DETERMINING ECOLOGICAL THRESHOLDS FOR DAIRY

A pilot for setting science-based targets for nature

WWF

WWF is working with these partners to protect global environments.

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METABOLIC

COLOPHON

This project was commissioned by Bel Group and WWF France.

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FOREWORD SBTN

We are in the midst of two crises: climate change and nature loss. To secure a healthy, resilient and equitable world, we need to address both together.

The Science Based Target initiative (SBTi), launched in 2015, is tackling climate change by enabling companies to mitigate their GHG emissions in line with 1.5°C; with currently over 2,300 companies committing to emission reduction targets.

Building on this momentum, a collaboration of leading global nonprofits and mission driven organizations - including the core founding partners of SBTi - established the Science Based Targets Network (SBTN). SBTN aims to set the standard for ambitious measurable corporate action on nature, which includes, and builds upon, climate action. The Network is equipping companies with the guidance to set science-based targets for nature including freshwater, ocean, land and biodiversity.

We define science-based targets as measurable, actionable, and time-bound objectives, based on the best available science, that allow companies to align with Earth's limits and societal sustainability goals.

This isn't about incremental impact reduction, this is about setting targets which put companies and their activities on a path toward real sustainability and positive impact.

It is essential that companies start acting now. Since the release of our initial corporate guidance in 2020, over 100 companies with a market cap of approximately $4 trillion are preparing to set science-based targets for nature. As we finalize the detailed guidance this year, companies like Bel piloting methodologies serve as important input to our work.

It is inspiring to see companies lead the way; moving beyond making vague commitments on halting and reversing nature loss towards science-based target setting.

Erin Billman
Executive Director
Science Based Targets Network

FOREWORD WWF France

The fundamental question of the limits of ecosystems and the biosphere, which emerged in the 1970s, has been ignored for far too long by decision-makers. However, knowledge of ecological thresholds has progressed considerably in recent years, and what we know about the potentially disastrous consequences of exceeding them, at all scales, must urgently push for their integration into decision-making, at all levels.

This issue, which involves reintegrating economic activities into the capacities of the biosphere, is gradually recognised as central and is pursued by a growing number of organisations. Nevertheless, the road to widespread awareness remains immense, and the challenges to be met in order to implement the profound transformations are even greater.

The WWF network has been working for many years to advance this issue. First, WWF France is involved in raising awareness about ecological limits among the greatest number of individuals, in particular through the "Overshoot Day". But the Foundation is also invested in the development of initiatives enabling economic actors to define objectives aligned with the best scientific knowledge: the Science Based Targets initiative (SBTi) for climate issues, and more recently the Science Based Targets Network (SBTN) for the conservation of biodiversity and terrestrial, aquatic and marine ecosystems.

WWF France has chosen to be at the forefront of this movement, by investing in the development of tools dedicated to strong sustainability (including SBT methodologies), and by bringing on board the largest number of private partners ready to experiment with the first prototypes of these disruptive approaches. This was made possible by the existence of fertile ground for the emergence of these projects in France and Europe, thanks to an ecosystem of actors favourable to these advances, with real expertise, and very complementary roles: NGOs, companies, experts, academics, and public decision-makers.

The project exposed in this report is part of our long-term partnership with Bel and of our strategy for natural capital supported by the MAVA Foundation. It has been built in collaboration with many other partners including Metabolic, the WWF NL, the University of Kent, the Wageningen Economic Research, and SBTN.

As the first proof of concept of a landscape methodology within SBTN, it is a crucial step in the development of science-based methodologies. We are convinced that these types of "ecosystem-centred" approaches, focused on the functioning of the ecosystems in which companies operate, must be widely pursued and generalised if we are to obtain convincing results, i.e. real impacts from the point of view of nature.

We are convinced that this project will pave the way for many empirical applications of this methodology, with Bel as well as with other partners, and we hope that reading this report will inspire the readers to also join this movement.

Véronique Andrieux
CEO
WWF France

V. Andrieux

FOREWORD BEL

It is a fact that: biodiversity is under threat, with 68% of wildlife population sizes lost since 1970 (Living Planet Report, 2020), nearly one million species facing extinction in the near future (UN, 2019) and 75% of terrestrial environment "severely altered" to date by human actions (IPBES, 2019).

The global food system is the primary driver of accelerating biodiversity loss (UNEP, 2021). At Bel, as a global player in the healthy dairy, plant-based and fruit snacks market, we work every day to contribute to a new food model that respects the planet and its ecosystems and we are convinced we are part of the solution.

As an agri-food company, at Bel, **we have a dual relationship with biodiversity and ecosystems:**

- Firstly, it is **a responsibility**, that of helping to feed a world population that will reach 10 billion people in 2050, without compromising the functioning of the Earth's system.
- Secondly, it is **a dependency**, because we benefit from what biodiversity offers us to ensure and sustain our activities. Without pollinators, there are no apples and therefore no Pom'Potes; without living soil, there is no pasture for cows to feed on and therefore no The Laughing Cow's cheese.

At Bel we believe it is vital to place living systems at the centre of our concerns. We already are on our journey to embed biodiversity in our business decisions, embodied by our ambitious biodiversity policy and dedicated action plan implemented across our entire value chain to work hand in hand with producers and growers to protect biodiversity.

To ensure that our activities do not exceed planetary boundaries, we aim to avoid and reduce our impacts, protect and restore biodiversity across all our operations.
To that end, we committed to measure our biodiversity footprint to set robust, science-based targets. As part of this engagement, we are proud to have pilot-tested with WWF France and Metabolic the development of a new methodology aiming at identifying local ecological thresholds in dairy farms based on the best available science.

This report is the outcome of this work that characterizes a framework for dairy companies to establish local ecological thresholds and associated limits, targets and action plans on biodiversity loss, soil usage and water usage for the preservation of species and ecosystems. This is a long journey and we still have many steps ahead to bring our activities within a safe operating space. But as an agrifood company, we want to act and do our part to preserve biodiversity. It's time to do what is urgently needed and science is our best compass.

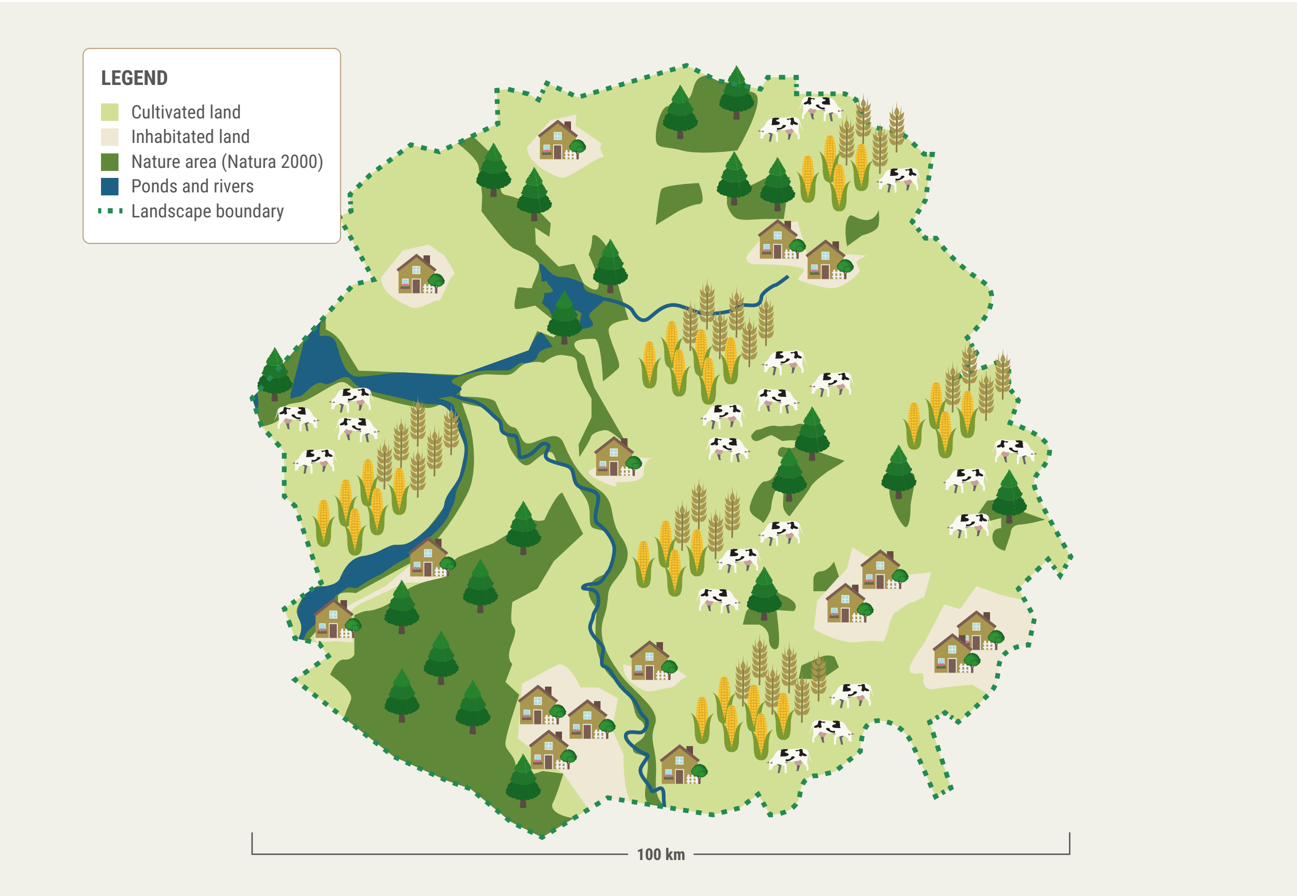
Simon Bonnet
Global Milk Upstream & Sustainability Director
Bel Group

EXECUTIVE SUMMARY

It has become increasingly clear that ecosystems and nature are in decline. Pressure on nature threatens its ability to provide the ecosystem services that we as a society rely on to prosper. The Science Based Targets Network (SBTN) was developed in response to nature's decline. The SBTN is a movement of international environmental nonprofit organizations, international agencies, and mission-driven entities working to turn science into targets for companies to tackle nature loss.

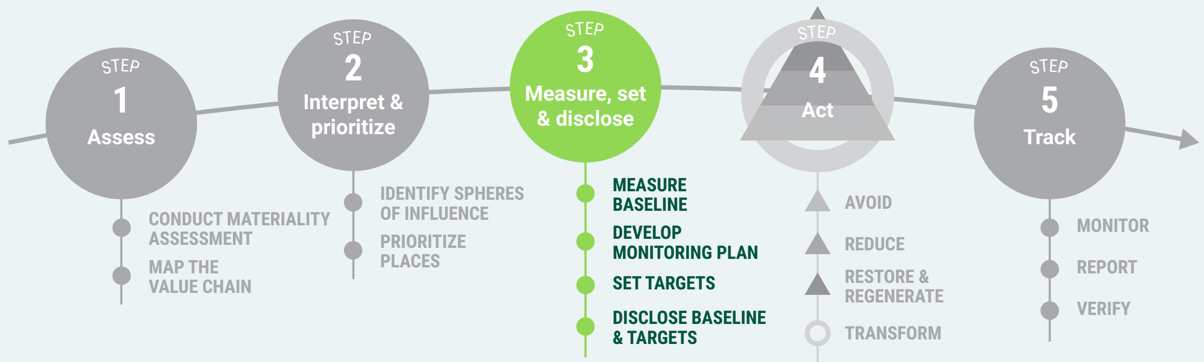
In this project, a subset of SBTN partners developed an approach with Bel Group for setting Science Based Targets (SBTs) for nature in a single dairy farming landscape. We developed a proof of concept for determining ecological thresholds that can be used as the basis for setting science-based targets for nature within a Dutch dairy landscape. We worked with the Initial Guidance of the SBTN, and used the Biodiversity Monitor for the Dairy Farming Sector (Biodiversity Monitor) (an instrument developed through a collaboration of FrieslandCampina, Rabobank and the Dutch chapter of the WWF) as the basis for target and Key Performance Indicator (KPI) development.

Our global food system, and in particular animal agriculture, is one of the leading causes of biodiversity loss globally (Benton et al., 2021). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) champions transformative change to protect biodiversity (IPBES, 2019). The SBTN framework builds upon the drivers of biodiversity loss as identified by IPBES. For agribusinesses looking to contribute to a nature-positive future, setting SBTs for nature is a key exercise. In this report, Bel Group fulfills its commitments: "(1) Defining local ecological thresholds by participating in research projects and (2) Working to measure their overall impact on biodiversity, in collaboration with experts in a prospective approach, across their entire value chain, to ensure that their activities are sustainable." Bel fulfills this by developing a proof of concept. The next step for Bel Group is to complete a value chain assessment, identify the material impacts on nature across their business, and implement them within landscapes as outlined in the methodology in this proof of concept.



In the first step, we specified which dairy basin to examine, determined the landscape boundary, and the most material impacts on nature within the landscape. Next, we contextualized these material impacts and addressed how to allocate the responsibility of these impacts on nature to dairy farming. In the next step, we set the ambition level for nature, i.e. determining what is really needed to enable ecosystem resilience/avoid collapse, according to science-based and societal-based references in the context of the selected landscape. We then assessed the gap between the current baseline and that ambition. Next, we mapped mitigation activities to understand what options exist to close the gap. Finally, we contextualized the activities with business cases, to show how farmers can be supported in the transition toward nature positive farming.

The project objective was to develop a proof of concept for the approach, with the intention of applying it to other European dairy basins in the future. Throughout the report, we have detailed where the methodology should delve deeper when implemented on a landscape or farm level.



Phase 1: Define Landscape and Scope

In the first phase of the project, we determined the landscape boundary, and completed a local materiality assessment for the landscape.

Phase 2: Define Material KPIs

Next, we refined the materiality assessment further based on the local landscape and determined the relevant KPIs to move forward with. We then defined the technique used to determine allocation of impact.

Phase 3: Measure and Set Targets

In the third phase, we set the ecological threshold for each of the KPIs using the following decision-tree:

1. Is there a set approach to downscale a planetary boundary?
2. Is there a science based societal goal available to inform the target?
3. Is there an established societal goal with less clear scientific foundations?
4. Is the most bottom-up and ambitious societal goal being used?

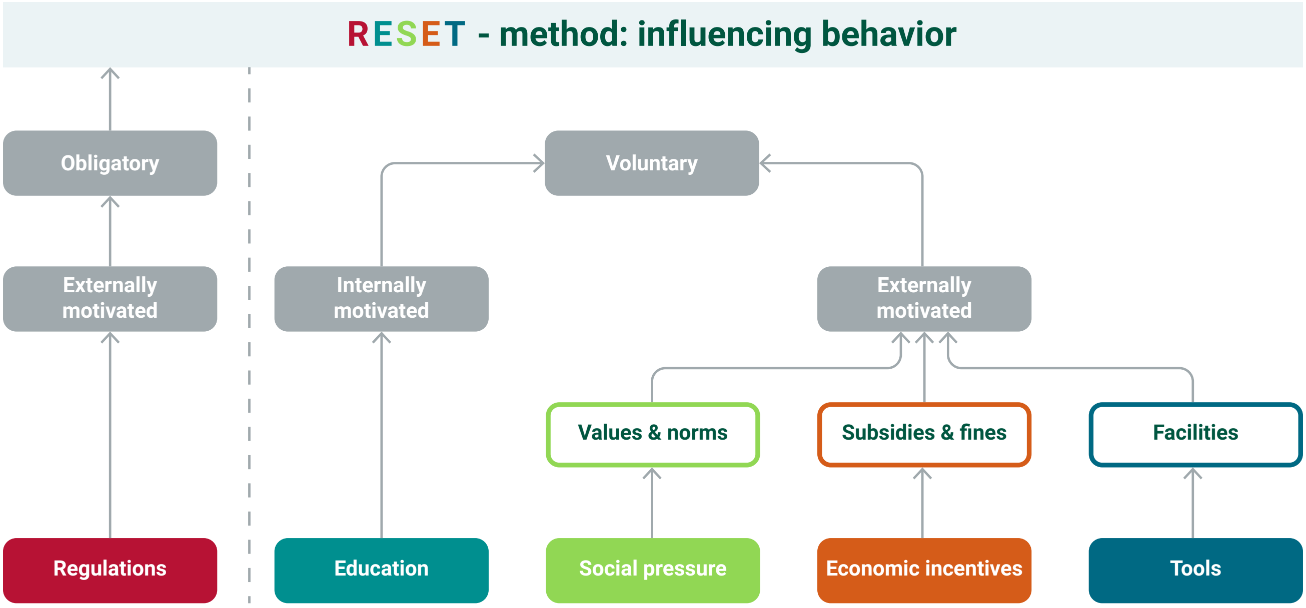
We then applied the ecological thresholds as targets and performed a gap analysis using empirical baseline data on the farm level. We performed the analysis distinguishing between two types of farms within the landscape: intensive (higher than 17000 kg Fat and Protein Corrected Milk (FPCM) per hectare) and extensive (lower or equal than 17000 kg FPCM per hectare).

Phase 4: Determine Action Targets

During the fourth phase of the guidance, we determined the actions available to farmers and other stakeholders to reach the targets.

Phase 5: Business Case

Finally, we assessed the appropriate paths forward contextualizing the action targets with clear business objectives. Though the business case is important, it is clear that a whole-of-society approach is truly necessary for transformation change and this is outlined in the RESET model, as represented in the figure below.



RESET model to influence farmers' behavior (adapted from Jansen et al., 2016)

RESULTS

Within the report, we were able to identify the KPIs that are measurable and meaningful. We calculated the gap between the 2020 baseline and the identified ecological thresholds (Tables 1 & 2). This approach was developed in a specific dairy landscape, however, the methodology is replicable and scalable to others. The farm data was split into two typologies: extensive (lower or equal than 17000 kg Fat and Protein Corrected Milk (FPCM) per hectare) and intensive (higher than 17000 kg FPCM per hectare). In this dairy landscape, there were gaps (in at least one of the typologies) for: ammonia emissions, chemical (pesticide, herbicide, fungicide) inputs, nitrogen soil surplus, percentage of own (or local) protein production, and percentage of natural habitat. For both farm typologies they have reached the goal of 60% permanent grassland. We examined pathways to improve the business case for farmers that want to close the gap on any farm level targets not being met (Table 3). Additionally, by using the RESET model, we have identified how a whole-of-society approach can support and incentivise farmers in making the transformation toward farming that contributes to improving biodiversity/nature.

Table 1: Gap between the thresholds/targets and the current state. We have used the above empirical KPIs as indicators used to determine the current state of nature on the farms within the target boundary as well as the gap between the target or threshold and the current state. There are two types of farms that are examined: intensive operations (higher number of cows per HA) and extensive operations (fewer cows per HA).

KPI	THRESHOLD		TARGET		EXTENSIVE		INTENSIVE	
	Value	Source	Value	Source	Current Data	Performance Gap	Current Data	Performance Gap
Chemical inputs (pesticides, herbicides, fungicides)	0.03-0.1 µg/L active matter/ ha*	*(Drinkwaterbesluit, 2018)*			0.64 µg/L active matter/ ha	0.54 µg/L active matter/ ha	0.53 µg/L active matter/ ha	0.43 µg/L active matter/ ha
Nitrogen soil surplus	20-30 kg N/ha	*(Bobbink et al., 2011)*	3.57 kg N/ha reduction per year	*Koekkoek, 2021*	122 kg N/ha	92 kg N/ha	146 kg N/ha	116 kg N/ha
Ammonia emissions	47 kg NH_3/ha	*Regulation (EU) No 1307/ 2013*	27 kg NH_3/ha	*Regulation (EU) No 1307/ 2013*	52 kg NH_3/ha	5 kg NH3/ha	68 kg NH_3/ha	21 kg NH3/ha
% Natural habitat	10%	*European Commission, 2020*			1.29%	9% natural habitat	0.80%	9% natural habitat
% Permanent grassland			60% permanent grassland	*Regulation (EU) No 1307/ 2013 van Doorn et al. 2019*	78% permanent grassland	n/a (target met)	65% permanent grassland	n/a (target met)
Landscape diversity (green/ blue)					1.21 types of landscape elements		0.84	
% Own (or local) protein production			65-100% own protein	*Commissie Grondgebondenheid, (2018)*	65% own protein	n/a (target met)	52% own protein	13% own protein

Ecological threshold well surpassed — *KPIs within ecological threshold*

** Specific chemical inputs - Pesticides (individual): 0.1 µg/L (microgram / L) - per matter; Aldrin, dieldrin, heptachlor and heptachlorepoxide: 0.03 µg/L; Pesticides (sum): 0.5 µg/L (microgram / L) (sum of individual pesticides with a concentration that is higher than the detection limit)*

Landscape level KPIs

Table 2: Ambient monitoring index values for landscape level KPI data over time

KPI	MEASUREMENT TECHNIQUE	SOURCE	CURRENT	TARGET
Landscape fragmentation	CAI_AM index	*(McGarigal & Marks, 1994)*	53.8199	Equal to or greater than the current value
Species composition change	Mean Species Abundance (MSA)	*(Alkemade et al., 2009)*	0.3307 (out of 1)	Equal to or greater than the current value

Table 3: The Action Targets and Farm Level KPIs associated through scientific evidence are mapped for the avoid/reduce and restore/regenerate categories. Action targets follow the ARRRT framework prioritizing first actions that avoid and reduce impacts, then actions that restore and regenerate, and all the while prioritizing transformative actions. Currently there is not sufficient evidence to report on the outcomes for transformative targets for them to be included here. (* Integrated pest management (IPM))

KPI	AVOID/REDUCE					RESTORE/REGENERATE			
	1 Soil management	2 IMP*/no spray	3 Organic Inputs	4 Manure management	5 Flowering grass	6 Natural land	7 Woody biomass	8 Riparian areas	9 High impact grazing
Chemical inputs		✓				✓		✓	
Nitrogen soil surplus			✓			✓	✓	✓	✓
Ammonia emissions			✓	✓					✓
% Natural Habitat					✓	✓		✓	
% Permanent Grassland					✓	✓	✓		✓
Landscape diversity (green/blue)						✓		✓	
Landscape fragmenta-tion					✓	✓		✓	✓
Species composition change	✓	✓	✓		✓	✓		✓	✓
% Own (or local) protein production					✓	✓	✓		✓

Sources: *[1] (Zabaloy et al., 2020) (Bowles et al., 2016) (Grab et al., 2018) (Ravetto et al., 2017) (Pulungan et al., 2019) [2] (Albrecht et al., 2020) (Grab et al., 2018) (Ravetto et al., 2017) [3,4] (Zhang et al., 2019) (Byrne et al., 2020) (Groenestein et al., 2011) (AHDB, n.d.) (Journeaux et al., 2016) (Dijkstra, n.d.) (Howarth et al., 2016) [5] (Luoto et al., 2003) (Ravetto et al., 2017) (Goosey et al., 2019) (Wrage et al 2011) [6] (Grab et al., 2018) (Pulungan et al., 2019) [7] (Pumariño et al., 2015) (Rigueiro-Rodríguez et al., 2010) (Luoto et al., 2003) [8] (Wilcock et al., 2009) (Luoto et al., 2003) [9] (Ravetto et al., 2017) (Goosey et al., 2019) (Pulungan et al., 2019)*

CONCLUSIONS

As more companies commit to SBTs for nature, it's critical that frameworks and precedents are in place which can guide them in addressing upstream and downstream impacts. In this work, we have shown that it is possible to assess upstream impacts by setting targets and thresholds within a landscape that will steer the system towards recovering and thriving nature. We have shown how approaches such as the Biodiversity Monitor provide a solid foundation for on-farm measurements, and how these can be linked to broader landscape outcomes. For these theoretical frameworks to become reality it will require on the ground work with stakeholders, data monitors, and the accountability and reward frameworks associated with the outcomes. Spheres of influence are particularly important, those within a local landscape have the ability to make transformative, lasting changes.

There is a limited but growing body of scientific literature defining regenerative response options, within which it is possible to qualify the connection between actions and outcomes. Further work on quantifying these connections are needed for widespread implementation. Additionally, it is clear there needs to be further work within the environmental community and SBTN to provide consistent guidance for ambient monitoring for nature and indicators going forward. As companies start to take action, we need to be sure that feedback is available for them to respond to.

We found that the basis for setting targets, according to scientifically derived planetary or regional boundaries, is not currently available for most issue areas. There are expected outputs, such as those from the Earth Commission, that aim to provide these boundaries. In the absence of such, there are societal goals upon which to base targets. However, it is critical that both the goals chosen are sufficiently ambitious to deliver on what nature needs, and that as science evolves, organizations and other stakeholders adapt to more stringent targets.

As the field of accounting for nature is still in progress, it requires that companies continue to pilot and test approaches, and exchange knowledge with the broader community. The SBTN is a facilitator and continually adapts their guidance towards a solid set of best practices that will help to prevent nature loss.

A business case for farming within ecological thresholds will likely not be enough. Rather, there will need to be a whole-of-society approach where there are many incentives to bridge the gap for farmers. Therefore, farmer livelihoods are an essential consideration in the transition to dairy farming that reaches targets for biodiversity.

What comes next?

In order to see results, projects like this will need to be implemented and the nuance that is learned with implementation will need to be documented. For example, sector wide indices can be useful tools for implementation. Ideally, an index will look at the impact on the farm level for a combination of thresholds. Projects implementing the SBTN guidance are useful when broadcasted for others to utilize.

INTRODUCTION

AGRICULTURE AS A CONTRIBUTOR TO BIODIVERSITY LOSS

Agriculture is one of the main causes of biodiversity loss, specifically livestock and feed production (Food and Agriculture Organisation [FAO], 2019). Although dairy production has contributed to the intensification of landscape degradation, it can also play an important role in its recovery (FAO, 2019). Dairy farming can play an important role in restoring biodiversity in grassland areas. A landscape with grazing cows in herb-rich grasslands interspersed with landscape elements (ditches or shrubs) can be a wonderful habitat for a diversity of wild animals and plants. In this report, we use the concepts of biodiversity and nature interchangeably.

BEL GROUP ENGAGEMENT FOR BIODIVERSITY

Bel Group, a major player in fruit and dairy single-serving portion snacking, is leading the way in setting Science-Based Targets (SBTs) for nature. Bel Group has set ambitious biodiversity goals on a company-wide level. One of the key goals for their biodiversity strategy is to measure the company's biodiversity footprint, and to set robust SBTs for the improvement of biodiversity across its supply chain. In order to accomplish this target setting, Bel Group has identified two key commitments:

1. ***"Defining local ecological thresholds by participating in research projects."***
2. ***"Working to measure our overall impact on biodiversity, in collaboration with experts in a prospective approach, across our entire value chain, to ensure that our activities are sustainable."***

In 2020, Bel joined the corporate engagement program (CEP) of the Science Based Targets Network (SBTN) to examine its global footprint and reduce its impact on nature. Bel aims to be a pioneer in biodiversity conservation and launched a pilot project in the Netherlands to identify local ecologial thresholds that will be used to set limits on biodiversity loss and soil and water usage for the preservation of species and ecosystems. In the long run, Bel plans to extend this approach to other activities and farming regions where they are present.

Bel Group is taking the initiative to pilot SBTN's target-setting framework with experts, and is committed to

driving systems change outside of its own operations by providing clear proof of concept case studies to inspire peers on their own journey toward reducing impacts on nature. This is a key step toward the adoption of science-based targets as it provides case evidence and precedents for other organizations to follow. The process of target setting is exploratory, using the best available data, research, and systems thinking to set practical and meaningful outcomes for a landscape.

SETTING TARGETS AT A LANDSCAPE LEVEL FOR NATURE

Core frameworks and methodologies that support the Proof of Concept

a. Science Based Targets Network

The SBTN is a group of international environmental nonprofit organizations, agencies, and mission-driven entities, which seeks to translate the best available science on a safe ecological operating space for humanity into methods, guidance and tools which companies and cities can use to set quantifiable. Businesses carry a central responsibility in bringing about systemic societal transformation towards sustainable operating patterns, given both their role as a major driving force of ecological challenges, as well as their fundamental dependency on services provided by nature.

In 2020, the SBTN released initial guidelines for corporations on how to embark on developing and working towards science-based goals to become "nature-positive" (SBTN, 2020). This guidance enables companies wishing to sustainably transform their operations to start taking "no regret" actions immediately and lead the way in transitioning towards sustainable economies. Corporations laying the foundation with pilot projects in different sectors are of immense importance in this context. This is due to the unique opportunities presented by pilot initiatives for developing and testing methodologies, for setting stringent reduction targets, identifying limitations and further research needs, and facilitating the process while raising ambition for other entities in the sector.

The SBTN defines science-based targets for nature as "measurable, actionable, and time-bound objectives, based on the best available science, that allow actors to align with Earth's limits and societal sustainability goals." A global goal, as agreed by the network, is to achieve a nature-positive state: no net loss of nature from 2020, a net-positive state of nature by 2030, and full recovery of nature by 2050.

The purpose of the initial SBTN guidance is to provide a framework for target setting and implementing in the form of a 5 step process, which entails the following components (Figure 1):

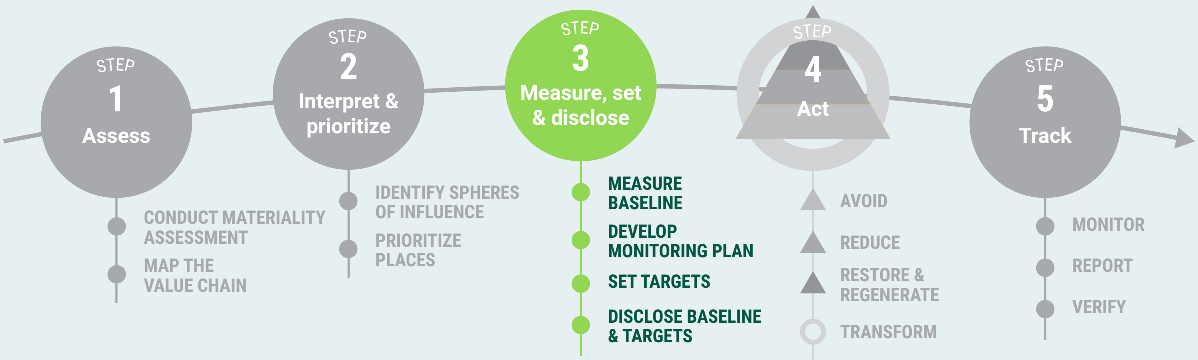


Figure 1: The five steps for setting science-based targets for nature- adapted from the SBTN Initial Guidance.

In this project, we complete a proof of concept as a first attempt to complete step three at a landscape level.

STEP 3: Measure, set & disclose

Measure baseline impacts, set targets, and disclose data. Guided by a set of principles, indicators are selected to quantify baselines of prioritized pressures on nature, and specific targets are determined. This step represents the focus of this project, and is elaborated on in the following section.

b. Biodiversity monitor

The Biodiversity Monitor for the Dairy Farming Sector (Biodiversity Monitor) is an instrument developed through a collaboration of FrieslandCampina, Rabobank and the Dutch chapter of the WWF (WNF). The ambition is to reach biodiversity recovery in the dairy farming sector (Van Laarhoven et al., 2018). The purpose of the Biodiversity Monitor is to develop new revenue models in the supply chain, while making biodiversity-enhancing performances uniformly measurable among farmers. As the three parties have a large support base or customer base, the idea is that their support for the biodiversity monitor can kickstart a wide application of this instrument.

The Biodiversity Monitor uses key performance indicators (KPIs) to measure the influence of individual dairy farms on biodiversity on the farm and beyond. The KPIs were developed through an integrated, systemic approach with scientific research, available data, and understanding the KPIs connection to one another. This makes it possible to monitor the role of dairy farmers in the preservation of the landscape and the environment using a standardized system. In addition to providing a metric for assessing the impact on the environment (both positive and negative), the monitor proposes specific measures dairy farmers can take to improve biodiversity.

Key performance indicators (KPIs)

The KPIs are variables that uniformly measure the influence a single farm has on the biodiversity on and beyond its own farmland. Based on the results of these KPIs, specific measures can be taken by the farmers to improve biodiversity (Van Laarhoven et al., 2018). This makes it possible to monitor the role of dairy farmers in the preservation of the landscape and the environment using a standardized system.

The KPIs are developed to serve one or more of the four conceptual pillars of biodiversity, and there are built-in guardrails between the different indicators. These pillars are: functional agrobiodiversity, landscape diversity, diversity of species and regional biodiversity (Van Laarhoven et al., 2018). As a KPI that serves one pillar can have a negative influence on another pillar, activities must also prevent negative side-effects and spillovers. This way, the composition of the KPIs is meant to have an accelerating effect on the biodiversity on the farmlands and beyond.

OBJECTIVE OF THIS PROOF OF CONCEPT AND MAIN DEFINITIONS

The Initial Guidance of the SBTN recommends that companies start to set targets where they are able, either within their value chain or within a landscape (SBTN, 2020). Although SBTN's final methodology will not be fully finalized until 2022, we hope that this proof of concept will help to define Step 3 target setting at the landscape level for dairy farmers and participate in further development. This project is thus a pilot for the SBTN, putting into action the target setting process within a landscape. The project is a proof of concept with the consideration of scaling the methodology to be applied to other dairy basins within the EU.

Within a landscape, the target setting procedure involves addressing the material impacts of the sector and allocating those impacts within the landscape to the target setting company. In this report, we detail the methodology followed and results gathered through this target setting process. We tested the approach using statistically representative, empirical farm-level data. We validated the process with scientific stakeholders and the SBTN community rather than with local stakeholders, as should be done in an implementation project.

Thresholds and targets (action and outcome targets)

For this assessment, as with the Biodiversity Monitor, we determined that it is useful to have both thresholds, the minimum requirement for a safe operating space, as well as targets which raise ambition for biodiversity positive landscapes.

Threshold: Thresholds define a value for the boundary for an activity (i.e. nitrogen soil surplus) for which the landscape can remain within a safe operating space (Rockström et al., 2009).Thresholds scaled from planetary or local ecological boundaries are applicable for some activities, but are less suitable for others. For example, nutrient flows like nitrogen are well categorized in terms of ecological thresholds, but thresholds for KPIs such as percent natural grassland do not have as clear cut an ecological threshold. In the absence of determinable scientific thresholds, we use societal goals (i.e. jurisdictionally determined) to set the level of ambition.

Outcome target: In this report, we use threshold values for the gap analysis. We do this because they are determined as the minimum level to reach for ecosystem protection. We have also outlined more ambitious outcome targets that move beyond a safe operating space toward biodiversity recovery, where they are applicable. The outcome targets are quantified KPIs using values that come from either planetary boundaries, local ecological thresholds, scientific literature, or societal goals.

Action target: Action targets are quantifiable actions that relate directly to the outcome targets. In this report, we qualify the action targets against scientific evidence for each of the KPIs associated with the outcome targets. In order to reach the outcome targets, we have qualitatively described the actions, derived from scientific evidence, that improve biodiversity. These actions help to close the gap between outcome targets and the current state of nature. In this proof of concept, we categorize the actions according to the determined farm typologies.

Landscape boundary: The area within the assessment is performed based on defining the relevant area within the dairy basin.

PRIVACY AND DATA LIMITATIONS

The farm-level data used in this analysis has been collected through Wageningen Economic Research and is a statistically representative sample of farms within the defined landscape. We recommend using farm-level data when applying the concept to other cases.

The data collection and management were conducted by Wageningen Economic Research. The Dutch Farm Accountancy Data Network (FADN) data is collected for economic purposes but - with appropriate sampling - can be used for research studies. This is empirical farm data reported by farmers through an agricultural census. There is statistical normalization and weighting based on the number of farms within a certain group to provide accurate sample results.

The FADN is a panel of 1,500 agricultural and horticultural business representatives that take part in the Farm Structure Survey from Statistics Netherlands (only includes farms with a revenue of over €25,000). Within the FADN there is statistical normalization and weighting based on the number of farms within a certain group to provide accurate sample results.

Agricultural databases are protected by the EU's General Data Protection Regulation (GDPR). This means that there are no exact locations available for the farm data provided by the FADN. Rather, we use average farm KPI values from within the landscape to develop outcome targets.

METHODOLOGY

SCOPE OF ASSESSMENT

The scope of this assessment is the pressures on biodiversity within the landscape boundary. Below, in Table 4, we outline which impacts are within and outside of scope. As we are piloting target setting for the SBTN, CO2eq emissions are outside of the scope. For this proof of concept, water table levels are also out of scope as their implementation is not scalable outside of a Dutch context. We further narrow down the scope of relevant pressures through a landscape level materiality assessment using the ENCORE materiality matrix and local context.

Table 4: Scope for the impacts considered in the project mapped against the SBTN materiality matrix

IPBES PRESSURE CATEGORIES	IMPACTS	
Land/Water/Sea Use Change	Terrestrial ecosystem use	*In scope*
	Freshwater ecosystem use	*In scope*
	Marine ecosystem use	*In scope*
Resource exploitation	Water use	*Out of scope **
Climate Change	GHG emissions	*Out of scope ***
Pollution	Non-GHG air pollutants	*In scope*
	Water pollutants	*In scope*
	Soil pollutants	*In scope*
	Solid waste	*In scope*
Invasives & Other	Solid waste	*In scope*

** Water use is outside of this project's scope because of the narrow Dutch context for water table management as a pressure on biodiversity.*

*** While the climate impact of agriculture is also critical to tackle, within the context of the SBTN, corporate targets and action are methodologically addressed through the Science-Based Targets Initiative, and deemed out of scope for this project. We recommend every company to set ambitious, Paris-aligned targets to address their climate impacts.*

STEP 1 | STEP 2 | STEP 3 | STEP 4

ASSESS

STEP 1.1:

DEFINE TARGET BOUNDARY

In determining the focal area of the project, two geographically distinct landscapes were considered. Each location centered around a processing facility that receives milk from within a 50 km radius. The characteristics of the soil, percentage of cultivated land, and the percentage of protected areas (Natura 2000 areas) within the landscape were considered. These qualities were examined through Geographic Information Systems (GIS) mapping and analysis of the following datasets: soil type (SoilGrids, 2020), land use (Buchhorn et al., 2020), and protected areas (Natura 2000) (European Environment Agency, 2020). The outcomes of the landscape comparisons are outlined in Table 5.

The target boundary, or landscape boundary, was a single dairy sourcing basin within a 50 km radius of a milk processing plant. We selected a single soil type to refine the target boundary based on scalability of the outcome. The area selected for the landscape analysis, option 1, had a higher percentage of agricultural and protected area, predominantly sandy soil (therefore assumed greater replicability as most northern European agricultural soil is sandy). Figure 2 represents an anonymized map of the dairy basin.

Table 5: Comparison of the two landscapes for setting the landscape boundary.

CRITERIA	OPTION 1	OPTION 2	SOURCE
Type of soil	Mostly sandy soil (5301 km^2)	Mix of sand/clay/loam (4369 km2), sandy (1911 km2), & peat (1176 km^2)	*(SoilGrids, 2006; International Soil Reference and Information Centre [ISRIC], 2017)*
Agricultural area	4262 km^2	3217 km^2	*(Buchhorn et. al., 2020)*
Average nitrogen surplus	152 kg/ha (sandy soils)	225 kg/ha (peat soils)	*(Wageningen University & Research, 2021)*
Natura 2000 areas as % of landscape	31.38%	14.73%	*(European Environment Agency, 2020)*
Number of farms %	53.7%	46.3%	*Provided by Bel*
Production volumes	339,000,000 kg	394,000,000 kg	*Provided by Bel*
Data availability	Same		*(Wageningen University & Research, 2021)*
Replicability of model	52% of Dutch dairy sandy soils, 32% clay, 11% peat; EU Soils (total): 26.71% sand/clay/loam, 14.74% clay/sand, 13.67% sand (most sandy soil concentrated in northern Europe), 6.48% peat		*(Tóth et al., 2008; Koskamp & van Kuik, 2001)*

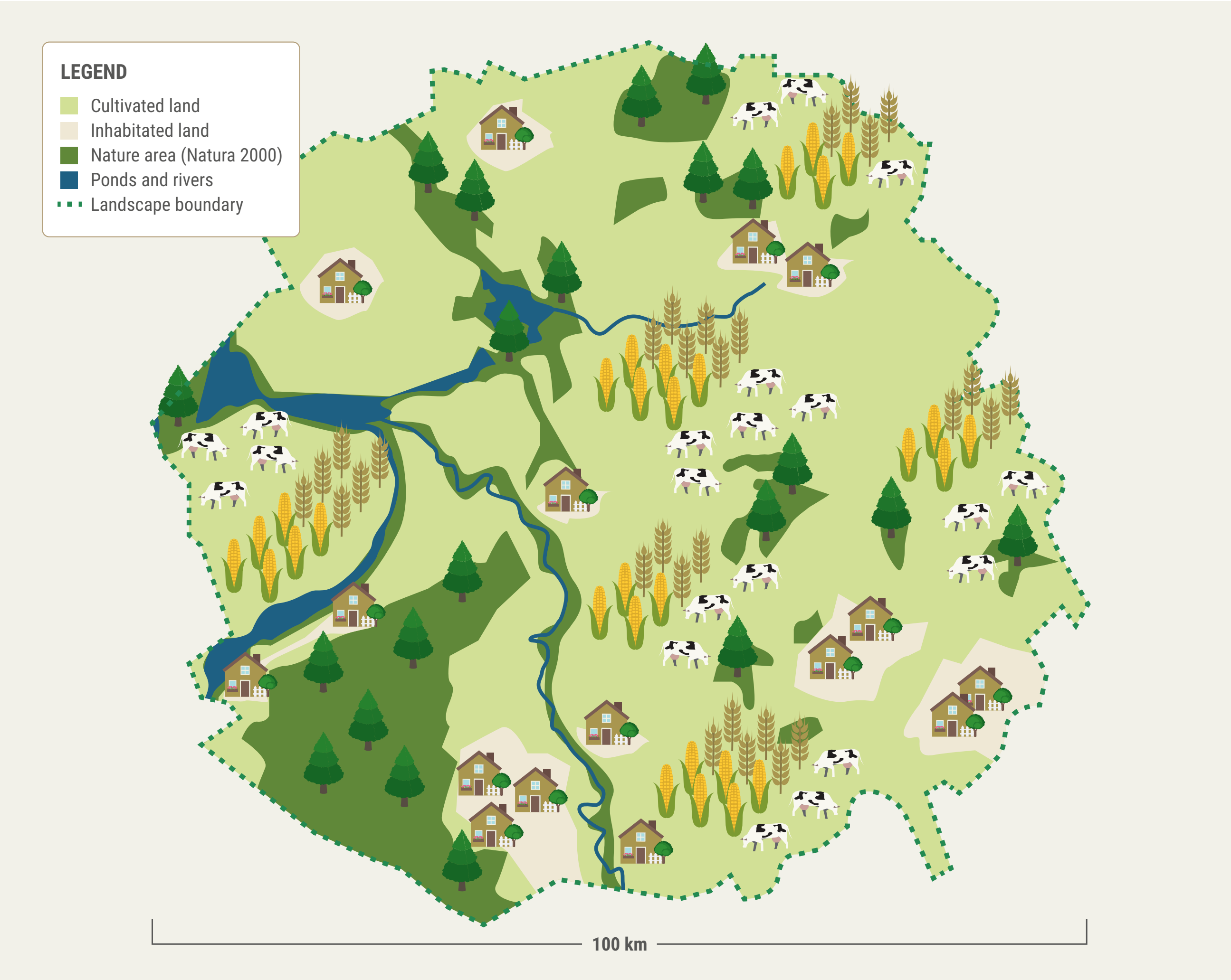


Figure 2: Map of landscape. Selected landscape to move forward with and defined target boundary for investigation in this proof of concept.

STEP 1.2:

LANDSCAPE LEVEL MATERIALITY ASSESSMENT

To identify the pressures within the landscape, we developed a long list of the most material and related pressures to dairy production. We developed KPIs for these material pressures and used the Biodiversity Monitor as a base for building the KPIs. Finally, we determined the most appropriate way to allocate responsibility for the impacts given the data limitations in this project.

Determining material pressure

In the next step we determined the material impacts on nature within the landscape. This determination was done by:

- Compiling the material impacts as detailed by the ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) tool, the Biodiversity Monitor, a literature review, and information from the Natura 2000 management plans (Table 6).
- Conducting a literature review to compliment the outcomes from ENCORE that pertain specifically to the dairy sector.
- Contextualizing material pressures by quantifying the relevant Natura 2000 pressures (Figure 3).
- Assessing the overall relevance of the material pressures to dairy farming (Figure 4).

Natura 2000 areas are a network of protected areas in the European Union, created to protect the habitats of designated animals and plants, in order to preserve and improve Europe's biodiversity (Natura 2000, n.d.). The Netherlands counts 162 onshore and offshore Natura 2000 areas, protecting various habitats, flora, and fauna. All Natura 2000 areas in the Netherlands must have a management plan, which is renewed every six years (Rijksdienst van Ondernemend Nederland [RVO], 2016). Each plan describes the current state of the individual habitats and species, alongside the specific measures that are taken to reach or maintain the designated conservation objectives of the site. For the materiality assessment, these objectives, measures, and specifications were used to determine which habitats and species are in the most precarious condition.

The manner of assessing priorities for nature based on the Natura 2000 management plans can be applied across the EU. Key pressures of impact on biodiversity in protected areas, as well as the specific objectives and measures associated with each were identified and quantified. Natura 2000 areas are sufficient within this highly modified landscape, but if this were an area of high biodiversity importance, more metrics would be needed to determine biodiversity priorities.

From this assessment of relevant Natura 2000 area management plans, we identified a list of pressures on biodiversity according to a high, medium, or low impact, as well as their occurrence across the areas (Figure 4). We then cross-referenced these pressures with those identified in the ENCORE assessment and assessed each of them according to both importance and connection to dairy farming, to arrive at a final shortlist of pressures to use in target setting (Figure 5).

In the end, we had a list of pressures that were contextualized further to determine whether they can be measured at the input, midpoint, or endpoint stage of their impact (Figure 5). This final piece is critical because it allows the KPI development process to address measurements and relate directly to the data collection for things farmers can address (input, midpoint) and confirm these KPIs are directly related to the overall impact through endpoint monitoring.

Contextualizing Pressures

Permanency of pasture	The more established (older) a grassland, the less disturbed / better functioning it is likely to be, leading to overall higher rates of biodiversity.
Grazing management practices	Overgrazing can lead to habitat degradation, but properly managed grazing e.g. rotational / extensive grazing can promote biodiversity.
Diversity of grassland species	Herbal grasslands which contain a number of different herb and grass species increase biodiversity by providing a diverse source of food.
Landscape diversity (green / blue)	Landscape diversity increases biodiversity of other plant and animal species.
Crop / protein production	Protein that is produced on a farmer's own land has a lower biodiversity impact than protein sourced from important biodiversity area. At farm level, grassands result in higher biodiversity than cropland.
Landscape fragmentation	Habitat change can lead to fragmentation and lack of connectivity between groups of species.
Habitat conversion	Conversion of previously forested lands / high biodiversity lands to cropland leads to a decrease in species richness and abundance.
Scale of land use	Larger scale land use does not automatically mean greater biodiversity impacts. Organic milk production requires more land, but has a lower impact on biodiversity than conventional farming.

Methane emissions	Enteric CH_4 emissions from dairy cows on the farm are linked with climate change, which has impacts on biodiversity.
Ammonia emissions	Ammonia emissions from manure / nitrogen deposition can make plants and trees more vulnerable to disease, damage and drought, thereby impacting potential biodiversity.
Nutrient inputs (N)	High inputs of nutrients e.g. fertilizers can lead to excess nitrogren levels, which impact soil health and runoff into waterways, causing algal blooms.
Nutrient inputs (P)	High inputs for nutrients e.g. fertilizers can lead to excess phosphate levels which impact soil health and runoff into the waterways, causing algal blooms.
Chemical inputs (pesticides)	The use of pesticides and veterinary products can lead to ecotoxicity in the environment; impacting biodiversity negatively.
Heavy metal use	Feed concentrates can contain heavy metals, which accumulate in manure and can lead to soil ecotoxicity, negatively impacting biodiversity.

Terrestrial ecosystem use *Soil pollutants*
GHG emissions *Water pollutants*

Table 6: Long list of material impacts within the landscape determined through ENCORE, literature search, Natura2000 management plans, and the Dutch Dairy Biodiversity Monitor.

STEP 1 | STEP 2 | STEP 3 | STEP 4

INTERPRET AND PRIORITIZE

STEP 2.1:

CONTEXTUALIZE MATERIAL IMPACTS

From this assessment of relevant Natura 2000 area management plans, we identified a list of pressures on biodiversity according to a high, medium, or low impact, as well as their occurrence across the areas (Figure 3). In Figure 3, the x-axis lists the different pressures on biodiversity as per the Nature 2000 management plans within the landscape. The y-axis lists the frequency for which that pressure is listed as either high (red), medium (orange), or low (blue). We then cross-referenced these pressures with those identified in the ENCORE assessment and assessed each of them according to both importance and connection to dairy farming, to arrive at a final shortlist of pressures to take forward to target setting (Table 7).

We mapped the long list of material pressures (Table 6), against the relevant Natura 2000 area pressures (y-axis) and the link to dairy production (y-axis) (Figure 4). To account for the link to dairy production, both ENCORE sector materiality and the results from the literature review were considered. Mapping the pressures against the local and sectoral context further clarifies which pressures are both most important within the landscape and relevant to Bel's production.

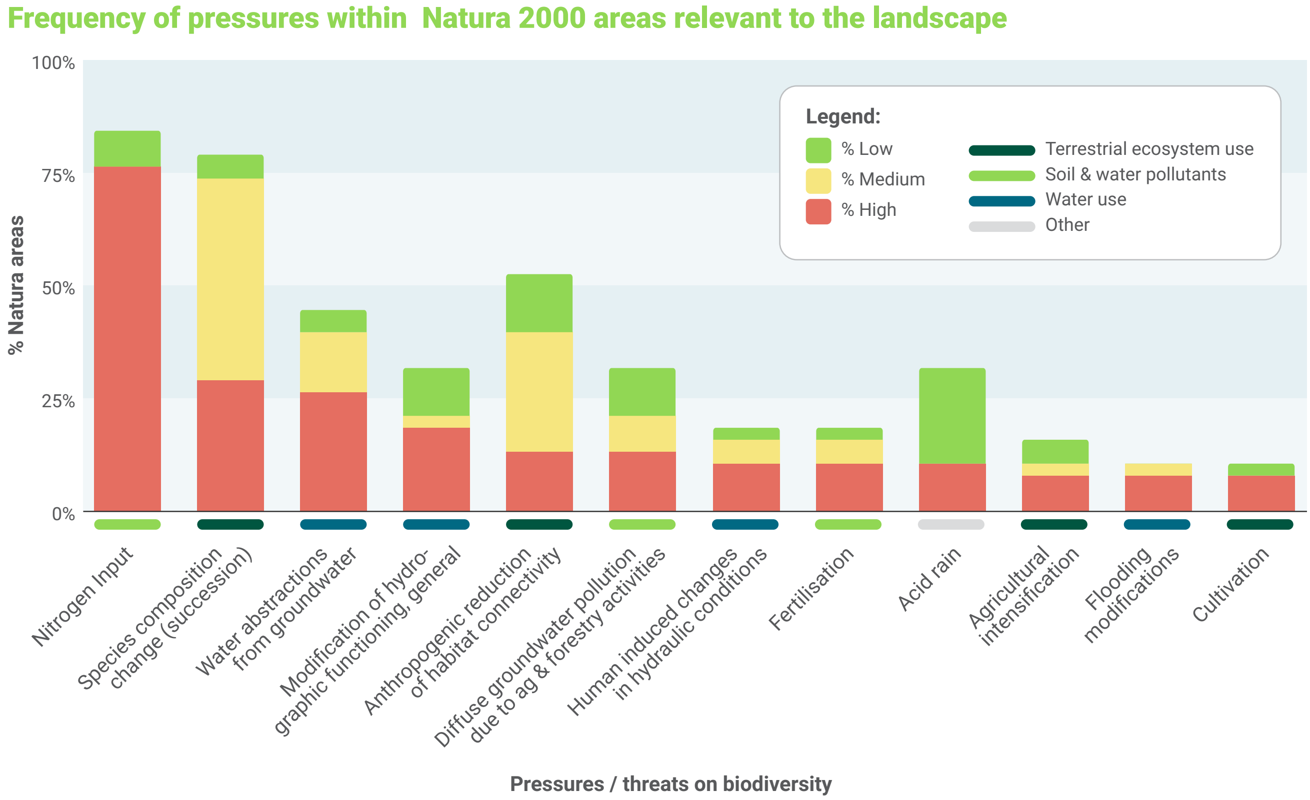


Figure 3: The frequency of pressures listed within the Natura 2000 management plans (y-axis) within the target per pressure within the landscape (x-axis) (mapped as high, medium, and low).

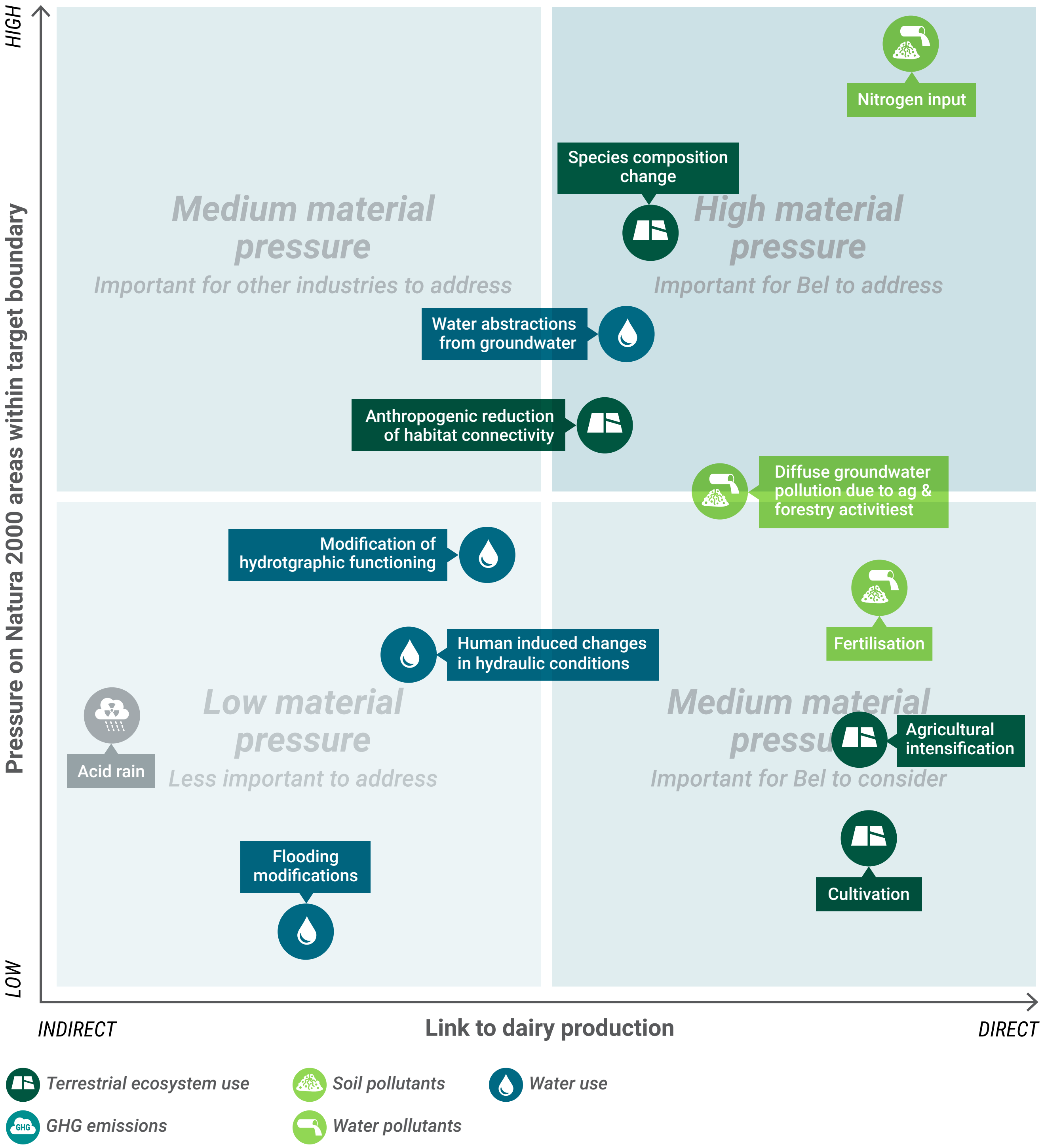


Figure 4: Most material pressure inside the landscape based on pressure Nature 2000 (y-axis) and direct link to dairy production (x-axis).

Note for implementation: *if this was not a proof of concept an extra step here would be to validate the shortlist of impact drivers with local stakeholders. In this proof of concept, we instead validated the materiality with scientific stakeholders.*

STEP 2.2:

HARMONIZE MATERIAL PRESSURE

The KPIs in the Biodiversity Monitor are designed in an integrated way. In order to ensure integration of KPIs in the case of our final list, we harmonized the pressures based on whether they are inputs, midpoints, or endpoints (Figure 5). These are life-cycle assessment (LCA) terms that help to determine whether an impact is related to a pressure, a state, or a response. The only indicator that is not mapped according to this standard is percentage of own protein production, which is rather added to prevent externalities from outside the landscape. This is therefore not measurable in the same way within the landscape boundary.

In this report, we aim to emphasize the indicators (the midpoint and input indicators) that farmers can have a direct impact on. Endpoint indicators reflect the issues of concern, which in this case are biodiversity loss or species composition change. Species composition change is the response to the midpoint indicators, which can, in theory, be monitored to ensure that by reducing the pressures and improving the state, there is a positive outcome as a response. The final set of KPIs and the type of data available for each indicator are listed in Table 4.

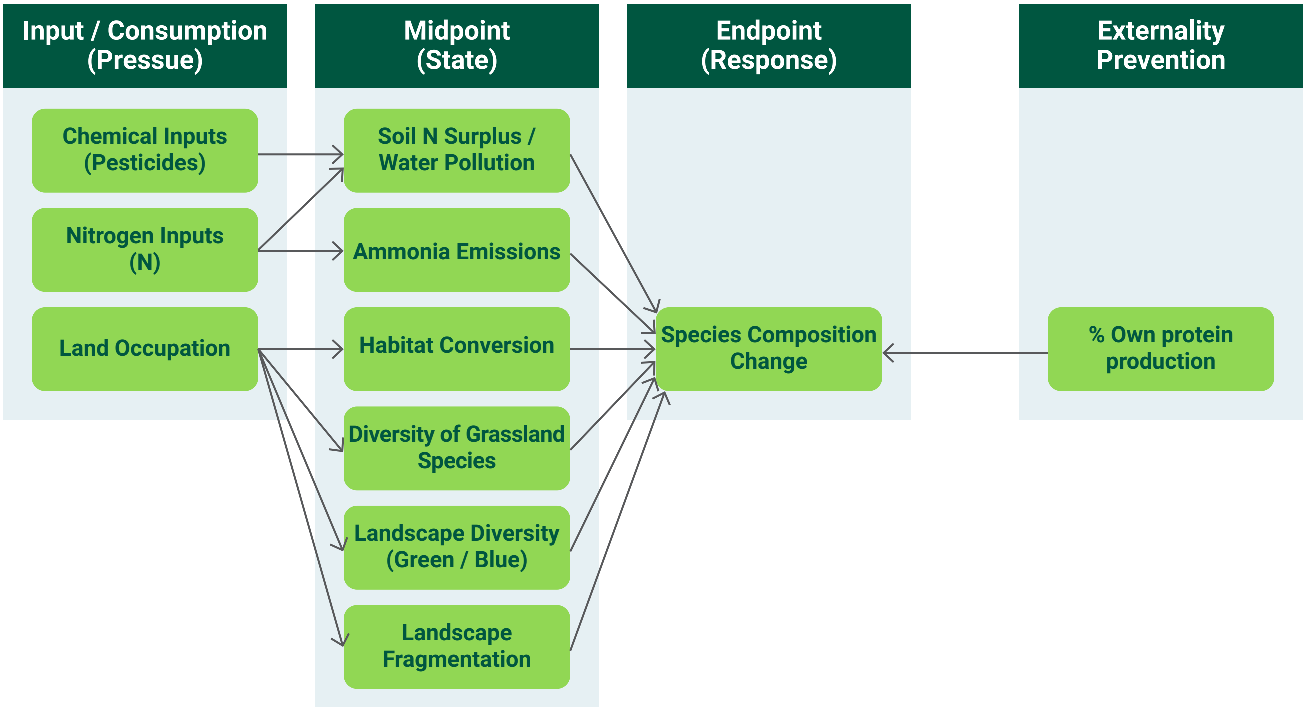


Figure 5: The final material pressures deemed within scope were mapped based on whether they are inputs, midpoints, or endpoints.

Table 7: The final set of integrated KPIs based on the final contextualized materiality assessment (Figure 4)

FINAL KEY PERFORMANCE INDICATORS			
KPI	TYPE	BIODIVERSITY MONITOR?	WUR DATA?
Chemical inputs	Input	No	Yes
Nitrogen soil surplus	Midpoint	Yes	Yes
Ammonia emissions	Midpoint	Yes	Yes
% Natural habitat	Midpoint	Yes	Yes, proxy data
% Permanent grassland	Midpoint	Yes	Yes
Landscape diversity (green/blue)	Midpoint	Yes	Yes, proxy data
Landscape fragmentation	Midpoint	No	No, Earth Observation Data
Species composition change	Endpoint	No	No, Earth Observation Data
% Own protein production	Externality Prevention	Yes	Yes

STEP 2.3:

ALLOCATION OF IMPACT DETERMINATION

In order for a landscape to move toward improvement of biodiversity, the contribution of impact, and in particular, what share of the impact a certain business or entity is responsible for, must be taken into consideration. Therefore, allocation – making the decisions of how much of a resource any given actor is responsible for improving – is an essential part of target setting (SBTN, 2020). The SBTN has highlighted some options for determining the allocation of impacts within a landscape, but currently does not endorse any single allocation approach. At this stage, methods should be piloted and their strengths and weaknesses determined through practice. Table 8 highlights all the possible allocation options outlined by the SBTN (2020).

Table 8: Possible allocation methodologies assessed, adapted from the SBTN technical annex

ALLOCATION METHODOLOGY	DESCRIPTION
Production Output	Distributes permissible environmental impacts according to a company's production volume proportional to the production within a landscape. The higher the volume, the larger its budget for resource use and emissions.
Polluter Pays	Businesses pay for the costs of environmental damage that stems from their activities proportional to the total pollution within a landscape.
Equal per Capita Allocation	Distributes permissible environmental impacts equal to each human being within a landscape. Based on the concept that each human being has equal rights to the access of planetary resources.
Contraction of Impact	Every company reduces their absolute impacts at a uniform rate (toward defined safe operation space), meaning that the company-specific level of decrease equals the level of decrease of all companies altogether.
Economic Capacity	Distributes permissible environmental impacts according to a business's capacity to act or pay. Businesses with high financial capacity will receive smaller shares for resources use and emissions, leading to more ambitious reduction/ regeneration/ restoration targets.

We examined the different methods in order to allocate impact, focusing on both local stakeholder involvement and the potential for impact reduction (Figure 6). Due to the limited available data within the current project, a contraction of impact approach was determined as the most feasible allocation method, while at the same time being sufficiently ambitious in addressing impacts. Using this approach, we examined Bel's potential for impact based on their own activities, rather than taking into account other stakeholder's impact on the landscape. Allocating impacts based on per capita, economic capacity, or measured pollution levels has potential to be more equitable and take into account differing impact creation, but requires extensive engagement with all stakeholders in the landscape. As we did not have access to other companies' data for this assessment it was not feasible to assess and allocate the impact of other stakeholders within the landscape.

***Note for implementation:** If this was not a proof of concept an extra step here would be to determine the contribution of impact within the landscape and possibly pilot a different allocation methodology*

Figure 6: Feasibility assessment for the allocation of impact approaches.

STEP 1 | STEP 2 | STEP 3 | STEP 4

MEASURE AND SET TARGETS

In the previous step, we determined which were the most important pressures within the landscape as well as the integrated set of KPIs related to these pressures. We also determined which allocation approach is feasible. Next, we focused on setting target and threshold values for each pressure, based on what nature needs. These targets and thresholds are based on the best available science as well as on societal goals and policy objectives.

STEP 3.1:

OUTCOME TARGETS

A science-based target for nature is a measurable, actionable, and time-bound objective based on the best available science that allows actors to align with Earth's limits and societal sustainability goals. We used ecological threshold, boundary for an activity for which the landscape can remain within a safe operating space, when applicable (i.e. nitrogen soil surplus). Oftentimes, there are no empirically derived ecological thresholds available. In these cases, the target is a goal for the landscape to encourage net positive impact for biodiversity as determined by societal goals. In this report, the targets identified are often more ambitious than the ecological thresholds describing actions that move beyond a safe operating space and toward ensuring biodiversity improvement.

To set a target and threshold for each of the KPIs, we used the following decision-tree:

1. **Is there a set approach to downscale a planetary boundary?**
2. **Is there a science-based societal goal available to inform the target?**
3. **Is there an established societal goal with less clear scientific foundations?**
4. **Is the most bottom-up and ambitious societal goal being used?**

Furthermore, targets should not be centered around a single aspect of biodiversity but rather encompass all aspects (Biodiversity Monitor pillars) of biodiversity. Targets and thresholds should be built around what nature needs and when possible include context-specific KPIs, such as proximity to key biodiversity areas (KBAs), protected areas, and threatened species. When possible, there should be spatial components exercised in target setting.

Ideally, all ecological thresholds should be based on understanding what nature needs and determining local safe operating spaces. However, this is a nascent scientific field, and is not always developed enough for a company to base their goals on (Hillebrand et al., 2020). Furthermore, societal goals are appropriate in some cases (for example with biodiversity/ ecosystem functionality), and these goals then determine what proportion of permanent grassland is deemed necessary by that jurisdiction. In the cases that the planetary boundaries are not clear, we utilize societally determined thresholds and targets. In Table 9, we outline the targets and thresholds used in this report. We then summarize the final KPIs and their data sources in Table 10. Targets were refined based on the SBTN feedback session. In this session, the preliminary targets and thresholds were presented to the SBTN and the general methodology was validated and some of the specific targets were tweaked based on recommendations from experts.

To determine the outcome goals for the landscape, we used the best available targets and thresholds using the decision tree and principles above.

Societal goals used in this report:

EU Biodiversity Strategy

The EU Biodiversity Strategy for 2030 is an important part of the European Green Deal, set up by the European Commission. It is a long-term policy plan, which started in 2020, containing specific actions and commitments for the European member states with the goal to reverse the degradation of ecosystems, recover biodiversity and protect nature (European Commission, n.d.a). The EU wants to realize these goals by enlarging the existing Natura 2000 areas, creating more funding for biodiversity, introducing new measures, and by strengthening governance frameworks. Nature restoration targets will be proposed by the end of 2021 (European Commission, n.d.a).

EU CAP Directive

The Common Agricultural Policy (CAP) is a European policy aimed at supporting farmers, improving agricultural productivity, and maintaining rural areas and rural economies. This policy document has already existed since 1962, but has been altered over the past decades. The new CAP is expected to be implemented on the 1st of January 2023 in all EU countries (European Commission, n.d.b). Currently, transitional regulations are in force in preparation of the new CAP in 2023.

Dutch Chamber of Commerce nitrogen thresholds

The Dutch Chamber of Commerce is an institute with a legal duty to register, inform and assist entrepreneurs and others. It also encourages innovation and regional economies, and manages entrepreneurial networks (Kamer van Koophandel [KvK], n.d.). Through articles written by the organization's advisors a wide variety of complex themes, like nitrogen emissions in the Netherlands (Koekkoek, 2021), are explained.

Dutch Drinking Water Mandate

Within the EU, drinking water guidelines guarantee the quality of drinking water in every European member state. Based on these guidelines, the Netherlands has formulated its own quality requirements for drinking water (Rijksinstituut voor Volksgezondheid en Milieu [RIVM], 2018). These requirements are specified in the Dutch Drinking Water Mandate (Overheid.nl, 2018). This mandate has been applied from 2018 onwards.

Table 9: Outcome targets and thresholds for the relevant KPIs that farmers have control over (midpoint KPIs)

KPI	THRESHOLD		TARGET	
	Value	Source	Value	Source
Chemical inputs	0.03-0.1 µg/L active matter/ha ** †	*(Drinkwater-besluit, 2018)*		
Nitrogen soil surplus	20-30 kg N/ha **	*(Bobbink et al., 2011)*	3.5717085 kg N/ha reduction	*Koekkoek, 2021*
Ammonia emissions	47 kg NH_3/ha *	*Regulation (EU) No 1307/2013*	27 kg NH_3/ha *	*Regulation (EU) No 1307/2013*
% Natural habitat	10% *	*(European Commission, 2020)*		
% Permanent grassland			60% *	*Regulation (EU) No 1307/2013 van Doorn et al. 2019*
Landscape diversity (green/blue)				
% Own protein production			65-100%*	*(Commissie Grondgebondenheid, 2018)*

** societal goal*
*** scaled from scientifically derived safe operating space*
† Specific chemical inputs - Pesticides (individual): 0.1 µg/L (microgram / L) - per matter; Aldrin, dieldrin, heptachlor and heptachlorepoxide: 0.03 µg/L; Pesticides (sum): 0.5 µg/L (microgram / L) (sum of individual pesticides with a concentration that is higher than the detection limit)

Table 10: Final KPI summary

KPI	TYPE	BIODIVERSITY MONITOR?	WUR DATA?	THRESHOLD?	TARGET?
Chemical inputs	Input	No	Yes	✓	
Nitrogen soil surplus	Midpoint	Yes	Yes	✓	✓
Ammonia emissions	Midpoint	Yes	Yes	✓	✓
% Natural habitat	Midpoint	Yes	Yes, proxy data	✓	
% Permanent grassland	Midpoint	Yes	Yes		✓
Landscape diversity (green/blue)	Midpoint	Yes	Yes, proxy data		
Landscape fragmentation	Midpoint	No	No, Earth Observation Data		✓
Species composition change	Endpoint	No	No, Earth Observation Data		✓
% Own protein production	Externality Prevention	Yes	Yes		✓

STEP 3.2:

KEY PERFORMANCE INDICATORS (KPIs)

The stakeholders who put together the Biodiversity Monitor did so in a way that developed integrated KPIs with guard rails to prevent tradeoffs between the KPIs. Also important in KPI development is the availability of data to measure and monitor performance. In the section below, we provide the rationale for each of the KPIs and describe how each indication is calculated.

Chemical inputs

Chemical inputs of pesticides, herbicides, and fungicides were found to be material impact drivers of biodiversity loss within the landscape. For KPIs for chemical inputs, we used ecological thresholds derived for drinking water standards. The specific chemical inputs thresholds for drinking water are as follows: Pesticides (individual): 0.1 µg/L (microgram / L) - per matter; Aldrin, dieldrin, heptachlor and heptachlorepoxide: 0.03 µg/L; Pesticides (sum): 0.5 µg/L (microgram / L) (sum of individual pesticides with a concentration that is higher than the detection limit).

Nitrogen soil surplus

The high input of nutrients into the landscape through the use of fertilizers, manure, and animal feed make it possible to achieve high levels of agricultural production. However, high-nutrient deposition (inputs) can lead to excess levels of nitrogen (midpoint), which impacts soil health (endpoint). Nitrogen which runs off into the water or surface water and the deposition of nitrogen from the air contributes to the eutrophication of the water and the soil.

Runoff from a nutrient-laden landscape deposits vast quantities of phosphorus and nitrogen into the local watershed, resulting in water contamination. With high enough concentrations, this contamination can lead to an anoxic environment. The immediate result is the increase of the nutrient and sedimentation load that results in algal blooms that kill micro and macro invertebrates and aquatic vertebrates such as fish and frogs.

Indicators for measuring water pollution at farm-level can be the nitrogen balance in waterways, or the frequency and extent of algal blooms and the percentage of riparian zones protected with buffers. At the territory level, another indicator can be the nutrient concentration in receiving waterways (van Doorn et al., 2017; Van Laarhoven et al., 2018; Zijlstra et al., 2019).

Calculation of nitrogen soil surplus per cultivation: nitrogen inputs - nitrogen removal (crops) - nitrogen emissions (air).

*Crop level calculation (provide by biodiversity monitor) [% grassland * soil nitrogen surplus (grassland - kg N/ha) + % corn land * soil nitrogen surplus (corn land - kg N/ha) + % land used for other roughage - kg N/ha) + % land used for arable crops * soil nitrogen surplus (soil used for arable crops - kg N/ha)] / 100%. In practice, this is calculated on a farm level. The agrimate data system utilizes a farm level calculation which uses the same methodology as the crop level.*

Definition surpluses are defined as the difference between the nitrogen inputs into and outputs from the agricultural system.

Ammonia emissions

The lower ammonia emissions are, the better it is for nature, as the emission of ammonia (kg NH3/ha) is a large contributor to excess nitrogen deposition in the Netherlands. Ammonia emissions account for approx. 70% of nitrogen deposition in the Netherlands (Van Laarhoven et al., 2018). Excess ammonia emissions can make plants and trees more vulnerable to diseases, damages and drought. Furthermore, nitrogen-favouring vegetation will eliminate nitrogen-poor vegetation, which has a negative effect on biodiversity.

As with nitrogen, the emission of ammonia is an indicator of nutrient-efficiency on a farm, because they come from the same source (manure). The way manure is managed on a farm can influence these emissions (van Doorn et al., 2017; Van Laarhoven et al., 2018; Zijlstra et al., 2019).

Calculation ammonia emissions per ha: (ammonia emissions from the barn + manure storage + grazing + fertilization using animal manure + use of fertiliser) / total acreage of farm

Definition: The effects of ammonia emissions are negative, and can be observed in aquatic ecosystems, forests, crops and cultivations. Where excessive emissions are recorded, increased acid depositions and excessive levels of nutrients in soil, rivers or lakes are observed.

Definition total farm acreage: acreage used or managed by the farm.

KPI in context: Ammonia emissions account for approx. 70% of nitrogen deposition in the Netherlands (Van Laarhoven et al., 2018). A total of 75% of this share originates from Dutch sources, with agriculture being the main contributor (Van Laarhoven et al., 2018). This nitrogen deposition has an impact on the natural world, which results in a decline in biodiversity (see KPI: nitrogen soil surplus).

Percentage natural habitat

To calculate the percentage of natural habitat KPI, we use subsidy proxy data. The total average subsidy value per hectare has been calculated in order to determine the number of hectares on each farm (based on the amount of subsidies the farm is receiving). The more diverse a landscape, and the more varieties of species present, the more resilient the landscape.

- *Calculation contribution of nature and landscape: Σi (Oi x Ci x 100%)/T*
  - *O = Total surface of nature and landscape elements (for type i)*
  - *C = Weighting factor (for type i)*
  - *T = Total farm acreage*

A limitation of this exercise is that we don't know the type of natural areas found on each farm but rather the total value of nature subsidies received. We estimated the percentage of natural habitat by using the average value of subsidies for natural areas each farm type receives. We divided the total value of the subsidies by the average price per HA to estimate the number of HA of natural areas on farm. In order to accurately estimate this, the types of natural areas (i.e. subsidy type) must be provided.

Definition weighting factor: Since different elements contribute to biodiversity in different ways, a weighting factor is used to determine the amount of land used for nature and landscape elements, including full-scale elements, line-shaped elements and point elements. These weighting factors are very complex and are based on the amount of compensation paid and the effort required for management.

Definition farm acreage: acreage of land used or managed.

KPI in context: Landscape diversity on the farm improves the quality of the landscape, people's perception of this landscape, biodiversity, and supports functional agrobiodiversity. This KPI is a composite indicator for landscape management and species management.

Percentage permanent grassland

The more established (older) a grassland, the less disturbed and better functioning it is likely to be (condition depending), leading to overall higher rates of biodiversity.

Permanent grassland is defined as pasture that remains intact and is not rotated for other crops for at least five years. The percentage that is taken is the percentage of the total business area that is dedicated to this type of grassland. The higher the percentage the better. Compared with arable lands, grasslands offer better support for soil biodiversity and organic matter. Furthermore, eventually, permanent pasture delivers a better grass production per ha, environmental functions like water regulation and more biodiversity like meadow birds. The older the grassland, the more these functions will have developed. The older the grassland, the less soil cultivation has been used so the more the ecosystem remains intact and there are greater chances for biodiversity below and above ground. Older grasslands also harbor more carbon which means organic dust content is higher, which improves soil fertility and reduces net carbon emissions. Intensification of these grasslands results in a higher biodiversity loss

(Van Laarhoven et al., 2018; Erisman et al., 2016; Pulungan et al., 2019; Zijlstra, 2019).

The larger the amount of grassland in the farming system, the more favourable the outcome for organic matter, soil biodiversity, and ultimately for ecosystem services. The share of grassland is therefore an indirect indicator of more functional biodiversity on the farm. Additionally, the age of the grassland is important. The older the grassland, the less the soil cultivation, the more the ecosystem remains intact, and the greater the chances for biodiversity above and below the ground.

*Calculation % of permanent grassland: Total acreage of permanent grassland / total acreage of farm * 100%.*

Definition of permanent grassland: A plot of grassland that has not been included in the farm's crop rotation for a minimum of five years.

Definition of farm's total acreage: acreage used or managed by the farm.

Landscape diversity (green/blue)

Landscape diversity is a specific piece of the % natural habitat calculation.

See calculation for % natural habitat.

Landscape diversity on the farm (e.g. hedges, hedgerows, banks of ditches, field margins, thickets, water levels, etc.) improves the quality of the landscape and people's perception of this landscape, along with biodiversity, and supports functional agrobiodiversity (Erisman et al., 2014). Green landscape diversity refers to variation in the terrestrial environment, while blue landscape diversity refers to the freshwater environment.

Landscape diversity KPIs provide a base for diversity of species on the farm. In addition, further protection can be provided to specific plant and animal species, including birds, butterflies or amphibians. The type of species depends on the regional landscape, the farm's location, the presence of source areas and other requirements.Different types of grass in the meadow provide extra opportunities for different types of plant and animal species. Diversity in types of grass and herbs has a positive effect on soil life, insects, small rodents, birds, and livestock. Grassland with a diversity of species can be created by changing the mowing policy, seed mixture and fertilisation (Zanen, 2017).The KPI 'Percentage of managed land' is a composite indicator for landscape management and species management. These elements play an important role for the provision of food, areas to nest, brood and rest, and for species to migrate.

Landscape fragmentation

Habitat change can lead to loss of connectivity and loss of habitat diversity. Indicators for measuring habitat loss caused by deforestation and fragmentation can be the rate of conversion, patch size/ isolation and connectivity/ fragmentation (Wang et al., 2014). The KPI used here is Core Area Index Area (CAI_AM) which quantifies core areas for the entire class or landscape as a percentage of total class or landscape area. Fragstat software was also used, which uses land cover satellite maps to calculate the fragmentation of a landscape (McGarigal & Marks, 1994). This index value was calculated in this case using the Copernicus land cover data (Buchhorn et al., 2020) within the landscape boundary. This calculation provides a general sense of how connected the habitats within the landscape are.

A limitation to ambient monitoring for measuring fragmentation on a landscape scale is that it doesn't differentiate between different types of land cover. Rather, in the implementation of a similar project, we would like to see agricultural land given a KPI for the CAI_AM index that is devised to promote connectivity between cultivated and natural areas.

Species composition change

Species composition change is an endpoint indicator of biodiversity loss and was found to be one of the most important metrics as per the Natura 2000 management plans within the landscape. Measuring species composition change is not a straightforward task and will likely need to be updated over time.

In this proof of concept, we use Mean Species Abundance (MSA) by GLOBIO (Schipper et al., 2019) to determine the current state of species in the entire landscape. The reason for using MSA instead of another biodiversity impact metric is because it has an operational spatial layer that is updated over time in order to monitor the change in species over time (Lammerant et al., 2021). However, the MSA is by no means a perfect metric as the updates are also methodological and may not allow comparison of biodiversity changes over time. This highlights a need for satellite or other ambient monitoring that can measure improvement or decline in species richness over time.

Within the SBTN there are recently developed metrics in development for identifying both Species Threat Abatement and Restoration (STAR) (Mair et al., 2021) as well as an Ecosystem Integrity Index (EII) for identifying the health of an ecosystem (Blumetto et al., 2019).

Important to note that in this project we identified a metric for measuring biodiversity endpoint taking into account the context that the Netherlands is a highly human dominated landscape environment. The first step in determining this was looking at the Global Safety Net (Dinerstein et al., 2020). The Netherlands has only 0.1% rare species sites, and 0% high biodiversity areas. The landscape examined in this report has over 30% Natura 2000 areas, meaning it surpasses the global target for percent protected area. If this were not the case, we would likely select different indicators for biodiversity and explore newer methodologies such as EII and/or STAR (Blumetto et al., 2019; Mair et al., 2021).

Percentage Own protein production

Concentrated cow feed production is dependent on fertilizers, pesticides and often produced within a monoculture ecosystem, which results in increased rates of erosion and water contamination within local waterways. There are biodiversity externalities with outsourcing feed production that have been identified in studies throughout Europe (Mueller et al., 2017). Efforts to initiate greening in Europe, such as this one, should not outsource their externalities to biodiversity rich tropical countries as was identified in a Spanish study where many of the impacts were sourced to more biodiversity significant areas such as Brazil through feed production (Martínez-Valderrama et al., 2021). Indicators for measuring the intensification of feed production can be output oriented or input oriented (output oriented: milk/ha, input oriented: inputs/ha).

Meadows and pastures are the most biodiversity-friendly feedstock for milk production and when left to grow flowers and seeds provide adequate protein. Meadows and pastures will generally have a higher species richness than arable land, assuming stocking rates are not detrimental to biodiversity. The larger the share of pastures and meadows on the land occupation of milk, the lower the impact to biodiversity will be (Van Laarhoven et al., 2018; Erisman et al., 2016; Mueller et al., 2017).

*Calculation % of protein produced by own farm: % of protein produced on the farmer's own land / % N (1-N in purchased feed / N in total feed) * 100%*

- *Purchased feed = purchase of concentrated feeds + roughage and by-products.*
- *Total feed = concentrated feeds + roughage + by-products + meadow grass.*

KPI in context: Firstly, the percentage of protein produced on the farmer's own land indicates the level of self-sufficiency in feed production, and is related to the intensity of dairy farms. The lower the level of self-sufficiency, the more intense the land is used, resulting in declining biodiversity. Secondly it indicates the size of the footprint from external suppliers. This affects biodiversity in other parts of the world. Thirdly, it indicates the share of grassland maintained by a dairy farm. Grassland scores higher in terms of biodiversity and its functions than agricultural land.

STEP 3.3:

GAP ASSESSMENT

Next, we used the available empirical data to determine the difference between the landscape baseline (2017-2019) and the determined threshold or target. The gap assessment is done by first grouping the farms into two types based on the intensity of the operation. Next, each KPI threshold is assessed based on the available data.

Data from the Dutch Farm Accountancy Data Network (FADN) was obtained from Wageningen Economic Research. The FADN is a panel of 1,500 agricultural and horticultural businesses. Data was sampled from dairy farms with main soil type sand, located within a 50 km radius of our defined landscape boundary. This resulted in 86 representative dairy farm data points. We characterised the farms according to management intensity:

- **Extensive:** lower or equal than 17000 kg Fat and Protein Corrected Milk (FPCM) per hectare (less than/=17,000 kg/ha) as determined by FADM data.

- **Intensive:** higher than 17000 kg FPCM per hectare (greater than 17,000 kg/ha) as determined by FADM data.

Calculate performance gap

To calculate the performance gap, we first determined the baseline for both typologies. The data from Wageningen is from a three year average (2017-2019). The year 2017 was a relatively normal year with regard to weather conditions. The year 2018 was a very dry year and 2019 was average. We calculated the difference between the outcome targets and the current baseline. In Tables 11 and 12, we outline the threshold values, target values, and the gap between the threshold and current performance. We chose to use the threshold value as a more objective tipping point for quantification.

Table 11: We have used the above empirical KPIs as indicators used to determine the current state of nature on the farms within the target boundary as well as the gap between the targets and the current state. There are two types of farms that are examined: intensive operations (higher number of cows per HA) and extensive operations (larget number of cows per HA).

KPI	THRESHOLD		TARGET		EXTENSIVE		INTENSIVE	
	Value	Source	Value	Source	Current Data	Performance Gap	Current Data	Performance Gap
Chemical inputs (pesticides, herbicides, fungicides)	0.03-0.1 µg/L active matter/ ha*	*(Drinkwaterbesluit, 2018)*			0.64 µg/L active matter/ ha	0.54 µg/L active matter/ ha	0.53 µg/L active matter/ ha	0.43 µg/L active matter/ ha
Nitrogen soil surplus	20-30 kg N/ha	*(Bobbink et al., 2011)*	3.57 kg N/ha reduction per year	*Koekkoek, 2021*	122 kg N/ha	92 kg N/ha	146 kg N/ha	116 kg N/ha
Ammonia emissions	47 kg NH_3/ha	*Regulation (EU) No 1307/ 2013*	27 kg NH_3/ha	*Regulation (EU) No 1307/ 2013*	52 kg NH_3/ha	5 kg NH3/ha	68 kg NH_3/ha	21 kg NH3/ha
% Natural habitat	10%	*European Commission, 2020*			1.29%	9% natural habitat	0.80%	9% natural habitat
% Permanent grassland			60% permanent grassland	*Regulation (EU) No 1307/ 2013 van Doorn et al. 2019*	78% permanent grassland	n/a (target met)	65% permanent grassland	n/a (target met)
Landscape diversity (green/ blue)					1.21 types of landscape elements		0.84	
% Own (or local) protein production			65-100% own protein	*Commissie Grondgebondenheid, (2018)*	65% own protein	n/a (target met)	52% own protein	13% own protein

Ecological threshold well surpassed *KPIs within ecological threshold*

** Specific chemical inputs - Pesticides (individual): 0.1 µg/L (microgram / L) - per matter; Aldrin, dieldrin, heptachlor and heptachlorepoxide: 0.03 µg/L; Pesticides (sum): 0.5 µg/L (microgram / L) (sum of individual pesticides with a concentration that is higher than the detection limit)*

Landscape level KPIs

Table 12: Ambient monitoring index values for landscape level KPI data over time

KPI	MEASUREMENT TECHNIQUE	SOURCE	CURRENT	TARGET
Landscape fragmentation	CAI_AM index	*(McGarigal & Marks, 1994)*	53.8199	Equal to or greater than the current value
Species composition change	Mean Species Abundance (MSA)	*(Alkemade et al., 2009)*	0.3307 (out of 1)	Equal to or greater than the current value

STEP 1 | STEP 2 | STEP 3 | STEP 4

ACT

STEP 4.1:

ACTION TARGETS

The next step of the SBTN Initial Guidance provides a framework for how companies should move from assessing impact toward action: the ACT framework. Through an adaptation of the Mitigation and Conservation Hierarchy (MCH), the SBTN has determined companies should implement interventions throughout the landscape and supply chain that (in order of priority) avoid, reduce, restore, regenerate, and transform the current practices. In this section, we outline the response options that stakeholders in the dairy value chain have to close the outcome gap outlined in Table 11. We use the SBTN's ACT framework to categorize activities, and place them in a sequence of priority that focuses first on impact reduction before moving to restoration. Finally, we mapped the response activities to each of the KPIs identified in the materiality assessment.

Dutch dairy farmers have faced economic hardship as policies have continually changed, there is an ongoing debt crisis, and dairy farming is becoming less profitable. It is important that actions are taken in order to achieve a nature-positive future, but the actions outlined in this report do not lie solely on the shoulders of farmers (Klootwijket al., 2016; Dolman et al., 2014). There is a predicted decline in dairy farming in the Netherlands within the next decade, which reinforces the need for cohesive plans to protect farmers' livelihoods as they go through yet another structural transition within the sector (Wageningen University and Research, 2020).

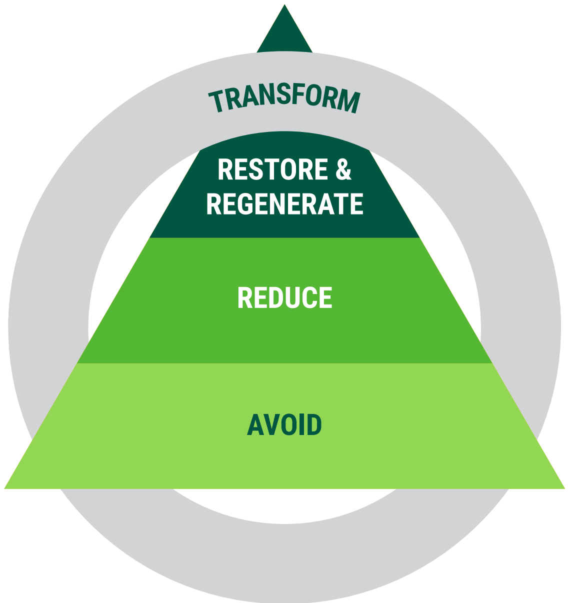


Figure 7: SBTN's ACT framework is based on the Mitigation Conservation Hierarchy (MCH).

Initially, when intervening in a landscape, the priority is to minimize future impact, then to improve the state of nature, and finally to implement transformative initiatives that will continue to develop over time to assist the implementation of interventions. The transformative interventions will deliver additional conservation benefits, but there is little scientific evidence for the connection between the transform interventions and outcomes. The MCH advises that targets should be a result of participatory, transparent and empowering collaboration among value-chain stakeholders (Milner-Gulland et al., 2021). Additionally, the MCH recommends the following principles for the prioritization of interventions:

1. **as remediation is more difficult than prevention of nature-loss, avoidance of impact is prioritised over offsetting,**
2. **as a society have a limited understanding of how reversible impacts are, companies should always adopt a precautionary approach,**
3. **wherever possible, future impacts should be avoided or reduced, and**
4. **interventions should be pursued that create multiple benefits and help tackle multiple problems at once, and where company goals do not align with local objectives, trade-offs/compromises should be aimed for.**

STEP 4.2:

PRIORITIZING ACTIONS

Van Laarhoven et al. (2018) propose a range of activities that a dairy farmer can follow to improve the biodiversity functioning in the landscape. We used the ACT Framework of the SBTN to group these actions into three categories: 'avoid and reduce', 'restore and regenerate', and 'transform' (Figure 7). These three categories are listed in order of priority based on the MCH. The actions are compiled through literature review and stakeholder interviews (Table 13).

List of science based actions

Table 13: Action targets collated, refined and grouped by the SBTN's ACT framework

AVOID/REDUCE	
	Soil management practices (i.e. no/minimal tillage, cover cropping, intercropping, organic mulching, biochar application)
	Avoid pesticide inputs by using IPM and natural pest control
	Avoid synthetic nitrogen inputs by using organic materials (i.e. leguminous cover cropping, leguminous mulching)
	Avoid nitrogen emissions and nitrogen soil surplus through manure management practices (manure management practices, acidification of manure, covering up slurry manure, low-emission spreading techniques, urease inhibitors, best-practice cleaning protocols, internal air scrubbing of animal housing)
	Avoid overgrazing and allowing grass to grow in permanent grassland to increase richness of herbs
RESTORE/REGENERATE	
	Increasing % of natural land on farm
	Introducing woody biomass (i.e. trees, hedgerows, silvopasture, agroforestry, natural area)
	Implementing riparian zones (which exclude livestock)/ Nature-based solution for water purification
	Implementing holistic grazing practices
TRANSFORM	
	Improve farm results and income stability & security
	Best practice exchange (networking and knowledge exchange for best practices between farmers)
	Increase market access for farmers
	Provide farmers access to finance
	Conservation concessions and payments (ecosystem services payments, government subsidies, conservation concessions)
	Multi-stakeholder collaboration/government capacity building
	Continued monitoring, evaluation, and adjustment

Connecting actions to outcome targets

The grouped actions were mapped against the KPIs that are relevant to each intervention based on a review of the scientific literature (Table 14). These were then validated with scientific stakeholders, Anne van Doorn and Jan Willem Erisman. For the transform interventions, we included interventions that didn't have a strong scientific evidence base, as these pertain more to systemic transformation activities and are typically not focused.

To further refine the actions for the landscape, we mapped the actions against the relevant KPIs in Table 11. Although not quantifiable, this aggregation provides insight into which actions farms should take based on their performance. The extensive farms are already in line with the target amount of feed coming from local sources as well as the percentage of permanent grassland on the farm.

Note for implementation: *if this was not a proof of concept an extra step here would be to further refine the actions based on the feasibility determined through interviews with local stakeholders.*

Table 14: The action targets and farm level KPIs associated through scientific evidence are mapped for the avoid, reduce, restore, and regenerate categories (there is not yet sufficient evidence to report on the outcomes for transformative targets) (* Integrated pest management (IPM))

KPI	AVOID/REDUCE					RESTORE/REGENERATE			
	1 Soil management	2 IMP*/no spray	3 Organic Inputs	4 Manure management	5 Flowering grass	6 Natural land	7 Woody biomass	8 Riparian areas	9 High impact grazing
Chemical inputs		✓				✓		✓	
Nitrogen soil surplus			✓			✓	✓	✓	✓
Ammonia emissions			✓	✓					✓
% Natural Habitat					✓	✓		✓	
% Permanent Grassland					✓	✓	✓		✓
Landscape diversity (green/blue)						✓		✓	
Landscape fragmenta-tion					✓	✓		✓	✓
Species composition change	✓	✓	✓		✓	✓		✓	✓
% Own (or local) protein production					✓	✓	✓		✓

Sources: *[1] (Zabaloy et al., 2020) (Bowles et al., 2016) (Grab et al., 2018) (Ravetto et al., 2017) (Pulungan et al., 2019) [2] (Albrecht et al., 2020) (Grab et al., 2018) (Ravetto et al., 2017) [3,4] (Zhang et al., 2019) (Byrne et al., 2020) (Groenestein et al., 2011) (AHDB, n.d.) (Journeaux et al., 2016) (Dijkstra, n.d.) (Howarth et al., 2016) [5] (Luoto et al., 2003) (Ravetto et al., 2017) (Goosey et al., 2019) (Wrage et al 2011) [6] (Grab et al., 2018) (Pulungan et al., 2019) [7] (Pumariño et al., 2015) (Rigueiro-Rodríguez et al., 2010) (Luoto et al., 2003) [8] (Wilcock et al., 2009) (Luoto et al., 2003) [9] (Ravetto et al., 2017) (Goosey et al., 2019) (Pulungan et al., 2019)*

STEP 5

SUPPORT BUSINESSES & STAKEHOLDERS FOR SBTS

TRANSFORMATION REQUIRES MORE THAN PROVIDING A SOUND BUSINESS CASE

Beyond building a business case, to ensure that ecological thresholds are met, farmers must be supported in this transformation. Alone, recommendations for actions will not be enough. A sound business case can be seen as a prerequisite to start the dialogue with farmers about implementing actions that have been mentioned in this report. We outline four steps for helping to ensure that targets are met. The five step approach starts with (1) setting priorities followed by (2) defining targets (3) define practices at farm level (4) develop targeted interventions and (5) monitor & evaluate progress (Reijs et a., 2021). This approach is in line with the SBTNs SBT for nature approach detailed in the report.

Farmers' behavior (and people's behavior in general) is not only rationally determined but also by a more peripheral route. This route is based on routines and executed more or less automatically and impulsively without thoughtful considerations. Rather than only focusing on incentivising a behavior, a desired action is possible using the five types of interventions summarized as RESET (Figure 8).

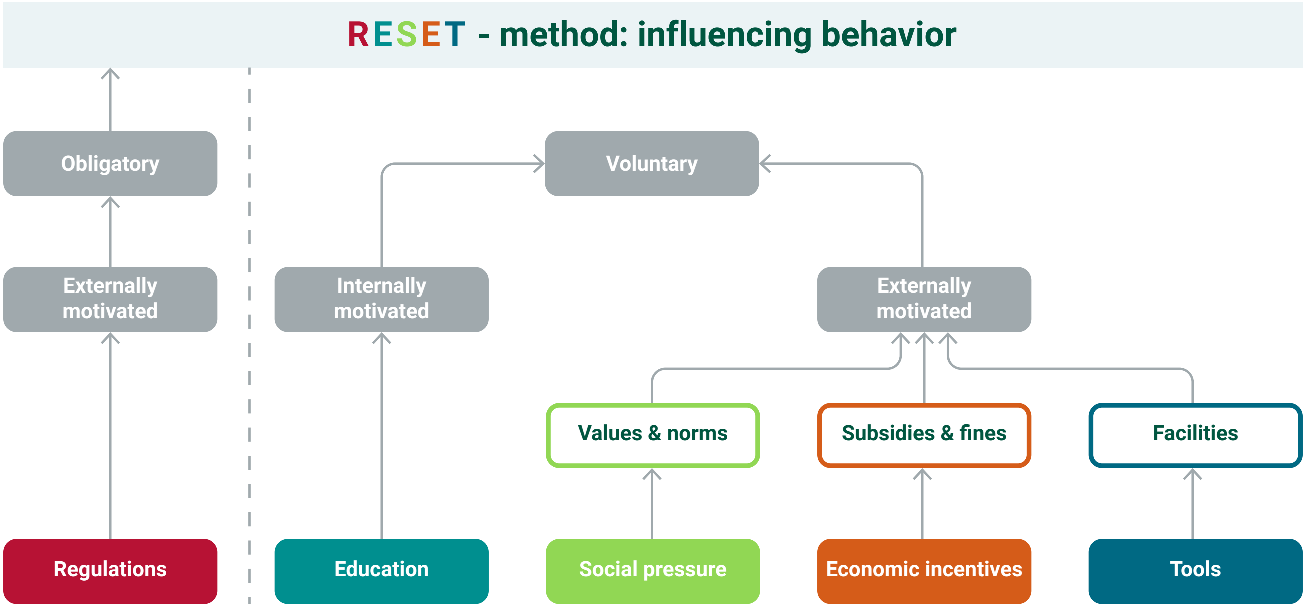


Figure 8: Reset model to influence farmers' behaviour (adapted from Jansen et al., 2016).

In practice, the education (E) route is often used as the first step toward changing a behavior. This route is and remains important as it is the only route that contributes to internal motivation. For example, providing rationale for why diverse landscape features are important in an ecosystem can intrinsically motivate someone to invest in such features by understanding the ecosystem services that they provide. This route can be supported by other incentives to voluntarily change behavior. Social pressure (S) is about changing the social norm within the group and can for instance be organized by recognizing farmers that already implemented certain practices (for example by certain awards or by a broad introduction of benchmarks for new KPIs). Premiums for higher milk prices can also help in stimulating adoption of certain best practices (E for Economic incentives). It can also help to make the implementation of the best practice easy, for example by offering support or turnkey solutions (T for Tools). An example of tools are farmers being directly diverse cover crop mix or provided no till machinery through lease. Finally, rules or regulations can be put in place to create clarity and equal playing field between farmers. It can be used to force (the last) farmers to implement the best practice.

The RESET model can be refined by different models to classify farmers in terms of mindset, values and preferences related to the innovation or adoption curve. The assumption is that early adopters are more intrinsically motivated to try out new practices and can be inspired by the innovators. The late majority will probably only do so if the best practices have been proven to work for a wide group of peers.

If more strategic changes are required (for example different structure of the farm) the process will be more complicated and a more intense process and more time will be required to choose and substantiate a new strategy. Stakeholders around the farmer can support this process like by providing independent facilitators.

FARM LEVEL ECONOMIC (E) IMPACT AND POSSIBILITIES

For a successful science based target, there must be a business case for farmers working on bridging the performance gap (as mentioned in Table 12). We highlight the current differences in sustainability performance, how they relate to economic results, and what options there are to improve the business case.

A higher level of sustainability of a dairy farm can go hand in hand with a better economic performance. An analysis based on data from the Dutch FADN network actually showed that the 25% best performing Dutch farms (selected on a number of environmental and animal health and welfare indicators) had better economic results in comparison with the 75% group (Reijs et al., 2021). We also know that organic dairy farmers on average had a higher income in comparison with conventional dairy farmers (van der Meulen, 2021). Due to the large variability within both groups, this difference was not statistically reliable.

It is important to be aware that the decision of a farmer to implement one of the defined actions is not just based on the net economic result of the action. Some other economy related considerations:

1. **Economics:** Direct and visible returns or a clear positive effect on cash flow are a stimulant to implement. Directly related premiums can help (e.g. example of grazing premium in the Netherlands). If an investment in hardware (e.g. machinery, buildings) is required as a threshold for implementation. The available amount of capital to invest is limited and can only be invested once.
2. **Labor:** Since the Dutch farms are usually family farms, meaning that most of the labor is provided by the family, this is not so much about costs but more about workload. This is not just about the amount of labor that is required, but also about the complexity of the action.
3. **Risks (e.g. trade-offs):** One action can be positive for one target but can have a negative impact on another target. Reversibility of an action is also important. If you already apply grazing and you want to increase the grazing period, this can be done safely and if it turns out less successful than expected you can easily change it back. This is not possible if you invest in manure acidification technology which was mentioned earlier as one of the possible actions to reduce impact.

For many farmers, there is room for improvement on several KPIs without major investments and probably with a positive impact on economic results. This is especially the case for efficiency indicators like nitrogen soil surplus and % own protein production production. The introduction of natural elements and of herb-rich grassland could also have positive effects on the resilience of the whole farm system, which in the end could also lead to better economic results. The concept of strip cultivation (alternating crops in narrow, partitioned cropping systems) is partly based on this principle. A recommendation is to try to assess the impact of these possible side effects on the economic performance and the resilience of the farm.

Overall it is important to be aware that these types of improvements cannot be achieved without extra effort and sometimes require extra investments. We know for example it is not that easy to convert from conventional to organic, especially because the farm structure has to change because the farm has to be more extensive with fewer cows per hectare. In a study in the Netherlands, the additional net costs as result of measures that had to be taken on dairy and arable farms to achieve a higher level of biodiversity was assessed (Beldman et al., 2019). The study mentioned the net costs also taking into account the economic benefits of measures. In this study the gap that had to be bridged was defined as the difference between the 70% group and the 30% best performing farms. The additional costs for the average dairy farm was estimated to be about €2.21 per 100 kg of milk.

Since the present study is at landscape level, most actions in this report have been defined at a rather generic level and have not been quantified on farm level (for example, which level of % of natural land). To be able to assess the economic impact on farm level, the action needs to be quantified. As an example: if 5% (or less) of natural land is introduced on the farm the effect on the business case will probably be neutral or slightly positive if a farmer receives payments through an agri-environmental scheme. If much higher levels (> 10%) are required, the integration in the current farm system will be more complicated and might actually require a more strategic change of the farm, e.g., introducing different breeds of cows that can deal better with the different quality of feed produced on the farm. And equally important: the whole package of actions needs to be taken into account, since actions will also interact. In order to increase protein production on farm level a farmer might want to increase the grassland area, but this can easily result in higher nitrogen surplus per hectare and a higher ammonia emission.

Looking at the gaps that have been identified in this report, it will at a first glance certainly require more than optimizing the current farm systems. It seems that the targets that have been set require strategic changes (e.g. substantial lower intensity) and investments for the farm. For the next phase it is recommended to specify the desired or required actions in more detail, e.g., in case studies. Especially since these will definitely be a few of the first questions a farmer will ask: what do you expect me to do (and why), and what will be the impact?

OPPORTUNITIES FOR VALORIZATION

An important question is whether it is possible to create extra returns. We will explore a number of options. First there is the option for an individual farmer to build their own chain with a specific product for a specific market. Secondly, we will explore the possibilities that will probably be relevant for a wider group of dairy farms. For this group, we'll go into the opportunities for valorization through the dairy chain, either through the farmer himself or through a dairy company, and access to landscape initiatives.

Developing your own market and short chain

There are several examples of individual farmers that have chosen specific strategies to valorize their own farm system. Some well-known Dutch examples are "De graasboerderij" (http://www.graasboerderij.nl/), the farm from the van de Voort family 'De groote Voort' producing Remeker cheese (https://www.remeker.nl/) and farmer Pelleboer who's producing 'Save the meadow bird cheese' (https://www.boerpelleboer.nl/). What these farms have in common is that they created their own story, their own chain, and their own brands. Some also have income from additional activities. It is important to be aware of the fact that designing and executing such a strategy requires specific skills.

Opportunities for valorization of biodiversity provisioning by a dairy company

The dairy processor can be seen as one of the main partners of the dairy farmer for his business case. Looking at the share of milk in the total returns from the farm this is very clear. For the average Dutch dairy farmer the returns for milk account for 81% of the total returns of the farm (Wageningen University & Research, 2021).

So how can a dairy company contribute to the valorization of biodiversity on a farm level? The simple answer is to pay a high milk price, this can help to cover potential extra costs related to the earlier mentioned actions the farm can implement. A high(er) milk price does however not guarantee that the desired actions will be implemented. So it is important to have a direct link between (extra) payments and the desired actions or results. A successful example of this was the introduction of the premium for grazing in the Netherlands. For the average Dutch dairy farmer the premium for grazing is about € 1.60 per 100 kg, this makes in total about € 14.000 (Duurzame Zuivelketen).

It is also possible for a dairy processor to pay a premium for farmers that achieve a certain level for a set of criteria. This is already very common related to milk quality, but there are also several programs in place in which farmers can achieve points for certain activities that are implemented or performances that have been achieved for a number of sustainability indicators. All Dutch dairy processors have sustainability programs in place with these kinds of systems. There are also a number of certification programs in place which also build on similar principles. Examples from the Netherlands are: On the way to planet proof, used by FrieslandCampina, "Better for Farm, Nature and Farmer" set up by Albert Heijn and dairy processor A-ware, and Better-Life which is introduced by the NGO Dutch Society for the Protection of Animals (SPA).

Besides financial incentives a dairy company can also support the farmer in other ways. This can be done by providing knowledge in workshops, training or facilitating farmers to learn from each other.

- Farmers discussion groups are a well-known tool to bring knowledge to farmers, partly from farmer to farmer but also facilitated by experts. Improving soil management would be a suitable topic for this through a workshop series, starting off with a workshop facilitated by an expert sharing basic soil knowledge and sharing practical experiences from farmers within the group by visiting these farmers in follow-up workshops. This approach could also work very well for the action to work with clover in order to reduce the use of synthetic nitrogen fertilizer.
- Coaching is another option to transfer knowledge (e.g., for grazing certified coaches) are available that can support a farmer in improving his grassland management.
- Facilitation in data collection and benchmarking can also support the learning process. To have a good understanding of the nitrogen surplus and find ways to improve comparing your data with better performing colleagues can help. In the Netherlands these data are generally available through the kringloopwijzer tool.

For working on sustainability it makes sense to work with long-term relationships. Especially if strategic choices have to be made (e.g., larger investments) this is important. Some processors have long-term contracts with their suppliers, which also include certain targets to be achieved. Long-term relationships between dairy farmers and dairy companies are very common in the Netherlands, unlike many other countries.

Access to landscape initiatives for payments for nature's contributions to people or other advantages

Another way to improve the business case for farmers is to unlock other sources of income directly related to biodiversity provisioning. This is a topic that has been receiving a lot of attention in the last couple of years. In the Netherlands a large platform has been established in which many stakeholders work together on the recovery of biodiversity and one of the main topics of this platform is the improvement of the business case for farmers, partly by looking for extra returns ('stacking rewards').

One option that is already known is making use of EU-agri-environmental schemes. Within such a scheme, a farmer can make a contract for e.g. meadow bird grassland or herb-rich grassland for a certain area of his farm. For this area management practices have to be adapted, much in line with actions that have been mentioned in the report. In return, the farmer receives a subsidy that is based on a reimbursement of extra costs or lost revenues. These schemes are financed by the EU, the program is executed by regional organizations, the so-called collectives (https://www.boerennatuur.nl/collectieven/). This will help to improve the score on some KPIs while maintaining the business case at the same level. The impact would actually be bigger if it could improve economic outcomes, though this requires a change of policy.

What could be interesting however, is stacking rewards (fees or advantages). If a better score on KPI's does not just result in an EU subsidy but also in other returns or advantages, then it becomes more interesting.

One of these options is that a farmer with better performance on his biodiversity monitor indicators can get a discount (of 0.2%) on the interest rates for loans. Rabobank has introduced this recently, the system is based on a system in which farms are categorized in levels. The farms that are in the highest level can receive this discount. Another example is now piloting in the province of Noord-Brabant, where farmers can get a reward of up to €5000 for a high performance on the KPIs of the biodiversity monitor. This monitor is based on the national biodiversity monitor, but uses some additional KPI's.

A relatively new option is to be paid for carbon sequestration, and this could be interesting for farmers who want to increase their area of permanent grassland. A number of pilots are currently executed in this field in the Netherlands.

- "Valuta voor veen" (Money for peat) is one initiative. A farmer has raised the water table level significantly (from -50 to -15 cm) on his peat soil farm to prevent carbon emissions. The carbon emission reduction is sold as certified carbon certificates. The farmer receives almost € 800 per hectare This example is however not relevant for the landscape of this study.

The southern farmers union (ZLTO) is involved in a pilot project on carbon farming, which is part of an EU project. In this project farmers work on sequestration of carbon. This sequestration will be monitored. Accurate monitoring is difficult because the topsoil can contain 50-100 ton of carbon per hectare, so measuring a difference of 0.5 - 1 ton per hectare is challenging. Based on this monitoring certificates can be sold to companies that want to compensate for their GHG emission. The project is still in an early stage, so economic returns have not yet been published. In Austria there is a well-known example of payments to farmers for carbon sequestration. In Austria they sell the carbon certificates for €35 per ton CO_2. For grassland sequestration of 0.5 - 1 ton per year seems to be possible. One of the ideas in the mentioned pilot project is also to work on short chains, which means that certificates are directly sold to regional companies that want to compensate for their carbon emission. This should result in a higher price.

Another example of an advantage that can be obtained is also in the province of Noord-Brabant. Farmers with a higher sustainability score have better access to additional lease land, so they don't have to pay the highest price. This has also recently started, so there is no information available yet on economic impact.

Earlier was mentioned that it seems that the targets that have been set require strategic changes e.g. substantial lower intensity. This can be achieved by reducing the number of cows, but especially the capital costs will remain the same. Another option is to add extra land to the farm. Land is expensive in the Netherlands, in the area of this landscape study the price per hectare is between €60.000 and €70.000. New initiatives like "Aardpeer" and "Land van ons" can possibly help to reduce costs for additional land. These initiatives aim to buy land from conventional farmers and make the land available for a low lease price for nature-inclusive farmers under certain conditions.

OVERALL

Several options for valorization are available or in development. At the moment it is mainly the group of front runners that is exploring several of these options. The majority of farmers will ask for more clarity and assurance.

The payments for ecosystem services are in development and are so far often based on compensation of extra costs. Stacking could help, if this is allowed. Subsidies can not always be combined. It would help if there would be a real market for ecosystem services to actually improve the farmers' business case.

Looking at the gaps that have been defined in this report and realizing that the different thresholds will have to be combined on a farm level will certainly require more than optimizing the current farm systems. They will require strategic changes (e.g. substantial lower intensity) and investments for the farm. For the next phase it is recommended to specify the desired or required actions more in detail e.g. in case studies. In anticipation of this, it can be expected that substantial fees for ecosystem services will be needed and/or other ways to limit the level of additional costs of, for example, extra land.

And last but certainly not least: there is a great variety in farms and farmers. Starting points differ in farm structure and in farm performance. One required action will fit better for farm A and another will fit better for farm B given these differences. Farmers themselves also differ both in ambitions and in skills. Therefore, any package of solutions for supporting farmers in a nature-positive journey will have to be flexible to the realities of a diverse and challenging sector.

Business implications of the action targets

Table 15: Connecting the action targets with the business case.

AVOID/REDUCE	INVESTMENT (CAPEX)	OPERATIONAL COSTS (OPEX)	SKILLS	REMARKS
Soil management practices	Some of these actions might require investment in machinery and therefore result in higher costs	Not specific enough to assess	Requires different set of soil management skills	*Cover cropping is obligatory in combination with corn silage on sandy soils in the Netherlands A better soil can also result in a more resilient farming system e.g. because of better retention of water and minerals*
Avoid pesticides inputs	To assess costs of additional reduction more detailed information is needed how this should be achieved (e.g. by mechanical weeding)		Requires additional skills for integrated pest management	*Pesticide input is already low at dairy farms compared to arable farming systems.*
Avoid synthetic nitrogen	No major investment	Depends on the level of reduction. E.g. 100% of reduction of nitrogen fertilizer in grassland and introduction of clover will result in a reduction of feed production.	Requires different set of skills to manage grass-clover systems	
Avoid nitrogen emissions and nitrogen soil surplus through manure management practices	Differs a lot between the mentioned examples. Acidification of manure requires high investments, internal air scrubbing requires major investment	In general improving management and efficiency is cost effective	Requires improvement of skills	*Low-emission techniques are already obliged in the Netherlands. Further improvement depends on available techniques and might result in additional costs or investments e.g. diluting manure with water to lower N-emission.*
Avoid overgrazing	No major investment	No direct operational costs	Requires improvement of skills	

CONCLUSIONS & RECOMMENDATIONS

FURTHER WORK ON AMBIENT MONITORING

There are many useful biodiversity impact indicators available that work on a global scale. Currently, there is a very limited number of useful indicators that can be used to monitor biodiversity within a landscape over time. In this proof of concept, we use MSA to measure biodiversity on an index that can be adjusted over time to ensure that the midpoint KPIs are aligned with the overall goal of biodiversity improvement and therefore the endpoint KPIs. Moving forward, it would be very useful to ensure that there are sufficient methods for monitoring biodiversity that can be used across sectors. The current biodiversity monitor does not consider a species composition change endpoint marker, and in this report we have determined that this is essential for determining the validity of the midpoint KPIs.

Chemical inputs should also be added to the empirical data taken within the farm survey and included within the biodiversity monitor. Thus far, it is inconclusive whether there is an appropriate way of monitoring landscape fragmentation in an ambient manner. Additionally, it became clear throughout the analysis that the biodiversity monitor could be more closely connected to the Natura 2000 protected area system for understanding what different landscapes need.

Continual evaluation and adjustment are key to reaching outcome targets. The science is still murky and accounting systems for nature-related impacts are nascent. As the science catches up there are faster and faster complex analyses to allow complex food systems to take credit for reaching environmental KPIs.

MOVING FROM PROOF OF CONCEPT TO PILOTS

In this report, we assessed a human-dominated landscape, therefore there are different considerations when setting SBTs for nature. The goal is for this methodology to be reused, and throughout the document we have listed “notes for implementation” areas where, if the methodology is being reused, there are further considerations based on the landscape.

Because this landscape analysis was completed within an extremely human-modified environment, preventing externalities from other areas of the world from the purchase of feed will require improvements to supply chain visibility and transparency. The project cannot claim to be improving biodiversity while outsourcing their impacts elsewhere, where the biodiversity would likely be of higher global importance. Therefore it is critical that any company setting science-based targets for nature has sufficient supply chain visibility and influence further upstream to ensure they can take appropriate action.

Instead of trying to prevent biodiversity loss, the goal in this assessment is to improve it. If this was a landscape assessment within a high biodiversity area (i.e. covered by the Global Safety Net) the target setting procedure for the landscape would be different (Dinerstein et al., 2020).

For other human-dominated landscapes within the EU and similar mosaic landscapes, this study serves as a framework for developing science-based targets for nature. Many of the societal goals for establishing the targets come from an EU level (EU Biodiversity Strategy, Regulation (EU) No 1307/2013) or from local targets that can be determined within local landscapes. In particular, this report is useful for establishing dairy targets for farms on primarily sandy soil. There are different priorities for areas with peat or clay soil and the results should not be scaled generally for other soil types without careful consideration.

Within the Dutch dairy landscape, where this proof of concept took place, there is available empirical data through collated farm surveys. This allows the company to understand the impact of the dairy industry within the landscape. In this proof of concept, we were unable to contextualize the contribution of Bel Group within the landscape in comparison to the dairy industry, and therefore moved forward with the contraction of impact allocation methodology. In an implementation context, piloting an allocation methodology that has strong stakeholder engagement would be ideal. Overall within the SBTN, there is a need for greater consensus as to what the ideal approach is to allocating impact.

KNOWLEDGE DEVELOPMENT AND EXCHANGE

In this proof of concept we make big strides toward understanding how to set science-based targets within a landscape. There is a continual need for more examples of target setting. A library of public precedents raising ambition is key for successfully moving toward biodiversity recovery. There is a need for more landscape locations, sectors, piloting different approaches to allocating impact, and utilizing different aggregated empirical data sources. Ecological thresholds are appropriate for the current gap assessment, but ambition should be continually raised both by the SBTN and the private sector to move towards action that will be transformative. Additionally, targets may need to be updated as societal goals evolve with science. For example when the biodiversity monitor was first developed, the nitrogen laws were not as strict as they are now, and these have been updated since the initial release in 2018.

BEL GROUP’S CONTRIBUTION TO A NATURE-POSITIVE FUTURE

By participating in this study, Bel Group has opened the door to help determine what a company’s contributions toward a nature-positive future can be. These contributions require robust set precedents that truly aim to uncover what nature needs. The targets determined in this report are not static, but rather dynamic and will continue to evolve as society adjusts goals and science catches up to the need for transformative change. What is important is that the targets are transparent, the evidence behind them is cited, and they are set to develop sector-level precedents. We have seen that for a company setting science-based targets for nature, there is a strong need for upstream engagement and support. Setting targets is the easy part. Achieving them in a stakeholder-inclusive process, which includes the right business incentives for supply chain partners, will be a critical next challenge to overcome. The prize is a landscape that is nature-positive, alongside producing the materials needs for society.

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BIODIVERSITY MONITOR KPIS

Percent of permanent grassland (% of total acreage):

- **Calculation % of permanent grassland:** Total acreage of permanent grassland / total acreage of farm * 100%
- **Definition of permanent grassland:** A plot of grassland that has not been included in the farm's crop rotation for a minimum of five years.
- **Definition of farm's total acreage:** Acreage used or managed by the farm.
- **KPI in context:** The larger the amount of grassland in the farming system, the more favourable the outcome for organic matter, soil biodiversity and ultimately for ecosystem services. The share of grassland is therefore an indirect indicator of more functional biodiversity on the farm. Additionally, the age of the grassland is important. The older the grassland, the less soil cultivation, the more the ecosystem remains intact, and the greater the chances for biodiversity above and below the ground.

Percent of protein produced by own farm (less than 20 km):

- **Calculation % of protein produced by own farm:** % of protein produced on the farmer's own land / % N (1-N in purchased feed / N in total feed) * 100%
- **Purchased feed** = Purchase of concentrated feeds + roughage and by products
- **Total feed** = Concentrated feeds + roughage + by-products + meadow grass
- **KPI in context:** Firstly, the percentage of protein produced on the farmer's own land indicates the level of self-sufficiency in feed production, and is related to the intensity of dairy farms. It therefore indicates the size of the footprint from external suppliers. This affects biodiversity in other parts of the world. Thirdly, it indicates the share of grassland maintained by a dairy farm. Grassland scores higher in terms of biodiversity and its functions than agricultural land.

Percent of herbrich grassland (% of acreage):

- *** No data available for this KPI ***
- **Calculation of % herbrich grassland:** Total acreage of herb-rich grassland / total farm acreage * 100%
- **Definition of total acreage of herb-rich grassland:** Permanent grassland with a mix of at least four types of grass and herbs, but often more than 10 types (incl. Buttercups, cuckoo flowers, daisies, ordinary sweet vernal grass, crested dog's-tail, cuckoo flowers, Greater Yellow-rattle, water forget-me-not, red clover and plantain. The share of grass is lower than for production grass, and it has an open and diverse structure due to the numerous herbs, with their large number of stalks and little leafage.
- **Definition of total farm acreage:** Acreage used or managed by the farm.
- **KPI in context:** Herb-rich grassland strengthens the soil, leads to more stable production, is more resistant to drought, may have a positive impact on animal health, and helps reduce ammonia and methane emissions by ruminants. A diverse composition of grass also has a positive effect on aboveground biodiversity. Grassland with a rich variety of herbs, combined with a later mowing date, allows meadow birds to breed and raise their young in safety.

Nitrogen soil surplus (in kg N/ha):

- **Calculation of nitrogen soil surplus per cultivation:** Nitrogen supply - nitrogen removal - nitrogen emissions
- [% grassland * soil nitrogen surplus (grassland - kg N/ha) + % corn land * soil nitrogen surplus (corn land - kg N/ha) + % land used for other roughage - kg N/ha) + % land used for arable crops * soil nitrogen surplus (soil used for arable crops - kg N/ha)] / 100%
- Definition Surpluses are defined as the difference between the nitrogen inputs into and outputs from the agricultural system 1
- **KPI in context:** Nitrogen surpluses are one of the greatest threats to biodiversity and resilient ecosystems. The nitrogen surplus in the soil provides an indication of the burden on the soil and water system. The nitrogen soil balance is determined by the supply of nitrogen through deposition, eutrophication, leguminous plants, mineralisation and purchased feed, and the amount of nitrogen evaporated into the air. The smaller the nitrogen soil surplus, the smaller the risks.

Ammonia emissions (kg NH_3/ha)

- **Calculation ammonia emissions per ha:** (Ammonia emissions from the barn + manure storage + grazing + fertilisation using animal manure + use of fertiliser) / total acreage of farm
- **Definition:** The effects of ammonia emissions are negative, and could be observed in aquatic ecosystems, forests, crops and cultivations. Where excessive emissions are recorded, increased acid depositions and excessive levels of nutrients in soil, rivers or lakes are observed 1.
- **Definition total farm acreage:** Acreage used or managed by the farm.
- **KPI in context:** Ammonia emissions account for approx. 70% of nitrogen deposition in the Netherlands. A total of 75% of this share originates from Dutch sources, with agriculture being the main contributor. This nitrogen deposition has an impact on the natural world, which results in a decline in biodiversity (see KPI: nitrogen soil surplus).

Nature & landscape (% of managed land based on management contract)

- **Calculation contribution of nature and landscape:** Σi (Oi x Ci x 100%)/T
  - O = Total surface of nature and landscape elements (for type i)
  - C = Weighting factor (for type i)
  - T = Total farm acreage
- **Definition weighting factor:** Since different elements contribute to biodiversity in different ways, a weighting factor is used to determine the amount of land used for nature and landscape elements, including full-scale elements, line-shaped elements and point elements. These weighting factors are based on the amount of compensation paid and the effort required for management.
- **Definition farm acreage:** Acreage of land used or managed.
- **KPI in context:** Landscape diversity on the farm improves the quality of the landscape and people's perception of this landscape, along with biodiversity, and supports functional agrobiodiversity. This KPI is a composite indicator for landscape management and species management.

ADDITIONAL KPIS

Species composition change

- MSA values are retrieved by dividing the abundance of each species found in relation to a given pressure level by its abundance found in an undisturbed situation within the same study, truncating the values at 1, and then calculating the arithmetic mean over all species present in the reference situation
- Evaluating ecosystem functioning at the ecoregion level involves four steps:
  - (i) quantification of land-use biodiversity loss at the ecoregion level (calculation below)
  - (ii) defining safe operating space for each ecoregion, this part is based on the "nature needs half" (NNH), (see below);
  - (iii) deriving safe operating space for a country in each ecoregion based on a chosen effort sharing approach; (ex. ratio of population to global pop, or the Grandfathering approach using historical biodiversity loss data of the local region compared to the global equivalent)
  - (iv) evaluating if the environmental impact from (i) is within the safe operating space defined in (iii). according to https://ecoregions2017.appspot.com/ Netherlands is in the Nature Could Recover stage
- Biodiversity loss footprint: Hectares of area in use * (1-MSA)
- MSA values may be found from the GLOBIO3

Landscape Fragmentation

- For genetic biodiversity, having connected landscapes is essential. Currently, there are limited ambient monitoring capabilities for measuring landscape fragmentation. We used the KPI from CAI_AM index to determine the current landscape and then set boundary to not reduce the current connectedness of the landscape due to the lack of societal goals or ecological thresholds associated this or any landscape fragmentation index.

Chemical Inputs (herbicide, pesticide, fungicide)

- The ecological threshold used are the levels of chemicals safe for drinking water. The specific chemical inputs thresholds for drinking water are as follows: Pesticides (individual): 0.1 μg/L (microgram / L) - per matter; Aldrin, dieldrin, heptachlor and heptachlorepoxide: 0.03 μg/L; Pesticides (sum): 0.5 μg/L (microgram / L) (sum of individual pesticides with a concentration that is higher than the detection limit).

GLOSSARY

Biodiversity monitoring: Determining the status of biological diversity at one or more ecological levels and assessing changes over time and space. This should include genetic, species, and ecosystem level of monitoring as well as multiple groups within each of these to have a complete picture of the changes of biodiversity in an area over time.

DPSIR: (Drivers, pressures, state, impact and response): A framework developed to describe the causative chain of environmental issues:

- Drivers: The values and behaviors of individuals, organizations and society as a whole. "Drivers" feed into "pressures", which then fuel the degradation and loss of nature (measured in state variables) within the land, freshwater, and ocean realms.
- Pressure: Derived from the drivers (as per the DPSIR framework) of biodiversity loss as determined by IPBES .
- State of nature: a measurement of KPIs at a point in time that is used to benchmark impacts.
- Impact: Positive or negative contributions of a company or other actor toward the state of nature.

Materiality assessment: Assessment to determine issues which should influence decision making processes, or have the potential to do so and which should be included in corporate target setting. In a materiality assessment, we identify the main pressures on nature and the level of influence for the company to affect these pressures. Materiality can be assessed and reported in a number of ways, and in the case of our assessment we examine the material impacts on nature within our 50km radius landscape.

Key Performance Indicator (KPI): A metric used to measure the impact associated with a set of actions or outcomes. The indicators can be used on a broad, landscape level or more pinpointed at a dairy farm on biodiversity on the farm and beyond. In the case of this project, KPIs make it possible to benchmark and monitor the role of dairy farmers in the preservation of the landscape and the environment using a standardized system. Key criteria in the selection of KPIs are integrality and measurability. This means that the set of KPIs can be used to collectively quantify the performance of dairy farmers in an integrated manner with the objective of improving biodiversity:

- **Role of KPI:** KPIs ensure that there is across the board contraction of impact that lead to landscape level improvement of biodiversity outcomes
- **Input KPI:** KPIs that are related to initial load or use of a resource
- **Midpoint KPI:** KPIs that assess intermediary impacts between the impact and eventual decline in question (in this case biodiversity). It is important to measure midpoint KPIs because they appear before the endpoint, and can provide clear indication of how a system is behaving
- **End-point KPI:** KPIs that to the outcome or eventual goal are related to to target, and in this case, biodiversity monitoring

Threshold: defines a value for the boundary for an activity (i.e. nitrogen soil surplus) for which the landscape can remain within a safe operating space. Thresholds are applicable for some activities, but are not applicable for all activities.

Target: A sience-based target for nature is a measurable, actionable, and time-bound objectives based on the best available science that allow actors to align with Earth's limits and societal sustainability goals:

- **Action targets:** Are set to ensure that interventions are carried out appropriately to ensure that outcome targets and the goal will be realized
- **Outcome targets:** Are based on key results required to achieve the goal within a certain time period.
- **Target boundary:** A specific quantitative objective, usually nested under a goal, with defined measurement and an associated indicator. Defines the issue area (location) and/or aspects of a company's operations, brands/product lines where targets will be set. Within the context of this project, the target boundary is the dairy basin of the Bel milk processing plant. We are looking at biodiversity impacts (CO2eq considerations are out of scope) on sandy soil farming operations.

Pressures: Five key pressures contribute most to the loss of nature globally: Land and sea use change; direct exploitation of organisms; climate change; pollution; and invasion of alien species.