the regional and local levels, however, the cost on the local levels has an impact on the national level benefits.

> *"The MapField vision is to develop a concept that illustrates that it is possible to do target regulation at the field level. In doing so, it creates advanced technologies and knowledge that minimize costs and reduce the impact on the aquatic environment." (Meeting between researchers and agency, 2020)*

Throughout the project, benefits were identified for a large part of the stakeholders. Given the project's aim to enhance the quality of the aquatic environment, we here focus on presenting the residual or complementary benefits from using this technology to inform targeted regulation. However just to specify that it occurs in our data, we have multiple accounts for this benefit actualizing it among the stakeholders, *" I see it has a massive benefit for water protection in general by getting more details about the subsurface by using the developed technologies and concept"*. The important part of the sentence here is the latter, better use of instruments. This relates to all the above-mentioned strategic tools, such as the amount of fertilizers allowed and the use of catch crops.

The focus onward is on presenting residual or complementary benefits to overarching environmental gains from using this technology to inform targeted N regulation. What was a clear benefit, from the management team's perspective, was the amount of expertise and diverse knowledge taking part in the project; this adds and bridges to the comment from the industry agent, *"it has been very insightful to have more scientists from geoscience involved"*. The management team stated the benefits of the diverse knowledge in the following way:

> *"I think the consortium behind the MapField project is both unique and strong. We have here some of the best and most knowledgeable people in Denmark working together. Broadly speaking, it adds to the dimensions that we operate on."* (Management team)

Going towards more targeted or dynamic N regulation requires that the governmental agencies do comprehensive planning for targeted measures and justify reduction requirements connected to these measures: *"plan investment better, that is place resources more correctly, to gain a larger effect, and potentially getting more out of the subsidizing."*

Concept opportunities are an important theme when investigating point complementary gains. This theme bridges very well to the multisector stakeholder involvement dimension. As the technology is becoming more refined, the potential is revealed for all stakeholders, but in exploring these potentials it is very apparent that it will have a substantial impact on some farms. This has nurtured a dialog among stakeholders about a future pilot project to ensure that the technology is used correctly in terms of dynamic regulation. This was expressed during a work package leader meeting:

> *"With pilot projects, we test the shortcomings that we have identified, and further evolve them into new useful and practical projects going forward .... [ ] ... Pilots are great for doing scenario analysis where we consider farmers' production on the estimated N retention."* (work package leader meeting, Oct 2020)

Despite the complex task of creating, identifying, and formulating a value proposition for the product and its connected implementation, active and assertive stakeholder engagement provides a pivotal tool to achieve this. Here below in Fig. 3, we have outlined the overall effects, both positive and negative, and combined the value propositions for both MapField and its possible implementation. Balancing the left side (Cost and Benefits) of the model will assist in defining the dynamic regulation and the value drivers connected to it.

4.2. Governance model and value propositions

In the four parts above we have focused on the individual dimensions and their embedded connection to the process of creation of value propositions. Granted the technological advancement that the mapping tool developed in the project brings, it has no apparent benefit downstream, as one of the potential end-users, the farmers, see only a minor economical gain from buying into the concept. This is purely from an individualistic perspective, as the farmers expect to at least break even from the cost of mapping, and with no regulation in place, there are currently no benefits from mapping the field. Collectively, farmers might be more prone to opt-in for mapping if everyone sees a potential benefit. This could be done through rent-seeking regulation by a flexible governance model. In the following section, we will outline the conundrum for products that have a direct impact on the regulation if implemented. With Fig. 4 we show the impact that identified value proposition can have whether the authorities choose to include, exclude, or partially include it in the governance model. What is important to stress here is the fact that the governance model will guide the business model innovation within the industry. For example, the value propositions are formulated by the use of multisector stakeholder engagement to assure that as many costs and benefits as possible are disclosed.

The governance model is a method by which the regulation is also embedded in a flexible legal framework. This can be considered as the middle ground between pure market-driven demand and the governance command and control structures. Importantly, what we find is that the governance model can allow for end-users to be included in its formulation process. The main reason for this is to ensure that potential benefits from the good or service can be fully exposed but also to mitigate a potential larger pushback from the farming industry. However, with the inclusion of the farming industry and other stakeholders, the aim is to ensure a dynamic regulatory framework in which the farmers at large will also have received benefits. The multisector stakeholder engagement drives a consensus-driven approach which assists in outlining the potential benefits and costs connected to the implementation by the use of MapField. We argue that all of the dimensions above are crucial when formulating a dynamic governance model that is based on the identified value propositions. One very important notion is that, given the limitation and constraining nature of a governance model, businesses are more or less bound to the value propositions that are included in the final articulation of the governance model.

Certainly, the case of nitrogen retention on croplands and the regulation hereof is very intrusive on individual farmers. Therefore, incorporating a technology that changes the regulators' idea and understanding of N retention has to be based on value propositions that both the state and the industry can align to. The governance model and its formulation greatly impact an industry's flexibility in their final business models and business model innovation (Fig. 4). Within the project, several ideas of how this could unfold have been debated. One such example highlights the inclusion of farmers and provides them with the possibility to collectively sort out the reductions based on the retention mappings. In the case where a farmer has two crop fields that are vulnerable, this lowers the N retention of the entire catchment. This currently causes a reduction to every farmer in the catchment. However, with the use of the MapField mapping technology these two crop fields could be identified and perhaps taken permanently out of production. In such a scenario, the other farmers will not be subjected to any further reductions. If the farmer owning the discontinued fields will receive some kind of compensation, the whole solution represents a win-win case. However, an ideal type of implementation would consist of the compensation being only partly state-subsidized, while the remaining part being co-financed by the benefitting farmers. Such a governance model should be based on a more flexible regulation at the local levels.

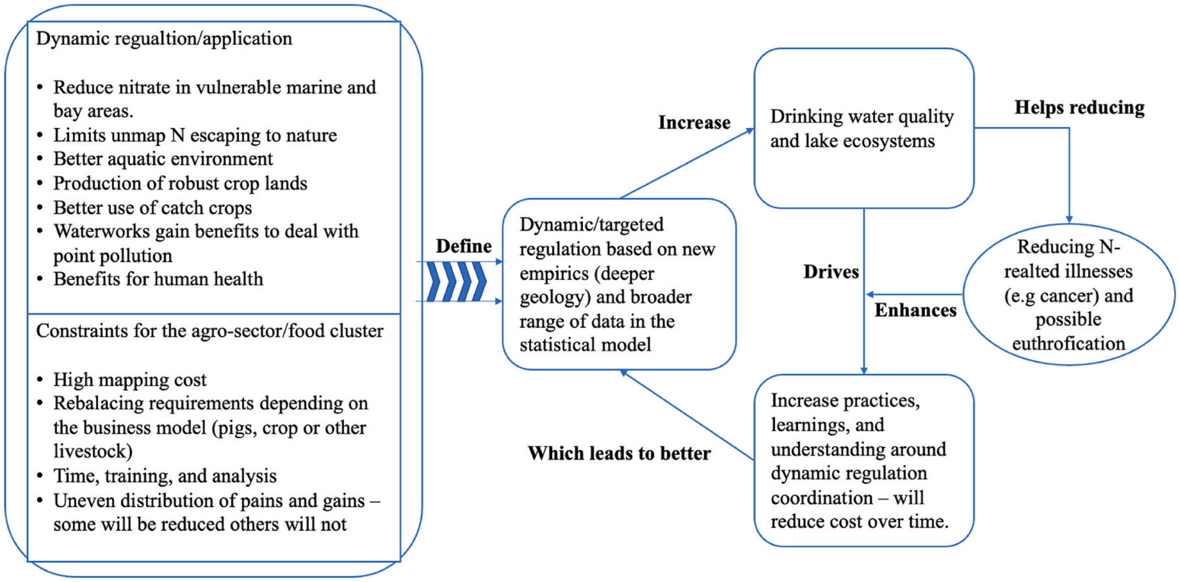

Fig. 3. Value Proposition and drivers connected to adoption and implementation of the MapField mapping tool.

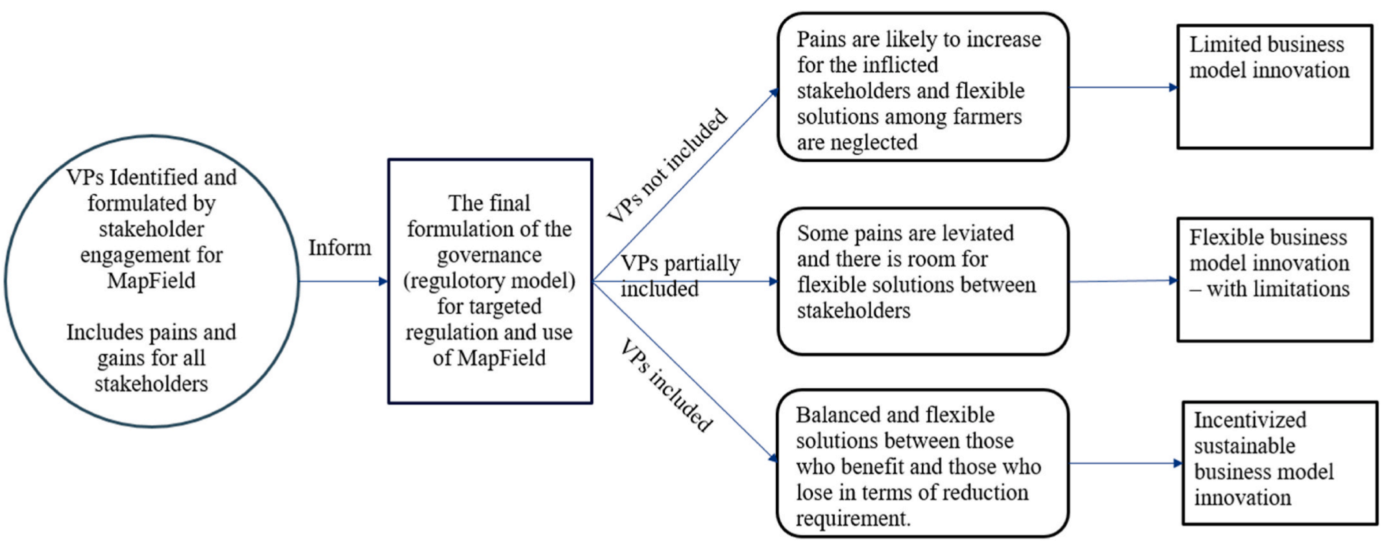

Fig. 4. Value propositions (VPs) outcomes if considered in the final version of the governance model.

Eventually, such regulation will aim to ensure production on robust lands and compensate farmers that discontinue vulnerable and polluting croplands.

5. Discussion

With the triple helix framework in mind, this paper explores how a new N retention concept is slowly introduced into the Danish agricultural industry. Our findings indicate a very delicate and complex process between the stakeholders while the mapping technologies and concepts are being developed. We argue that this embedded case study can add insights to the processes of implementation of research results. Based on the approach of value proposition development this paper urges large societal projects to identify pains and gains from introducing a technology that may alter the industry and its connected legislation. In arguing this we align with other studies that outline the importance of the triple helix interaction when driving sustainable change (Scalia et al., 2018). Practically, this exercise has many facets, starting with active stakeholder engagement locating benefits and hurdles connected to the technology itself. Secondly, this engagement also outlines where these benefits and hurdles will create solutions and problems connected to the possible regulatory implementation. These findings align well with the stakeholder process connected to collaboration between interdisciplinary workforces described by Podesta et al. (2013), who argued that such a co-creational task by the participation of relevant actors drastically increased the credibility and relevance of models developed in the project. This task can however be very difficult to facilitate, as discrepancies between the benefits of the measurement itself might create hurdles in connection to the regulatory implementation. Hurdles that are predominantly remaining on the side of one stakeholder create coordination problems that slow down the process of collaboration, as found by Eyiah-Botwe et al. (2016). From Fig. 3 we show that the pains and gains of the technology itself meet difficulties for commercialization, which follows very well with the findings of Hall et al. (2018). This is despite the technology being "pushed" in a country that has a strong green agenda and thus, this technology might face even stronger commercialization problems outside Denmark as a standalone solution.

This discrepancy in the value creation between product and regulation is an important finding as it connects to the second question we asked. As such, value propositions outline the economic benefits of users and can also help to identify pain relievers for those negatively impacted by the introduction of new technology and regulatory approach as in the case of this study. In our case, this is seen among the farmers, which as a target group will have little incentive to invest in the MapField technology. However, it appears that it would be valuable to inform and legitimize targeted regulation that would benefit society at a large. More so, in connection to these, the agricultural industry as a collective unit is also receiving benefits. We have highlighted the fact that identified gains for the industry can also create gains for society (see Fig. 3), e.g. the production on robust lands and better use of instruments to mitigate escaped N, eventually reducing water pollution. These are two value propositions that potentially enable some farmers to have the same or more yield from their lands than the current level due to removal or limitation in reduction requirements on selected fields. On the other hand, some farmers will need to pay for that collective gain of the industry. Thus, farmers with vulnerable croplands will likely be subjected to increased reduction requirements. Nonetheless, despite the positive value proposition, this movement is certain as those farmers that are not gaining (i.e. those that would be subjected to further reduction requirements) would likely be opposing the legitimization of the concept. To alleviate pains for these farmers, regulators could use governance models as a flexible guiding tool for farmers and advisors to collectively reach targets. The problem with governance models is that if the value propositions are not taken into account while formulating them, then value propositions created from the technology will have little to no effect. This leaves the developers in a situation where the value propositions are not only formulated for the technology but also the regulation. In dealing with such a problem, we found that stakeholder engagement between researchers, industry, and state alongside the development of the concept proves beneficial for the potential value creation of the concept, in that the engagement between triple helix actors provides a good base for driving the values connected to a sustainable transition, much like Cancino et al. (2018) suggested.

5.1. Implications for practice and policymakers

The stakeholder engagement dialog concerning the implementation has from the early phases of the project continuously challenged the value drivers of MapField. More importantly, these dialogs probed the concept's value propositions from early on to be more aligned with the value proposition for the regulation, as captured in Fig. 3 above, in the findings. Our findings suggest that formulations of governance models should include multi-stakeholder involvement and engagement in the case that the resulting governance model would be adequately articulated and informed based on value propositions for the specific industry. Such a governance model will arguably ease the coordination between industry and regulator in achieving the regulation's overarching goal. Therefore, we argue that exerting value proposition thinking is connected to the multisector stakeholder-inspired governance model, as our finding indicates that it will then be more likely to ensure flexibility for the inflicted users which is in line with the argumentation by Brown and Katz (2011). Therefore, it is important for researchers, as well as practitioners, to get an understanding of how this process can be facilitated, monitored, and executed. More importantly, with the ethnographic research design, we can account for major pitfalls during this process of articulating multisector value propositions (Brown and Wyatt, 2010; Ferraro and Beunza, 2018). We agree with this stream, and we find that the value proposition articulation can impact both flexibility and possible business models for the inflicted farmers. In the case where a reduction requirement in an area has to be achieved, farmers who own the vulnerable fields can by seizing crop production remove the requirements of the reduction, but would require some form of compensation from the nearby farmers who, as a result, would not need to take action. In this case, it is seen that instead of creating losers and winners, the stakeholders aim to articulate win-win situations from the value propositions. As such, the inclusion of stakeholder-driven value propositions can nurture governance models that advocate for a sustainable transition. With the European Water Framework Directive in mind, with this Danish case of moving towards a dynamic targeted regulation ensuring production on robust lands, we have depicted some of the ontological differences that make creating a common ground difficult. Other northern European countries are facing the same obstacles as Denmark with increasing environmental reduction requirements, protection of the aquatic environment, and a public movement towards more sustainability. For instance, in Germany, the focus is on how to improve groundwater quality in selected areas.[1] In both Germany and the Netherlands, there are efforts to reduce the agricultural industry's environmental impact in selected regions. The movement towards producing solely on robust cropland might be the solution that is soon a reality in many European countries. Thus, the learnings from Denmark could provide insight on how to facilitate this process amongst the affected stakeholders. That is to include all stakeholders and engage them to formulate value propositions that identify and capture all costs and benefits connected to the local implementation of dynamic nitrogen regulation. Regulating an industry dynamically is not a simple exercise, and governments are seldomly doing it. Thus the takeaways from the MapField case provide actors on all sides with practical implications. We have depicted some main obstacles that stakeholders were meeting during the initial transition towards a dynamic regulation of the farming industry. The overall message is that stakeholder formulated value propositions provide a good starting point for articulating the underlying governance model that supports that regulation.

5.2. Implications for theory

Our findings indicate that there is a clear need for more than only scientific publications, but also solid documentation and description of the data foundation to legitimize the adoption of a newly developed mapping technology. Similarly, we identified a discrepancy between the notion of developing a concept that consumes large amounts of data and providing a cost-effective solution. This collides with the justification for the implementation of the regulation being related to cost-effective thinking that the agencies operate by. From a more practical perspective, this discrepancy is partly generated by the industry itself, as it requests data-informed regulation to justify potential reduction requirements. However, this request might be too costly for one single actor to bear alone. The theoretical argument here is that data is expensive to acquire and process and that large amounts of the data thus become a "pain" for the individual stakeholder requesting it because its costs outweigh the benefits. However, in some exceptional cases, some farmers might be willing to sustain such costs to prove compliant nitrogen levels of their croplands.

A relevant discussion here connected to legal implementation is the "what constitutes a field?" and what the boundaries of legislation are. A question that at times becomes a very conceptual discussion for some stakeholders. Practically, fields can change over time, which for a regulator creates problems in terms of field-to-field regulation. The shared definition of "a (crop) field" is however an important practical finding central for future regulation that aims at creating field-level targeted N regulation. Doing this is an exercise that the management team and regulators need to prioritize early on in the project, otherwise, not defining what a field is will consume valuable time that could otherwise be spent on other practical issues connected to the

[1] An interactive map of reports on the results of the 2020 report on N pollution can be accessed from the website of the German Umwelt Bundesamt at: https://www.umweltbundesamt.de/themen/uba-startet-interaktive-nitrat-karte (link accessed last on 8 July 2021).

implementation of differentiated or targeted nitrogen regulation. Connected to this is another important practical aspect, namely the alteration in the management or administration connected to field-to-field targeted regulations. On the one side, stakeholder engagement between actors assists in figuring out at what level the mapping and connected regulation are correctly balanced. The conundrum, however, for the regulator is locating the balance between using higher resolution maps that allow for local or microlevel regulation of individual farmers and the costs connected to running individualized legislation. On the other side, farmers face logistics issues connected to crop production. The practical problem for farmers is that they are currently leveraging on the "ease of use" principle, which is managing clusters of fields at the same time (i.e same crop rotations and catch crops, subjecting the fields in the individual clusters to the same crop rotation). A differentiated or targeted N regulation for every field on a farm will disrupt these current cost-effective solutions created by the farms. This, at least in the short run, implies that there will be substantive switching costs for individual farmers in terms of time and rethinking the logistical coordination. This is also why the main reason why farmers are reluctant to accept field-level regulation.

All these 'pains' have been identified throughout the project, and all stakeholders are contributing to the dialog about how a connected governance model that aims at balancing these pains and gains and creating the incentives for implementation, should be formulated. To alleviate an industry push back it is arguably very central that value propositions for the technology and the regulation are aligned as much as possible. If this is the case, the state will have the possibility to formulate a governance model with some degree of flexibility within its regulating mechanisms. We have outlined the necessary stakeholder engagement that is unfolding as technology is being developed. This engagement drives a process of articulating value propositions for all stakeholders.

5.3. Future research

Lastly, further research will be needed to investigate how different outcomes of various governance models will inflict the interested stakeholders regarding economic implications. This could be done by the use of scenario-based field studies where the researchers explore the implementation of potential impacts of governance models on business model outcomes for farmers. Furthermore, the technology's value could impact other sectors and potentially add benefits for other or similar analyses in other countries. The benefits are not just for the N case in a Danish setting and these possibilities should be explored even further. However, this research is conducted in Denmark which is considered to have a consensus-driven governing style, where the state listens to and includes stakeholders' opinions. Therefore, the findings of this study might not be directly transferable to other countries that do not nurture the same consensus-driven governing style. Nevertheless, the practical findings from this study may still inspire PIs to include perspectives from all stakeholders from the early phases of technology development.

Further research could focus on the role of stakeholder engagement in the co-creation of possible solutions and legitimization of new technologies in agriculture production as well as on the actual impact of their implementation in making agricultural production cleaner. Targeted regulation is still highly positioned on the political agenda, however, more research is needed to further understand the directions that targeted regulation could take in its implementation and especially what its limits are. The focus should lie here on the interplay between political and economic perspectives towards a value-added implementation on a national level, efforts should verge on how the mapping applications can be designed in a cost-effective way while ensuring a high level of detail. More knowledge is also needed before the technologies can be standardized and upscaled. Market analysis of the business models (including value propositions) of other sustainable projects represents interesting opportunities for future research in the area of possible commercialization options, including compensation mechanisms for negatively affected stakeholders. Finally, a detailed economic analysis of cost and benefits, including the quantification of health costs and benefits is relevant in the future, especially to motivate the mobilization of public funds.

6. Conclusion

From a scientific point of view, the MapField concept has focused on developing technologies and concepts for determining the N retention in the subsurface groundwater zone. Further development of a complete concept taking N retention in the whole landscape into account might require 1) merging the MapField concept with the national N model currently used in N regulation or 2) further development of the MapField technologies and concept to include more knowledge about N retention in drains, lowlands and surface waters. The value propositions of the technologies and concepts developed in MapField are contingent upon a governance model that would enable them and their consequent implementation in the market. In other words, our analysis showed that the MapField technology, on its own, does not have the potential for independent implementation nor commercialization. However, we are not arguing that the technologies and concepts cannot be commercialized at all; instead, what we find is that the technologies and concepts cannot by market forces drive a sustainable transition towards a new targeted N regulation paradigm. This is mainly due to a lack of specific economic benefits arising for the farmers or at least very arbitrary outcomes (lack of a value proposition and business case for the farmers).

This transition instead needs to be driven through combined value propositions for both regulation and technologies. Indeed, a governance model would take into account the benefit for society at large by factoring in the benefits from the lower impact on the aquatic environment including groundwater and drinking water. Hence, supplemented with a subsidized and regulation-based governance model, the necessary conditions for MapField's implementation could be created, among others, by generating economic incentives for farmers to adopt the concept. Another road would be to develop a more automated tool based on few resources used on the mapping and the transformation to retention maps. With more mapping (increased scale) the technology will move into the next phase with more automation and cost-cutting which would be required also to allow for a transition from research to a commercial approach.

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CRediT authorship contribution statement

Kenneth Nygaard: Conceptualization, Data curation, Formal analysis, and, Investigation, Methodology, and, Project administration, Visualization, Writing – original draft, Writing – review & editing, Validation. **Stefan Schaper:** Conceptualization, Data curation, Formal analysis, and, Investigation, Methodology, and, Project administration, Visualization, Writing – original draft, Writing – review & editing, Validation. **Brian H. Jacobsen:** Conceptualization, Writing – original draft, Writing – review & editing, Validation. **Birgitte Hansen:** Writing – original draft, Writing – review & editing, Validation, The authors Kenneth Nygaard and Stefan Schaper are the main authors and have contributed together in all of the stages of the research for this article, Brian Jacobsen and Birgitte Hansen were contributing to some sections of the manuscript as outlined below.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Questionnaire construction

Question	Range	Theoretical perspective
Question 1: What sort of stakeholder are you?		
Farmer	-N/A-	
Advisor (consultant)	-N/A-	
Local legislating enforcer (Region/Municipality)	-N/A-	
Governmental agency	-N/A-	
Ministry	-N/A-	
Agro-industry	-N/A-	
Research (Project-internal)	-N/A-	
Product/concept development	-N/A-	
Other	-N/A-	
Question 2: How many projects have you been a part of?		
MapField	-N/A-	Stakeholder engagement: participation
rOpen	-N/A-	
NiCa	-N/A-	
Other	-N/A-	
Question 3: What stakeholders do you mainly interact with? (Feel free to pick several options)		
Farmers	-N/A-	Stakeholder engagement: interactions
Advisors (consultant)	-N/A-	
Legislators	-N/A-	
Governmental agency (styrelser)	-N/A-	
Ministry services	-N/A-	
Agro-industries	-N/A-	
Researchers	-N/A-	
Product/concept development engineers	-N/A-	
Other	-N/A-	
Question 4: Rate the MapField concept based on your perception and understanding		
The value proposition is mainly on the farmer's side	*Disagree, Unlikely, Maybe, Most likely, Agree*	Value proposition canvas: value propositions drivers
Society is the main beneficiary of the concept	*Disagree, Unlikely, Maybe, Most likely, Agree*	
MapField concept is mainly a "tool" for advisors to incorporate in their service offerings	*Disagree, Unlikely, Maybe, Most likely, Agree*	
MapField creates the most value for the local municipalities and waterworks	*Disagree, Unlikely, Maybe, Most likely, Agree*	
The value proposition is mainly for society as a whole	*Disagree, Unlikely, Maybe, Most likely, Agree*	
Question 5: Commercialization of the technology: MapField is to		
be implemented and commercialized in the advisor's toolbox (voluntary)	*Disagree, Unlikely, Maybe, Most likely, Agree*	Value propositions canvas: products & services and/or governance model
be combined with a rootzone measurement to enhance the usefulness	*Disagree, Unlikely, Maybe, Most likely, Agree*	
be a tool for national regulatory bodies (dynamic regulation) and mainly be subsidized	*Disagree, Unlikely, Maybe, Most likely, Agree*	
focused on groundwater preservation measurement for environmental agencies	*Disagree, Unlikely, Maybe, Most likely, Agree*	
so that farmers should sustain a(the) majority of the costs	*Disagree, Unlikely, Maybe, Most likely, Agree*	
Question 6: MapField maps should		
be considered in future regulation	*Disagree, Unlikely, Maybe, Most likely, Agree*	Triple helix/governance model
considered as a "right place/placement" application	*Disagree, Unlikely, Maybe, Most likely, Agree*	
enhance farmers understanding of soil and drain composition on their fields	*Disagree, Unlikely, Maybe, Most likely, Agree*	
Question 7: Consider the following		
I am engaged with the project PI and I am willing to help and assist the project as much as possible	*Disagree, Somewhat disagree, Either/or, Somewhat agree, agree*	Stakeholder engagement: involvement and communication
I find that learn a lot from engaging with researchers, therefore I choose to participate	*Disagree, Somewhat disagree, Either/or, Somewhat agree, agree*	
The MapField team is easy to engage with and they are good at explaining what they are trying to do	*Disagree, Somewhat disagree, Either/or, Somewhat agree, agree*	
It is easy to collaborate with the MapField team	*Disagree, Somewhat disagree, Either/or, Somewhat agree, agree*	
I feel like I should be more involved in the projects	*Disagree, Somewhat disagree, Either/or, Somewhat agree, agree*	
Question 8: Expected benefits from having the MapField concept at your disposal?		
Are you expecting to get any benefit from having the MapField concept at your disposal?	*Yes, no, not relevant*	Value proposition: expected return on investment
Would you be willing to invest in the concept	*Yes, no, not relevant*	

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(*continued*)

Question	Range	Theoretical perspective
If the concept reports the right place to apply fertilizer, would you consider buying the technology, e.g., if you were a farmer	*Yes, no, not relevant*	
Question 9: Where do you see the potential benefit of MapField?	*Free text*	Value propositions
Question 10: Please assess the current statement: Over the last year within the project, the focus of who will eventually sustain the costs of implementing the technology has changed	*I agree, I somewhat agree, I do somewhat disagree, I do not agree*	Stakeholder engagement: attitudes/ perceptions
Question 11: Who do you think should sustain the cost?	*Free text*	Value propositions canvas: pains
Scenarios: Assess the following scenarios in terms of likeliness and feasibility:		
MapField concept integrated into the national retention map analysis: Scenario 1 suggests that, as of the year 2025, MST, GEUS, and agricultural advisors will have a better understanding of geology locally. Then, by strategic use of retention mapping, the ministry will get confirmational data from areas verifying the political initiatives and policies. This is done to strengthen the national retention maps by including the MapField concept. Strategically MST and MFVM would need to require retention maps (sustaining the costs) to include a more precise measurement of the redox zone. This leaves regulators with having a more accurate and sustainable forecast for needed N supply to fields within the national retention map. The primary value proposition from scenario 1 is a societal gain stemming from less nitrogen contamination of the ground and surface waters. Broken down, this means that society will have more balanced leaching to drinking and coastal waters. MST will rely on data from MapField measurements to improve the national retention calculation by having more accurate measures of the redox zones.		Value propositions canvas - Pain relievers and gain creators
Question 12.1 Likeliness	*Not very, Not, Either/or, Somewhat, very*	
Question 12.2 Feasibility	*Not very, Not, Either/or, Somewhat, very*	
Scenario 2, fewer uncertainties in the future: With MapField technology, retention mapping will help lower uncertainty for high uncertainty catchments on the national retention maps i.e., sandy soils. This will assist MST in better and stronger justification of leaching permits or reductions for these catchments. As of the year 2025, MST is accessing the retention capacity of all local fields in the targeted (pinpointed by a task force) catchments with nitrogen retention uncertainty (field-scale measurements). Catchments with uncertainty are mapped and from these maps, MST provides specific reductions per field. As such, with lower uncertainty farmers need to comply with mapped nitrogen retention capacity and therefore only apply the amount of nitrogen accordingly. With the reduction of uncertainty in these catchments, MST will have better tools and thresholds to comply with the nitrate and water directives, securing clean drinking water and less environmental impact. MST sustains the cost, and the benefits lie in the resolvents of areas/catchments that currently have high uncertainties in connection to retention capacity.		Value propositions canvas - Pain relievers and gain creators
Question 13.1: Likeliness	*Not very, Not, Either/or, Somewhat, very*	
Question 13.2: Feasibility	*Not very, Not, Either/or, Somewhat, very*	
Scenario 3: reduced reduction requirement in high variation catchments: High-resolution mapping of catchments with variation provides unique opportunities for farmers to obtain eased reduction requirements compared to average catchment reduction requirements. From the year 2025, MST can allow for farmers to ease the reduction requirements on fields in high variation catchments if mapped using the MapField measurement. MST pinpoints the catchments with sufficient variation. The leaching permits are granted by using the current forecast calculation, however, due to known variation, MST reduces the allowed amount to be below the catchment calculated average. But farmers can get reduced reduction requirements in these pinpointed catchments if they optionally choose to get their fields mapped. By acquiring a retention map of fields, farmers can obtain eased reduction requirements (right of claims), corresponding to the retention value from the mappings. As, the regulation allows for high-resolution mapping, that justifies and allows farmers to apply nitrogen according to the mapping result (correct reduction requirements). Farmers opting for the maps get the benefit of rights of claim within catchments with a retention variation, in the positive case. However, some uncertainty exists, as maps might reveal that some fields are beneath the catchment retention average. Farmers sustain the cost if they want to obtain possible reduced reduction requirements.		Value propositions canvas - Pain relievers and gain creators
Question 14.1: Likeliness	*Not very, Not, Either/or, Somewhat, very*	
Question14.2: Feasibility	*Not very, Not, Either/or, Somewhat, very*	
The broader health and groundwater perspective: The detailed data mapping and enhanced understanding of geology will improve groundwater protection and planning hereof in the future. As such, from the year 2025 can the MapField approach be used by municipalities and environmental authorities, among others, in combating various environmental incidents linked to point source pollution. These are not necessarily connected to only farmland uses only, but also pollution arising from burning fossil fuels industrial wastewater contamination, local landfills, ineffective treatment plants, and biorefineries. This ensures that waterworks can proactively map areas where potential terrestrial eutrophication may occur due to leaked N pollution. Terrestrial eutrophication has spill-over effects on nearby freshwater basins, and by knowing that drinking might be contaminated, waterworks can shut down "production" in such periods. Lastly, from a biodiversity angle, MapField actively could be assisting in mitigating surface water eutrophication and bay area hypoxia of protected areas within the Natura 2000 program.		Value propositions canvas - Pain relievers and gain creators

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(*continued*)

Question	Range	Theoretical perspective
In other words, MapField will be licensed to advisors and consulting firms that offer services around the above-mentioned topics, including isolated cases of farmers that might be interested.		
Question 15.1 Likeliness	*Not very, Not, Either/or, Somewhat, very*	
Question 15.2 Feasibility	*Not very, Not, Either/or, Somewhat, very*	

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