

# Acknowledgments

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The following companies are members of the Future Fit Dairy Initiative (FFDI) and together developed this FFDI farm-level monitoring guidance:

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#### Reviewers

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# Summary

#### **Background**

The Future Fit Dairy Initiative (FFDI) is a collaboration between Arla Foods, Danone, FrieslandCampina, DSM-firmenich, and Rabobank. Together, they aim to show that the dairy sector can contribute to nourishing communities within planetary boundaries, by applying regenerative agricultural practices in Northwest Europe.

#### **Objectives**

- 1. Show that dairy production can contribute to environmental, economic, and social sustainability.
- 2. Create clear and practical farm-level monitoring guidelines based on the SAI Platform Regenerating Together Programme (RTP).
- 3. Support farmers in transitioning to regenerative agriculture.

#### Methodology

- 1. **Context Analysis:** Identify key environmental and production risks in the dairy sector in Northwest Europe.
- 2. **Outcome Selection:** Prioritize regenerative agriculture outcomes based on the context analysis.
- 3. **Selection of Indicators and Metrics:** Determine performance levels and aspirational targets for various indicators such as soil health, biodiversity, water use, and greenhouse gas emissions.

#### **Key Indicators**

- Soil Organic Carbon: % of farmland under a high-SOC regime.
- High-Biodiversity Landscape Elements: % of agricultural area with non-productive elements like hedgerows and buffer strips.
- Sustainable Feed: % of protein from low-opportunity cost feed and land-conversion-free feed.
- Greenhouse Gas Emissions: CO2-equivalent per kg of milk and absolute reduction of total CO2equivalent.
- Ammonia Emissions: Emissions per animal or per hectare, aligned with national and regional policy goals.
- Soil Nitrogen Balance: Difference between nitrogen applied and removed, expressed in kg N/ha or kg N/animal.

#### **Future Developments**

- Keep improving guidelines and indicators.
- · Work with more farmers and expand to new regions.
- Partner with universities and financial institutions to provide support for the transition to regenerative agriculture.

#### Conclusion

The FFDI guidelines offer a holistic approach to monitoring the environmental impact of dairy farms in Northwest Europe. By working together and learning as we go, the FFDI is helping the dairy sector move toward a more sustainable, and regenerative future.



# Background on the Future Fit Dairy Initiative (FFDI)

As Arla Foods, Danone, FrieslandCampina, DSM-firmenich, and Rabobank—five companies in the dairy value chain in Northwest Europe—we are working together in a precompetitive program called the Future Fit Dairy Initiative (FFDI).

We share a common commitment: to demonstrate that dairy can contribute to nourishing communities while operating within planetary boundaries, giving back to the planet more than is taken from it. And we are ready to show that it can be done. By collaborating, we can accelerate the transition toward a regenerative dairy system in Northwest Europe - one that benefits both people and the planet. We call this vision "Future Fit Dairy".

Future Fit Dairy is about applying a science-based approach to drive positive ecological outcomes while acknowledging the real-world challenges that farmers face. Each farm operates within a unique context, with specific barriers and hurdles. That's why we must optimize our approach, tailoring solutions to fit these realities.

Being future fit means aligning the best strategies for a triple impact - social, economic, and ecological. It also requires resilience, preparing for and adapting to constrained environments and future challenges.

A key enabler of Future Fit Dairy is regenerative agriculture, which fosters efficient and resilient farming systems that balance environmental health, economic viability, and social responsibility.

However, this FFDI farm-level monitoring guidance doesn't define regenerative agriculture. We recognize regenerative agriculture as an ongoing journey of continual enhancement of natural processes within agricultural systems to increase the land's life-supporting capacity, rather than a fixed status that can be defined. The performance levels outlined in this FFDI farm-level monitoring guidance do not determine whether a farm is 'regenerative' but instead provide the direction of that regeneration journey in a holistic manner. We acknowledge that all farms have their own journey and that it's important to leave space for different approaches to achieve farm-level improvement towards regeneration.

This paper translates the Sustainable Agriculture Initiative Platform Regenerating Together Programme Framework (SAI Platform RTP Framework- SAI <u>Platform, 2024</u>) for dairy farming in Northwest Europe into a practical farm-level monitoring guidance. By closely collaborating with industry coalitions like the SAI Platform, aligning with initiatives such as WBCSD/ OP2B, and checking it with farmers and scientists, we strive to develop an effective measurement and reporting approach. Our goal is to provide clear, context-specific quidelines that help address the challenges of transitioning to a Future Fit Dairy system. The FFDI farm-level monitoring guidance is the result of this work - an outcome-based application of the SAI Platform RTP framework for defining and monitoring the environmental impacts of dairy farms in Northwest Europe.



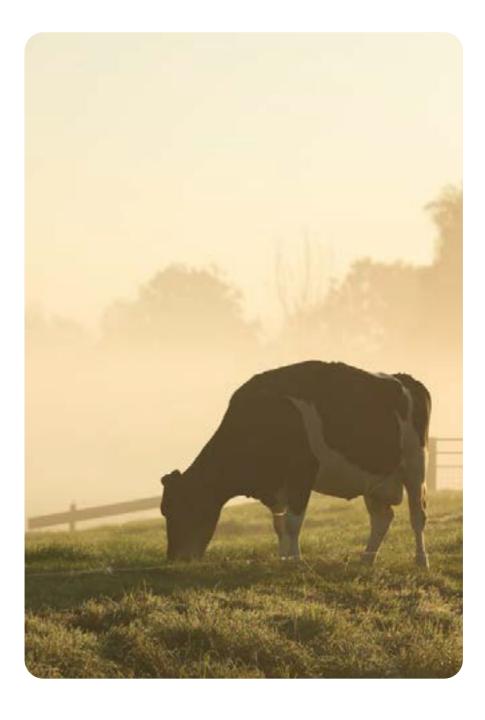
In addition to this outcome-based translation of the SAI Platform RTP framework (known as Pillar 1), FFDI is also working on a systemic approach to bring change through three other pillars:

- Pillar 2, with the objective to create transition support for farmers working toward a Future Fit Dairy farm model. To do so, FFDI is conducting a study to identify transition hurdles, costs, and benefits. The learnings will be used to identify priorities and to develop farm transition support solutions and public/private partnerships.
- Pillar 3, with the objective to enhance stakeholders engagement. Once the key concepts of pillar 1 and 2 are clear, we aim to align with other value chain stakeholders to enhance an industry-wide adoption of the FFDI approach and engage with policymakers and public institutions for knowledge sharing and advocating policy mechanisms.
- Pillar 4, with the objective to build farmer engagement. The current program engages a wide community of farmers across 9 countries in Northwest Europe, fostering knowledge sharing and support. We also use this program to collect farmers' insights and iterate our approach.

While the FFDI is a long-term initiative, we aim to achieve the following ambitions by 2027:

- Deliver impact with a minimum of 1,000 farmers in 9 European countries meeting science-based thresholds on soil health, biodiversity, water, and climate - building the knowledge needed to scale further.
- Develop and translate the SAI Platform RTP framework into applied outcomes and practices relevant to all dairy farming systems, starting in Northwest Europe to inspire scale-up of regenerative dairy globally.
- Support the farmers' journey with learning & knowledge for multiple transition perspectives.
- Show the business case for farmers and de-risk investment in regenerative agriculture (via transition support solutions).
- Meet the global demand for a transition and thereby seize commercial opportunities in the existing dairy value chain.

FFDI is testing the current approach with selected dairy farms in the Netherlands, Germany, Denmark, UK, and Poland. An outlook on the next steps is described in Chapter 6.





# Introduction to the FFDI farm-level monitoring guidance

This paper introduces the first version of the FFDI farm-level monitoring guidance (V1), a science- and outcome-based approach to defining and monitoring environmental impacts of dairy farms in Northwest Europe (Table 1). We, as the companies currently active in the Future Fit Dairy Initiative, developed the FFDI farm-level monitoring guidance using technical advice and project management from Metabolic, and feedback from several academic experts.

We based our FFDI farm-level monitoring guidance on the SAI Platform *Regenerating Together* Programme, a global framework for regenerative agriculture. Additionally, we aligned the terminology and categorization of 'pressures on nature' with the Science Based Targets for Nature (SBTN) methodology as much as possible (see Table 1, column 1 'SBTN pressure category' and column 2 'SBTN pressure indicator').

While the methods of the SAI Platform RTP framework can be applied to any sector in the world, the FFDI farm-level monitoring guidance is one of the first adaptations to a specific sector (dairy farming) and region (Northwest Europe). We took on the challenge of adapting the SAI Platform RTP framework to a specific practical context while aligning with each company's internal sustainability program. To address the complexities of alignment across companies, each FFDI company informed the FFDI translation

with its own experiences. This included insights into the operational challenges related to sustainability monitoring within the farm portfolio, while maintaining balanced internal processes and farmer relationships. At the same time, this sector- and location-specific adaptation of the SAI Platform RTP framework provided valuable learnings and feedback to the SAI Platform (see Chapter 4).

We would like to emphasize that the FFDI farm-level monitoring guidance (V1), as presented in Table 1, is not fixed. The FFDI companies all commit to work on the first five columns (SBTN pressure categories, SBTN pressure indicators, SAI impact areas, outcomes and indicators), but have flexibility in setting companyand/or country-specific metrics and performance range -thresholds and aspirational targets - (last three columns). Ideally, we would also have a single set of metrics and performance ranges, but this is not feasible yet considering real-world differences in e.g. company structures, data availability, and farming systems populations. The metrics and performance ranges published in Table 1 are based on a desktop exercise and should be interpreted as an example for how to set metrics and performance ranges, and as a science-based basis for the company- or country specific translations.

We recognize that this FFDI farm-level monitoring

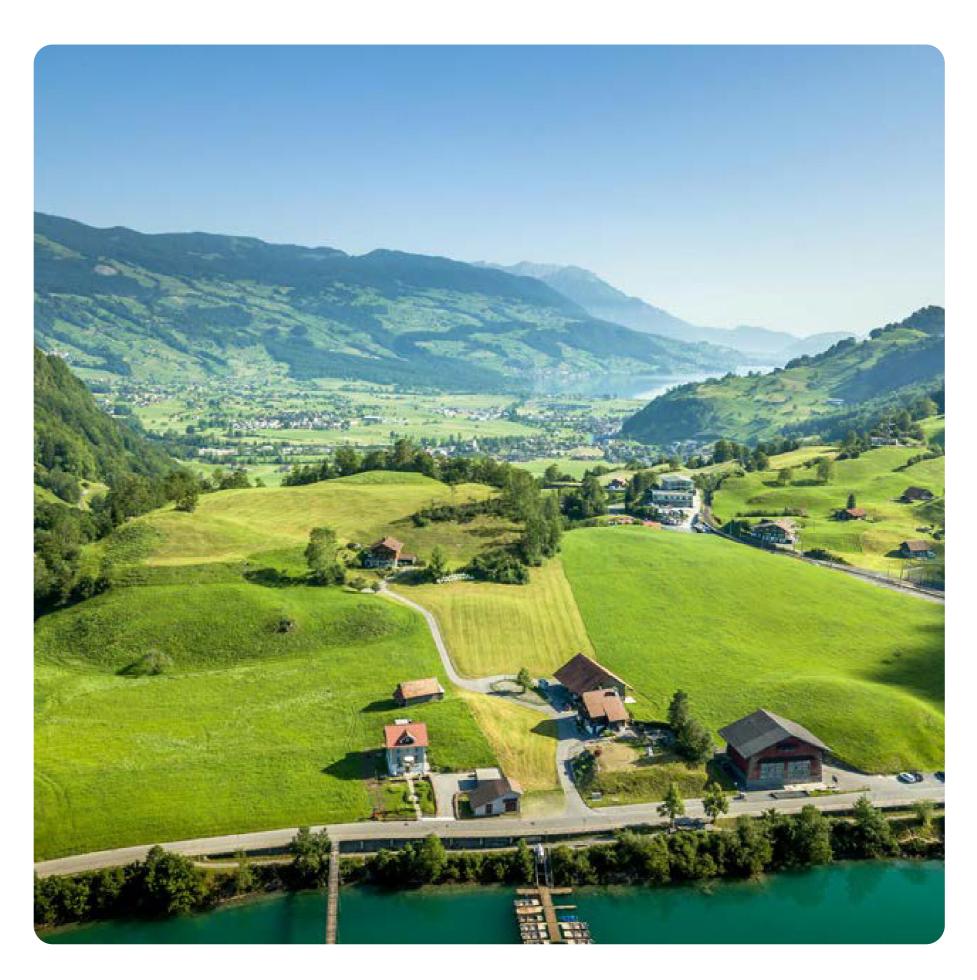


guidance(V1) requires further research and development to become more holistic and robust over time. Additional research is needed to:

- Provide in-depth guidance (e.g. metrics, thresholds, aspirational targets) for some indicators (see 'tbd' in Table 1), which were added to align with the October 2024 version of the SAI Platform RTP framework. This version was released after our research phase.
- Integrate and track continuous alignment with future updates to the SAI Platform RTP framework in 2025 (e.g. outcomes guidance document published on Jan 30, 2025)
- Explore additional themes we mention in Chapter 5 as 'future developments' for a version 2 (e.g. social & economic indicators, phosphorus pollution, peatland management, etc.)
- Further adapt to local specificities (soil types, farm archetypes).

We aim to complete the research in later stages, while publishing this work in progress and beginning to work with farms to transition toward Future Fit Dairy farm models.

The methodology for developing the FFDI farm-level monitoring guidance is described in Chapter 3, including guiding principles for implementation by FFDI companies. Chapter 5 provides more details about each indicator, including the selection of metrics, thresholds and aspirational targets, recommendations for data collection, verification and analysis, as well as recommendations for refining the FFDI farm-level monitoring guidance into a version 2.





**Table 1.** Future Fit Dairy Initiative (FFDI) farm-level monitoring guidance, version 1, February 2025.









SBTN Pressure	SBTN Pressure	SAI Impact	Outcome	Indicator	<b>Metric</b> (Example)	PERFORMANCE RANGE (Example)		
Category	Indicator	Area				Threshold	Aspirational Target	
		Se l	Improve soil health and	Soil organic carbon content	% of total productive farmland under high-SOC regime (reduced tillage, zero tillage, or permanent grassland)	Above company-average % of farmland under high-SOC regime, and max 5% loss of permanent grassland	Either 100% high-SOC regime or 60% permanent grassland, and 0% loss of permanent grassland	
			fertility		Soil Cover	tbd	tbd	
Ecosystem use and use change	Land use and land use change	ere	Improve on-farm biodiversity	On-farm high- biodiversity landscape elements	% high-biodiversity landscape elements (productive or non-productive) of the total farmland area	>10% non-productive high-biodiversity landscape elements	>20% high-biodiversity landscape elements, of which at least 10% non- productive	
	Change		habitat	Cultivated crop and pasture diversity	tbd	tbd	tbd	
		910 <b>(</b>	Reduce land use footprint	Sustainable feed	% protein from 'natural land conversion- free' areas % protein from own farm or local region % protein with low-opportunity cost	All feed either conversion-free or low opportunity cost. Pastures must be conversion-free	All feed low opportunity cost. Pastures must be conversion-free	
Resource exploitation	Water use		Reduce water use	Water use efficiency	tbd	tbd	tbd	
Climate change	GHG emissions	<b>(6)</b>	Reduce GHG emissions	Greenhouse gas emissions	CO <sub>2</sub> -eq total and CO <sub>2</sub> -eq per kg FPCM	No absolute increase in CO <sub>2</sub> -eq & below company average CO <sub>2</sub> -eq/kg FPCM	No absolute increase in CO <sub>2</sub> -eq & convert the company-wide absolute SBTi target to a CO <sub>2</sub> -eq/kg FPCM and apply to all farms	
	Non-GHG air pollution	\$5°0	Improve manure management	Ammonia emissions	kg NH <sub>3</sub> per ha kg NH <sub>3</sub> per animal	National NEC targets converted to NH <sub>3</sub> / animal or NH <sub>3</sub> /ha	Within 500m of protected area: conversion of Nitrogen Critical load to NH <sub>3</sub> per animal/ha. Not within 500m of protected area: country-specific	
Dell'ution	Water pollution			Nitrogen Use Efficiency (NUE)	tbd	tbd	tbd	
Pollution	Soil pollution	pollution		Soil nitrogen balance (SNB)	Kg N per ha KG N per animal	Conversion of 50 mg/L NO <sub>3</sub> or 11.3 mg/L NO <sub>3</sub> -N to regional targets per ha or animal	Conversion of 11.06 mg/NO $_{\rm 3}$ or 2.5 mg/L NO $_{\rm 3}$ -N to regional targets per ha or animal	
				Crop protection impact	tbd	tbd	tbd	



# 03 Methodology

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The FFDI farm-level monitoring guidance is designed around four impact areas: soil, water, biodiversity, and climate. Each impact area has specific desired outcomes. We measure these outcomes using (key performance) indicators, preferably outcome-based but practice-based if necessary. Each indicator has a suggested metric to track progress toward the outcome. For example, the outcome 'improve manure management' is measured with the indicator 'ammonia emissions', using the metric 'kg NH3 emissions per hectare'.

Alongside, we set thresholds and aspirational targets to define the desired performance level and ambition. Thresholds and aspirational targets are in principle determined using scientific evidence related to the safe operating space for dairy production within planetary boundaries. However, as scientific certainty about those 'safe operating spaces' is often lacking, we also use best available knowledge of environmental regulation and experts to set thresholds and aspirational targets.

When implementing the FFDI guidance, dairy farms adopt practices to achieve progress on indicators and reach desired outcomes. These practices are out of the scope of this paper.

In the following sections, we first describe the methodology for selecting outcomes and indicators, and then how the metrics, thresholds and aspirational targets were developed. More details per indicator are available in Chapter 5.

#### 3.1 DEFINITIONS



Scope of the environmental high-level topics which are impacted by farm-level actions on the desired outcomes. Impact areas include soil, water, biodiversity, and climate.



#### Outcome

Statement that reflects the desired farm-level changes over time (e.g. reduce greenhouse gas emissions).



#### **PN** Indicator

Parameter to track farm-level performance regarding the desired outcome (e.g. CO2-eg per unit of production)



#### **P** Metric

Quantitative measure or formula to monitor the indicator performance. Metrics are preferably outcome-based (e.g. CO2-eg/kg FPCM), but can also be proxy- or practice-based (e.g. % of total productive farmland under high SOC-regime).



#### ✓ Threshold

Minimum performance level to prevent the worst environmental degradation and ensure overall progress while being achievable in the short term. From an antitrust standpoint, thresholds should at least align with the most ambitious regulatory requirements from European and/or national governments.



#### Aspirational target

Performance level with optimal ecological outcomes for the respective indicators that farms can strive for. These outcomes usually correlate with regenerative outcomes and can be achieved in the long run.



#### **M** Performance range

designation of the performance between the thresholds and the aspirational targets. This range from the FFDI farm-level monitoring guidance doesn't correlate with the four "performance" levels" from SAI Platform RTP (onboarding, engaging, advancing, leading).



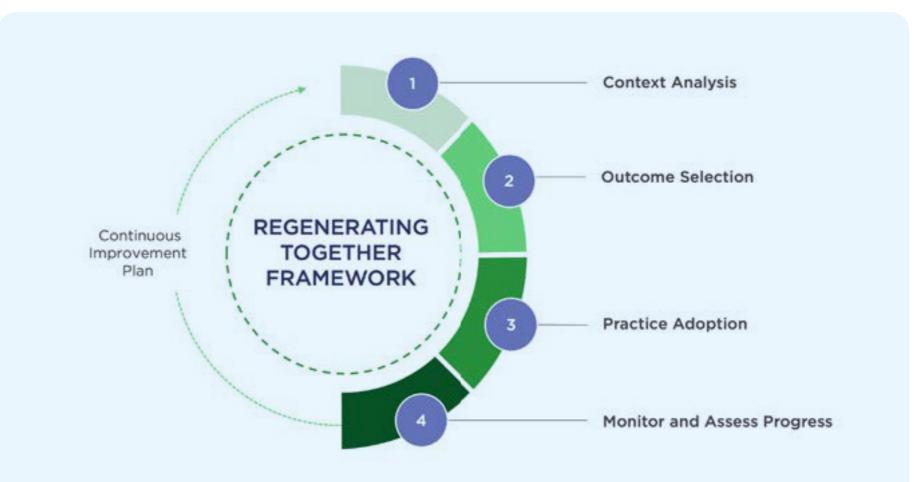
# 3.2 SELECTING THE OUTCOMES AND INDICATORS

# 3.2.1 Applying SAI Platform RTP framework to dairy farms in Northwest Europe

We applied the methods of SAI Platform's RTP framework to select outcomes and indicators for dairy farming in Northwest Europe (A global framework for regenerative agriculture, narrative 1.1, October 2024). This framework uses a four-step process, designed to be globally applicable and adaptable to local conditions (see Figure 1):

- **1. Context analysis:** Identify key material criteria regarding the predominant environment, inherent soils, and production systems.
- **2. Outcome selection**: Prioritize regenerative agriculture outcomes based on the context analysis.
- **3. Practice adoption:** Select appropriate practices to achieve improved performance against the prioritized outcomes.
- **4. Monitor and assess progress:** Develop and action locally applicable continuous improvement plans.

We completed Steps 1 and 2 and describe them here to inform the FFDI farm-level monitoring guidance V1. Steps 3 and 4 are out of scope to this report (Companies, together with farmers, will use Step 3 when applying the guidance in practice, to design farm transition plans; and Step 4 will be done over time to monitor and evaluate progress, as well as to inform the development process for refining the FFDI farm-level monitoring guidance V2).



**Figure 1.** The four step process to implement SAI Platform's Regenerating Together global framework for regenerative agriculture



### 1

#### **Context analysis**

We performed a context analysis to identify the most material environmental and production risks in the dairy farming sector in Northwest Europe. We conducted a high-level risk assessment, scoring 12 material criteria across four impact areas, using pre-

defined evaluation criteria from SAI Platform RTP's methodology for Context Analysis (Table 2).

We conducted this context analysis for dairy farming in Northwest Europe on average, while recognizing significant differences across countries, regions and farm types. The SAI Platform RTP framework recommends analysing the context on a smaller supply shed level, where farms have similar agroecological conditions and production systems, and thus similar risks and desired outcome priorities. Hence, the context analysis should be refined by each company per country/region and farm type, when implementing this FFDI farm-level monitoring within their supply chain.

**Table 2.** Context analysis of dairy farming systems in Northwest Europe, according to the SAI Platform RTP framework (SAI Platform, 2024). The 'risk score' was assessed for dairy farming in Northwest Europe on average, and the 'outcome scores' are pre-defined by the RTP framework. Per outcome, a total outcome/risk score is calculated by multiplying each material risk score with the strength of causal connection to the outcome and then adding up all twelve outcome/risk scores per outcome

Impact area					Outcomes										
Soil	Water	Bio- diversity	Climate	Material criteria	Risk score	Max soil organic carbon	Max soil cover	Optimize available [soil] water holding capacity	Optimize water use	Protect on-farm habitats and ecosystem	Enhance crop and livestock diversity	Max fertilizer use efficiency	Max pesticide use efficiency	Minimize air pollution	Minimize greenhouse gas emissio
				Soil erosion	3	1	2	2	0	0	0	0	0	0	0
				Soil fertility	2	1	1	1	0	0	1	2	0	0	0
				Soil salinity	1	1	0	0	1	0	0	1	0	0	0
				Soil compaction	2	1	2	0	0	0	0	0	0	0	0
				Organic matter management	2	2	1	0	0	0	0	1	0	1	0
				Groundwater depletion	2	1	1	2	2	0	0	0	0	0	0
				Surface water depletion	2	1	1	2	2	0	0	0	0	0	0
				Crop and animal biodiversity loss	3	0	0	0	0	0	2	0	0	0	0
				Land use change	2	0	0	0	0	2	0	0	0	0	0
				Pesticide leaching	2	0	0	0	0	0	1	0	2	0	0
				Nutrient leaching	3	1	0	1	0	0	1	2	0	0	2
				Non-renewable energy use	2	0	0	0	0	0	0	0	0	1	2
				Total outcome/ris	k score:	19	18	19	9	4	13	13	4	4	10
				R	anking:	1	2	1	2	3	2	2	3	3	2

### 2

#### **Outcome selection**

SAI Platform RTP framework lists 10 regenerative agriculture outcomes to report performance against the 12 material criteria and suggests prioritizing action on at least two outcomes across two impact areas with the highest total outcome/risk score.

For the FFDI farm-level monitoring guidance, we decided to cover all four impact areas (soil, water, biodiversity, and climate) as a minimum, and to include all outcomes.

FFDI aims for a dairy farming system that has a positive impact on nature - which requires a holistic approach to monitoring impacts and capturing trade-offs. The interaction between impacts across different areas especially determines the safe operating space for dairy farms to produce dairy while staying within environmental boundaries. A holistic approach is necessary to avoid negative externalities. In addition, focusing on just two impact areas (SAI Platform RTP - onboarding and engaging level) aligns with good farming practices and would rather be considered 'sustainable agriculture' with incremental improvements rather than 'regenerative agriculture'.

Taking inspiration from the FAIRR report (*The four labours of regenerative agriculture, September 2023*) that strongly advocates for at least six impact areas to deliver a credible regenerative approach, we decided to go for an intermediate solution. This is why FFDI includes four impact areas (soil, water, biodiversity, and climate) as the minimum, acknowledging that a future version (V2) of this farm-level monitoring guidance should also include two socio-economic impact areas. More arguments on this approach are detailed in Chapter 4.4 about Feedback to SAI Platform RTP.

# SAI Platform RTP framework - Performance levels

The SAI Platform RTP framework establishes four performance levels (on-boarding, engaging, advancing, and leading) to support and reward farms transitioning to regenerative agriculture (See Figure 2). These levels reflect varying degrees of engagement and progress toward regenerative outcomes while accommodating diverse farming systems globally.

The on-boarding level signals a commitment to transition, requiring a context analysis and the selection of two outcomes across two impact areas, but is not recognised as being engaged yet in the regeneration journey. The engaging level adds quantified baselines, a SMART continuous improvement plan (CIP), and the implementation of at least two practices tailored to the farm's context. Progress over time leads to the advancing level,

which requires outcome quantification and more extensive implementation.

The leading level includes all four environmental impact areas, the adoption of at least four practices, and ongoing improvement relative to farm-specific outcomes. While direct measurement of regenerative outcomes is challenging due to resource demands

and external factors like weather, the framework emphasizes monitoring, learning, and adapting CIPs over time rather than expecting immediate results.

FFDI takes a Leading level regarding Context analysis (done) and Outcome selection (>4 outcomes across 4 impact areas). The other steps (2.2, 3, and 4) are out of scope to this paper.

**Figure 2.** *Regenerating Together performance levels.* 







# 3.2.2 Aligning with SBTN and refining to dairy farms in Northwest Europe

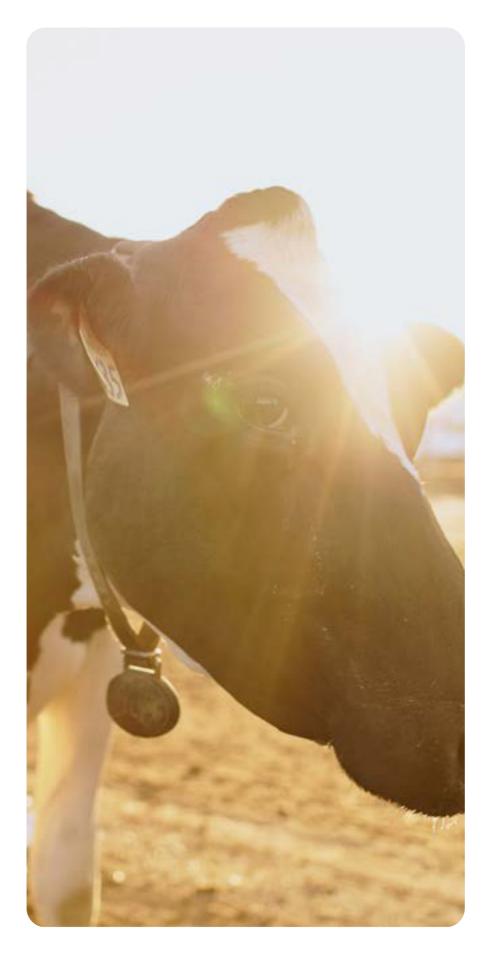
After the application of the SAI Platform RTP methodology, we took extra steps to refine the FFDI farm-level monitoring guidance to the context of dairy farming in Northwest Europe.

Firstly, we aligned the terminology and environmental risk categorization with the Science Based Targets for Nature (SBTN) methodologies (see SBTN Technical guidance Step 1 (Assess) and Step 2 (Prioritize)). This was a relevant step because SBTN is recognized as the science-based global standard for environmental risk assessment. Moreover, most of the companies participating in FFDI are exploring how to use SBTN and as such benefit from aligned language to incorporate FFDI in their nature strategies.

Secondly, we reorganized some outcomes and indicators of SAI Platform RTP to better match the FFDI definitions (see chapter 3.1). For example, SAI includes the two outcomes 'Enhance on-farm habitat provision' and 'Increase cultivated crop and pasture diversity', while in FFDI the second is considered an indicator for the first (next to the Indicator 'On-farm high-biodiversity landscape elements'). Also 'Increase nutrient use efficiency' and 'Optimise crop protection' are listed as SAI outcomes, but FFDI considers them as indicators for the outcome 'Reduce soil and water pollution' (which was included to better align with SBTN). Lastly, the SAI outcome 'Increase water use efficiency' is in FFDI considered an indicator for the outcome 'Reduce water use'.

Third, we excluded several indicators suggested by SAI Platform RTP and added some new indicators to the FFDI farm-level monitoring guidance. We decided to exclude some indicators to remain only with indicators highly relevant for the dairy sector in Northwest Europe, and also to comply with farm data availability & accessibility. For example, data about Water holding capacity of soils is not (yet) routinely measured on farms, while proxies for soil organic carbon content are measured already (e.g. tillage, permanent grassland) and were therefore selected instead. The new indicators were Sustainable feed and Soil nitrogen balance (SNB). Sustainable feed was added because it's a highly relevant topic in the dairy sector due to its relation with land use footprint and nutrient flows, thus can't be ignored in a holistic environmental impact assessment. Soil nitrogen balance (SNB) was added to complement the indicator Nitrogen use efficiency (NUE), because NUE is considered to only partially reduce risks for water and soil pollution (see Chapter 5.7 for more details).

Finally, the FFDI farm-level monitoring guidance extends beyond outcomes and indicators by including metrics, thresholds and aspirational targets, as explained in the next section.





#### 3.3 SELECTING THE METRICS AND PERFORMANCE RANGE (THRESHOLDS & ASPIRATIONAL TARGETS)

After selecting the outcomes and indicators, we matched them with metrics to measure progress and set thresholds & aspirational targets to indicate the performance range. The Future Fit Dairy Initiative considers thresholds and aspirational targets as essential to monitor farm performance progress over time, to clarify the direction of what's 'good enough', and to reward and support dairy farms in their transition towards those outcomes.

We want to emphasize that it's very difficult to select a uniform set of metrics which is relevant for all dairy farm types across Northwest Europe, let alone to set science-based thresholds and aspirational targets with limited scientific evidence available about planetary boundaries of these dairy farming systems. We tried to do this exercise as best we could, but acknowledge that there are knowledge gaps and that the results are not applicable to all farms. Hence, the metrics and performance range - as published in Table 1 - should be interpreted as the results of a desktop exercise, testing this methodology. The results can be used as an example for how to set metrics and performance ranges, and as a well-considered basis for companyor country-specific translations. For more detailed information about decisions made per indicator, see Chapter 5.

#### 3.3.1 Metrics

When selecting the metrics for each indicator, we prioritised outcome-based metrics (e.g. kg NH3

emissions per ha). Where this was not possible or when monitoring technology was still under development, practice- or proxy-based metrics were used (e.g. % of total productive farmland under zero/reduced tillage or permanent grassland - also called 'high-Soil organic carbon regime'). Metric selections also prioritized measurability at the farm level to allow for data collection with enough granularity. The final selection often involved a trade-off between evidence-based causal relationships with desired outcomes and the feasibility of implementation on farm.

# 3.3.2 Performance range: Thresholds and aspirational targets

It is important to emphasize that we don't consider thresholds or aspirational targets as 'regenerative agriculture'. The performance levels do not determine whether a farm is 'regenerative' but instead provide the direction of that regeneration journey in a holistic manner. Thresholds are the minimum performance level to prevent the worst environmental degradation and ensure overall progress while being achievable in the short term. Aspirational targets are the desired performance level with optimal ecological outcomes, which usually correlate with regeneration, and can be achieved in the long run.

We determined thresholds and aspirational targets using scientific evidence related to the safe operating space for dairy production within planetary boundaries.

However, in many cases science-based guidance or indicative literature was lacking. As an alternative, we consulted EU or national policy regulations which are based on science and expert knowledge, and often indirectly already take feasibility and local context into account. To comply with antitrust regulation, thresholds align at least with the most ambitious binding regulatory requirements from European and/ or national governments (when this is available).

When neither science-based guidance nor policy regulations were available, we used expert judgments (a.o. from listed reviewers) to determine thresholds and aspirational targets. As a last resort, when none of the above mentioned methods were sufficient. it's recommended that companies perform a baseline assessment using data from their suppliers/ farms. Analysis of the current performance levels of dairy farms - showing e.g. the performance range, averages, and 'best-in-class' for different farm types - can provide a baseline on which thresholds and aspirational targets can be set for farm improvements. This method has the potential benefit of creating company-, country-, region-, or even farm-typespecific goals, but it should be acknowledged that the resulting thresholds/aspirational targets do not necessarily reflect environmental boundaries ('safe operating space within planetary boundaries') or regenerative agriculture outcomes.

Where relevant, thresholds and aspirational targets should be tailored to soil type, farm type, and/or regional circumstances. This has not yet been done in the current version of the FFDI farm-level monitoring guidance - hence this remains a recommendation for future guidance development.



#### 3.4 GUIDING PRINCIPLE: A SHARED VISION WITH FLEXIBLE IMPLEMENTATION

While companies participating in the Future Fit Dairy Initiative (FFDI) are at different stages in their journey, they are united in their pursuit of the same goal: Develop and translate the SAI Platform RTP framework into applied outcomes and practices relevant to all dairy farming systems, starting in Northwest Europe to inspire scale-up of regenerative dairy globally.

The FFDI farm-level monitoring guidance (V1) serves as a common basis for dairy farming in Northwest Europe, with flexibility in implementation to accommodate varied transition speeds and capacities. We have agreed to the following 5 guiding principles for flexible implementation under a shared vision:

# 3.4.1 - Holistic monitoring of impact areas, outcomes and indicators

We monitor all four impact areas, seven outcomes and ten indicators while allowing flexibility in the selection of metrics, thresholds, and aspirational targets. This holistic approach surpasses SAI's minimum requirement of selecting just two outcomes and ensures a more nuanced understanding of trade-offs.

Holistic monitoring of all impact areas and a diverse set of outcomes and indicators provides better insights per farm into strengths and progresses to be made, while capturing trade-offs, which is an important basis for farmers when developing their improvement plan. Interventions on the farm always involve trade-offs between indicators, as well as costs, time availability, animal health, etc. For example, adopting more extensive grazing management can enhance on-farm biodiversity but may increase greenhouse gas emissions per liter of milk produced. By tracking all impact areas, outcomes and indicators, the effect of interventions on all levels can be monitored and steered.

If resource constraints exist, the companies should monitor at least one outcome per impact area, aligning with the "leading level" of the SAI Platform RTP framework.

# 3.4.2 - Flexible selection of metrics, thresholds, and aspirational targets

We implement the FFDI farm-level monitoring guidance in ways that reflect company- or country-specific farming contexts. This means that each company will set specific, context-appropriate metrics, thresholds and aspirational targets. The metrics and performance ranges shown in Table 1 can be used as an example and well-considered basis for the company- or country- specific translations.

Optimal sustainability strategies vary across regions and farm types. The objective of the FFDI farm-level monitoring guidance is not for all farms to meet targets for every indicator. Instead, farms should strive to meet all thresholds and aim for specific aspirational targets suitable for their farming context, while minimizing trade-offs with other indicators to attain an optimal 'impact profile' for their farm and unique circumstances. This will also allow multiple farm types to make progress on a path to future fit dairy.

Hence, we recommend to aim for tracking performance of all farms on all indicators, and not only for the topics that are 'material risks'. Tracking all indicators will provide useful insights in both things that are already going well on the farm and environmental impacts that require improvement. Each farm will develop its own farm improvement plan, to make trade-offs and select the right interventions to become future fit.



## 3.4.3 - A pragmatic approach to data collection

Recognizing the substantial transition required, both at the farm and company levels, we do not expect FFDI companies to monitor all indicators and metrics from the start. Data availability remains a key barrier for monitoring, making a phased implementation essential. Companies will initially select indicators to start tracking based on the following principles:

- · Availability and accessibility of farm-level data
- · Existing monitoring systems and programs
- Critical sustainability issues within the dairy sector in the given geographical context (e.g., regulatory and societal expectations)

We use a pragmatic approach, leveraging available data to initiate reporting while simultaneously identifying data gaps and planning for expanded data collection. As implementation progresses, learnings will inform future iterations of the guidance - refining indicators, metrics, and performance ranges - through an iterative 'learning by doing' approach.

The table 3 below presents an example of the current variability in monitoring for each of the FFDI dairy companies.

At the start of implementation, companies will:

- Choose relevant metrics aligned with existing monitoring systems.
- Acknowledge that not all indicators will be implemented immediately if corresponding metrics are not yet available.
- Set thresholds and aspirational targets following the approach described in chapter 3.3.2. When science- or policy-based guidance is insufficient or unavailable, company data can be used to set initial baselines.

**Table 3.** Example of current variability in metric indicator selection among FFDI companies.









SAI Impact Area	Outcome	Indicator		Me	tric					
			<b>FFDI</b> (Example)	Arla	Danone	RFC				
(L)	Improve soil health and fertility	Soil organic carbon content	% of total productive farmland under high-SOC regime (reduced tillage, zero tillage,	% grassland	soil cover (tbd)	% permanent grassland				
态		Soil cover	or permanent grassland)							
	Reduce GHG emissions	Greenhouse gas emissions	CO <sub>2</sub> -eq total and CO <sub>2</sub> -eq per kg FPCM	CO <sub>2</sub> -eq per kg FPCM	tbd	CO <sub>2</sub> -eq per kg FPCM				



If a company lacks the required data, it will:

- Use an interim metric with robust thresholds and aspirational targets while developing the necessary data collection capabilities.
- Identify data gaps and determine the steps needed for increased farm-level data capture.

Our guiding principles are summarized in the Table 4 below:

# 3.4.4 - Moving forward: A commitment to progress

Understanding how FFDI companies are implementing farm-level monitoring guidance reinforces the importance of pragmatism - ensuring that progress is made without waiting for perfect conditions. We take an iterative approach - learning and adapting as we implement the FFDI farm-level monitoring guidance. By embracing flexibility in

indicators, metrics, thresholds, and aspirational targets, the FFDI will drive meaningful progress towards a regenerative dairy sector while allowing for continuous refinement and improvement.

**Table 4.** A shared vision with flexible implementation.

	SBTN Pressure	SAI Impact	Outcome	Indicator	Metric (Example)	PERFORMANCE RA	NGE (Example)
Category	Indicator	Area			(Example)	Threshold	Aspirational target

#### HOLISTIC MONITORING OF 4 IMPACT AREAS, 7 OUTCOMES AND 10 INDICATORS

# FLEXIBLE SELECTION OF METRICS, THRESHOLDS AND ASPIRATIONAL TARGETS

- Choose relevant metrics aligned with existing monitoring systems.
- Acknowledge that not all indicators will be implemented immediately if corresponding metrics are not yet available.
- Set thresholds and aspirational targets following the approach described in chapter 3.3.2. When science or policy-based guidance is insufficient or unavailable, company data can be used to set initial baselines.



# Requirements for progressing regenerative frameworks for dairy

When applying the SAI Platform RTP framework to design the FFDI farm-level monitoring guidance, we learned a lot about the methodology's applicability. We summarized four key points of feedback below for SAI Platform to refine their methods. The justification and rationale behind such feedback are described in Chapters 3.2 and 3.3:

- 4.1 alignment with SBTN,
- 4.2 the selection of indicators, metrics, and performance range (thresholds and aspirational targets),
- 4.3 terminology, and
- 4.4 the holistic impact across minimum 4 impact areas.

Note: We gathered this feedback before the release of the new SAI Platform RTP Guidance documents on Jan 30th (which now includes a document on outcomes measurement). The FFDI members can provide further comments on this new guidance to assess if it resolves the identified gaps.

#### **4.1 ALIGNMENT WITH SBTN**

The Context Analysis (step 1) incorporates many elements of the Science-Based Targets Network (SBTN) guidelines for the materiality assessment (Step 1: assess) to identify environmental risks and select material outcomes. We recommend aligning the SAI Platform RTP methodology with SBTN guidelines and clearly defining how they correspond to step 1. (See chapter 3.2.2 to understand how the FFDI performed this step).

#### 4.2 SELECTING INDICATORS, METRICS, AND PERFORMANCE RANGE (THRESHOLDS & ASPIRATIONAL TARGETS)

When proceeding with the Outcome Selection (step 2), we noticed at least three additional steps that the SAI Platform RTP framework should provide guidance on:

- Guidance on the translation of outcomes into indicators based on context analysis. (See chapter 3.2 to understand how the FFDI performed this step)
- Guidance on the selection of metrics per indicator by addressing factors like data availability and outlining requirements for establishing causality. (See chapter 3.3 and 3.4 to understand how the FFDI performed this step).
- Guidance on defining the foundation for performance range and translating it into specific thresholds. As described in Chapter 3.3, we think it is crucial to set thresholds and aspirational targets as a solid tool to challenge incremental progress, accelerate impact, give a direction, define what's "good enough" and reward and support accordingly. FAIRR also highlighted this gap in its report *The four labours of regenerative agriculture Sept. 2023*): "Today, only 16% of companies who mention regenerative agriculture discuss metrics and data, [and] FAIRR urges investors to finance preferably companies with quantifiable targets, robust metrics, and progress tracking".



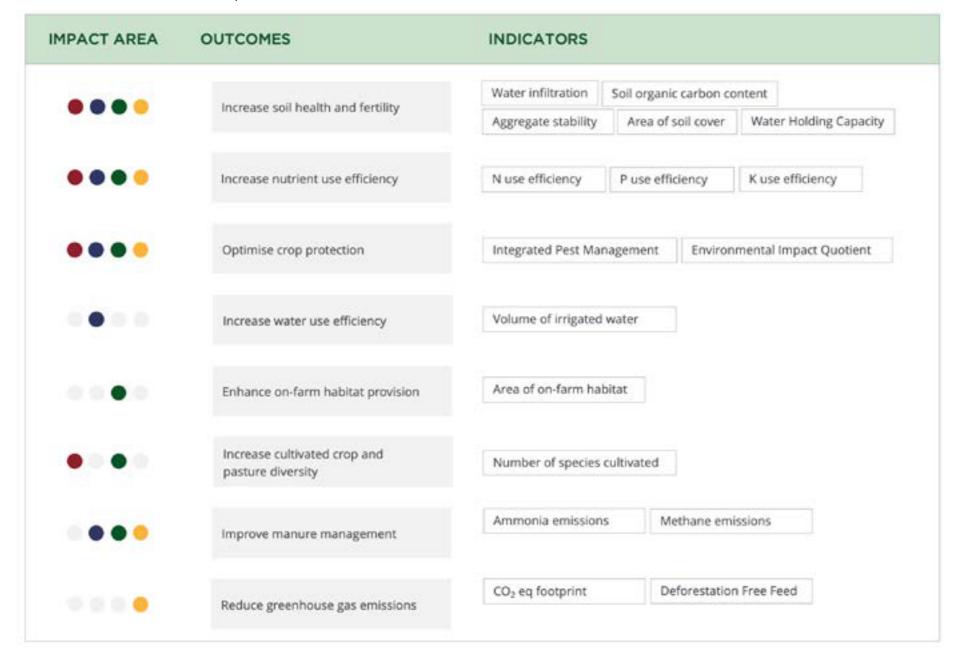
#### 4.3 TERMINOLOGY

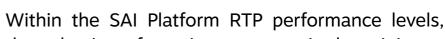
Within the SAI Platform RTP framework, our feedback is that the terminology is not consistent. Especially the use of 'outcomes' and 'indicators' is confusing.

In our opinion, some outcomes are rather indicators, such as 'nutrient use efficiency' (indicator for the outcome 'reduce water and soil pollution).

#### 4.4 HOLISTIC IMPACT ACROSS

**Table 5.** SAI Platform RTP - Impact area, outcomes, and indicators list





MINIMUM FOUR IMPACT AREAS

the selection of two impact areas is the minimum required for the 'engaging level' (already considered in the regenerative path), and the highest leading level includes all four impact areas.

Toensureaholisticimpact, FFDIfarm-levelmonitoring guidance strongly advocates for selecting outcomes across all four impact areas (soil, water, biodiversity, climate). This safeguards a holistic approach for monitoring impacts while capturing trade-offs. This decision, bringing a fundamentally different view from SAI Platform RTP, is based on a number of reasons:

· Holistic approach on regenerative agriculture is necessary to avoid negative externalities (including soil, water, biodiversity, climate) Focusing on farm-level soil carbon, for instance, may lead farmers to increase the use of chemical fertilizers to accelerate plant and root growth. Studies indicate that one tonne of nitrogen needs to be added for every 12 tonnes of carbon sequestered. This is usually done through synthetic fertilizers which significantly impact climate and biodiversity. An increase in nitrogen application could lead to higher emissions of nitrous oxide, a potent greenhouse gas, and become detrimental to surface and groundwater quality and biodiversity through the loss of nutrients to the environment. Another example is the adoption of low- or notill practices, which are a popular regenerative agriculture strategy for soil health and soil carbon. However, practising no till could lead to increased growth of weeds, which in turn could increase



pesticide use, posing a risk to biodiversity. These examples show that without consideration of other climate, biodiversity and social outcomes, a narrow focus on soil health and soil carbon (the two most popular outcomes cited in company disclosures) could cancel out the benefits of implementing a regenerative practice and lead to negative externalities. This is why FFDI considered the four impact areas (soil, water, biodiversity, and climate) as the minimum, acknowledging that a farm-level monitoring guidance version 2 should also include socio-economic impacts.

- Focusing on just two impact areas (SAI Platform RTP onboarding and engaging levels) follows good farming practices but does not align with regenerative agriculture. For example, if only two areas were selected, e.g. Climate and Water, a farm could be claiming to be on a regenerative path (SAI Platform RTP onboarding level) only by reducing emissions from the barn and improving its irrigation efficiency. Yet, without addressing soils and biodiversity, it fails to build long-term environmental and economic resilience and regeneration cannot be achieved without working on soils and biodiversity. Two impact areas could only be considered sustainable agriculture with incremental improvements.
- To define a holistic approach in terms of minimum impact areas and outcomes, we recommend taking inspiration from FAIRR report (The four labours of regenerative agriculture Sept. 2023), that strongly advocates for at least 6 impact areas to deliver a credible regenerative approach. The impact areas highlighted by FAIRR are in the Table 6 below (carbon, soil health, biodiversity, water, socio-economic factors and reduced inputs).

FAIRR also notes that "fewer than a quarter of companies that discuss regenerative agriculture in their public reporting comprehensively cover the six key [impact areas] most commonly associated with regenerative agriculture. Companies need to be clear and transparent when communicating

their regenerative strategies and be inclusive of climate, nature, and social [impact areas] to avoid a siloed approach and negative externalities."

**Table 6.** FAIRR- The Four labor of regenerative agriculture - six key [impact areas] most commonly cited in company disclosures

Outcome	Definition
Carbon reduction, removals and sequestration	Carbon reductions and removals <sup>v</sup> including sequestration or other means of achieving a net decrease in carbon emissions through regenerative agriculture
Improved soil health	Improvements to soil health through regenerative agriculture
Biodiversity improvements	Improvements to biodiversity through regenerative agriculture, such as enhancing wildlife habitats, connectivity and increasing the species of fauna and flora on and around farms
 Water quality, filtration and cycle improvements	Improvements to water availability, retention, quality, or cycling through regenerative agriculture. Also includes water bodies beyond the farm impacted by agricultural practices
Improved farmer income and/or costs, yields, livelihoods and other economic factors	Improvements to farmer livelihoods through regenerative agriculture, such as increasing yields and productivity, reducing costs, diversifying revenue and other economic factors
Reduced use of agrochemical inputs	Reducing inputs such as pesticides or fertilisers through regenerative agriculture

Source: FAIRR 2023



# FFDI Indicators: Deep dive

5.1 Soil organic carbon content	25
On-Farm high-biodiversity landscape elements	29
Cultivated crop and pasture diversity	32
5.4 Sustainable Feed	33
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5.7 Soil nitrogen balance	41

This chapter provides a 'deep dive' into the selection of metrics, thresholds and aspirational targets. For six indicators, we conducted in-depth research to find a quantitative measure or formula to monitor the indicator performance (metric) and to set a performance range to highlight desired environmental outcomes on dairy farms (thresholds & aspirational targets).

We based the indicator deep dives on a desktop exercise and providing an example of how to set metrics and performance ranges. Companies have flexibility to set company- and/or country-specific metrics and performance ranges, and can use the argumentation described below as a basis for their context-specific translations.

The six indicators highlighted in this deep dive chapter are:

- Soil organic carbon content
- On-farm high-biodiversity landscape elements

- Sustainable feed
- Greenhouse gas emissions
- Ammonia emissions
- Soil nitrogen balance

The other three indicators (Water use efficiency, Nitrogen use efficiency, and Crop protection impact) are not researched in-depth and therefore not included in this chapter. The indicator "Cultivated crop and pasture diversity" was also not covered through research, but a small chapter is included here to capture some initial ideas. Hence, information about the metrics and performance range for these indicators is missing from the summary table about this FFDI farm-level monitoring guidance (see 'tbd' in Table 1, Chapter 2). However, they are listed in the summary table to reflect the latest version of SAI Platform RTF Framework (October 2024) and as a reminder for further research.







#### Metric

Improving soil health and fertility is a key outcome according to the SAI Platform RTP framework, and Soil organic carbon (SOC) was selected as the key performance indicator to start monitoring soils for now.

Monitoring SOC content is most accurate using direct metrics such as Total organic carbon (TOC) or Soil organic matter (SOM) per hectare. However, the FFDI companies currently don't measure SOC in such manners, because it's resource-intensive, subject to long temporal scales and not easy to execute and scale. Moreover, SOC levels are highly spatially variable and there will be large differences between farms that will not only reflect their (changes in) management.

Instead, companies currently use different metrics which are proxies for soil organic carbon content. Particularly no-tillage (% untilled cultivated land), minimum tillage (<15cm tillage), and permanent grassland (% of grassland) - which implies no-or minimum tillage of grasslands for <5 years. To harmonize these different metrics, for both arable land and grassland, we defined a "high-SOC regime" definition, encompassing a set of management regimes that are proven to improve

and maintain high SOC. Using this broad definition, farms can achieve the thresholds and aspirational targets depending on their cropland-grassland proportions.

Alongside, soil cover is included as an alternative metric to monitor SOC content in case tillage regimes and permanent grassland are not monitored. For soil cover, the future development of V2 should include a stronger definition of the metric, and develop the thresholds and aspirational targets.

For the High-SOC regime, the proposed metric is '% of total productive farmland under a high-SOC regime'. High-SOC regime is defined here by the three following options, leaving the possibility of being under one OR the other depending on arable land or grassland:

- Reduced tillage (<15 cm, 20-30% plant material residues left on the surface)
- **Zero tillage** (0 or <5 cm, >30% plant material residues left on the surface)
- Permanent grassland (% permanent grassland of total grassland area)

The definition remains flexible, allowing companies to use either component or other proxies to measure soil organic carbon contents.

#### **DEFINITIONS**

#### Reduced tillage

The European Journal of Soil Science conducted a study that quantified through meta-analyses the effects of reducing tillage intensity on the density and diversity of soil micro- and mesofauna communities, and therefore the effect on soil health (Betancur-Corredor et al., 2022). They also studied how these effects vary among different pedoclimatic conditions and interact with concurrent management practices. The results showed that reduced tillage up to 15 cm has a medium to low effect on soil biodiversity, and still presents 15-30% of the residue of plant material left on the soil surface. Based on this study, and on existing internal guidelines put in place by some of the consortium members, we decided to use a definition of reduced tillage as no plowing or soil loosening, maximum soil disturbance depth at 15 cm, with 20% to 30% of residues of plant material left on the soil surface.

#### **Zero-tillage**

The same study by the European Journal of Soil Science defines the practice of no-tillage or zero tillage as soil disturbance up to 5 cm depth, with

more than 30% of residues of plant material left on the soil surface (Betancur- Corredor et al., 2022). This should have zero to minimal soil disturbance effect and consequently keep soil structures and biodiversity intact. To reach such an outcome, this definition leaves the freedom to the farmer with arable land to use practices such as direct sowing, undisturbed meadow, permanent green cover, etc.

#### Permanent grassland

The definition of permanent grassland here aligns with the EU definition (European Commission, 2009): "Land used permanently (for 5 years or more) to grow herbaceous forage crops, through cultivation (sown) or naturally (self-seeded), and that is not included in the crop rotation on the holding. The land can be used for grazing, mowing for silage or hay, or used for renewable energy production." Hence, the key practice defining permanent grassland is the lack of tillage for more than 5 years. Natural (self-seeded) permanent grasslands provide more ecosystem services and SOC storage compared to cultivated (sown) permanent grasslands (Lindborg et al., 2023).



#### Threshold and aspirational target



**Threshold:** Above company-average % of productive farmland under a high-SOC regime, and max 5% loss of permanent grassland.



**Aspirational target:** Either 100% high-SOC regime or 60% permanent grassland, and 0% loss of permanent grassland.

Regarding tillage regimes on Northwest European dairy farms, science-based guidance as well as laws and regulations are lacking. Therefore, we recommend using a mix of expert judgement to set the aspirational target and company-baselining to benchmark the threshold.

Regarding permanent grassland, European regulation provides guidance. The distinction between 0% (aspirational target) versus 5% (threshold) loss of permanent grassland, is important to explain. The protection of permanent grasslands in Europe has now been prioritized in the EU Common Agricultural Policy (CAP). The EU CAP Standard of Good Environmental and Agricultural Condition (GAEC) regarding climate change (#1) provides a general safeguard against any conversion of permanent grassland to other agricultural uses. This regulation provides flexibility to convert a max. of 5% of permanent grasslands compared to the reference year 2018 and flexibility for Member States to set national, regional, subregional, or holding levels (European Commission, 2022). The rationale behind the 5% flexibility is that some pasture-dominated areas might benefit from some conversion to arable to diversify the landscape. To align with current regulations



in the EU, the threshold for permanent grassland is set on max 5% loss. However, science is clear about the need for permanent grassland protection in Europe (BirdLife Europe and European Environmental Bureau, 2022). From an ecological perspective (Schils et al., 2022), and in line with international protocols on zero conversion (e.g. SBTi FLAG), the loss should be 0%. Therefore, the aspirational target suggested here is to strive for 0% loss of permanent grasslands.

Regarding the 60% permanent grassland aspirational target, we acknowledge that it should actually differ across regions as well as soil types. A study by Van Doorn et al. (2019) suggested soil-type specific permanent grassland aspirational targets for dairy in the Netherlands: 85%-100% for sand and clay soils, and 100% for peat soils. They also suggested soil typespecific thresholds: 60% for sand, 75% for clay, and 80% for peat. Van Eekeren et al. (2008) suggested a general aspirational target of 60% permanent grassland, combined with 20% temporary grassland and 20% arable land. Here, we suggest to use the 60% aspirational target for the first version of this FFDI farm-level monitoring guidance, and develop more refined soil-type specific aspirational targets in future versions of the farm-level guidance.



# Data collection, verification, and analysis

For permanent grassland, farms only need to report on area of total grassland including the split between temporary and permanent grassland. Regarding the SOC regime, farmers will have to report more information on their soil management practices which will require support for data collection and onboarding around specific definitions of the different practices.



#### **Future development**

- Replace the 'above company average' threshold by a more robust number reflecting national or regional averages. Seek to use national or local statistics from e.g. universities or governments
- As part of the SOC indicator, further define the proxy metric "Soil cover" and recommend associated threshold & aspirational target.
- Broaden the monitoring to other farm practices that are pre-conditions to increase SOC, particularly water table management in peat soils and permanent grassland management (e.g. exclude permanent grasslands which are intensively grazed and/or sown and favor permanent grasslands which are extensively grazing and/or self-seeded/natural multi-species grasslands).
- Reward older permanent grasslands incrementally, so not a minimum 5 years no tillage rule, but rather a 10, 15, 20 years progressive reward. The same can account for other high-SOC regimes, where longer limited soil disturbance is rewarded with exponential increases of incentives.





#### Research background - Some notes about grassland management

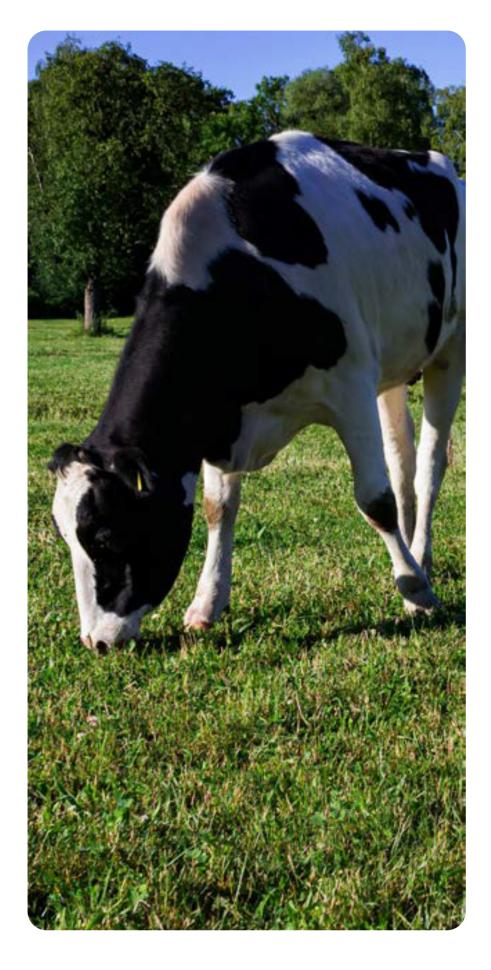
It should be noted that the older the grassland, the better for soil organic carbon as well as soil organic matter, soil water holding capacity, soil biodiversity, and above-ground biodiversity (Guillaume et al., 2021; van Eekeren et al., 2008). Even though the definition of permanent grassland is set at a 'minimum 5 years lack of tillage', it should be avoided to e.g. till & re-sow grasslands every 5 or 6 years, to avoid loss of benefits build-up over those past years. The build-up of benefits continues over 10, 15, 20 years. The lack of tillage allows the soil ecosystem to stay intact and grow an abundance of soil organisms, organic matter, organic carbon, above-ground organisms, and so on over time. The benefits can continue growing for decades (van Eekeren et al., 2008). Unfortunately, permanent grasslands in Europe have declined severely over the past decades, now covering about 34% of the EU agricultural area (Schils et al., 2022).

Next to the general definition of permanent grassland regarding grassland age, countries might have additional conditionality requirements. For example in the Netherlands, the permanent grassland should be mown a minimum of once per year and before October first. It is suggested that companies add such conditionalities to specific countries when relevant, in order to align with national and EU requirements for subsidies.

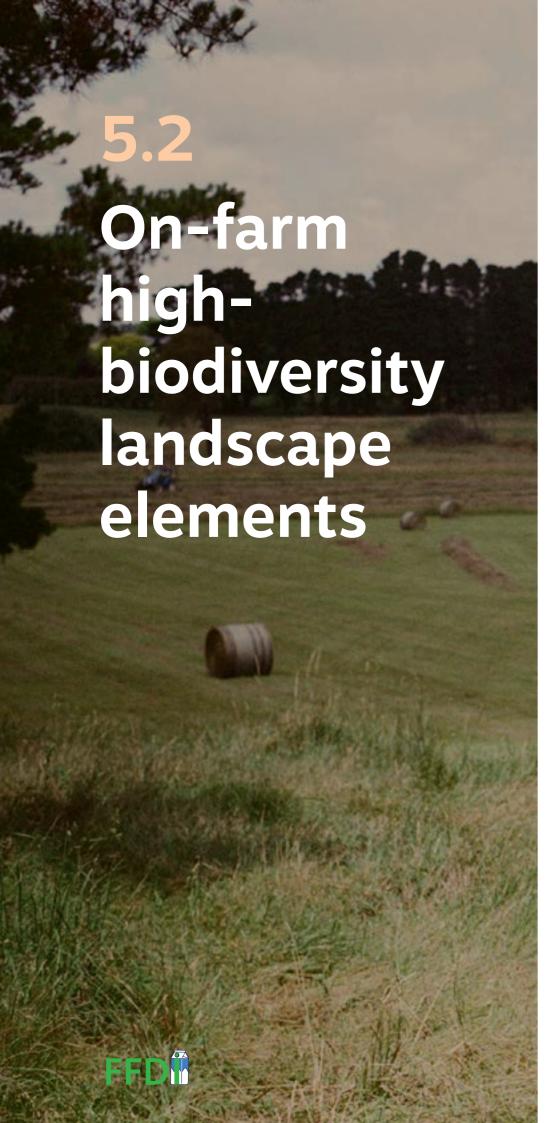
The effect on soil organic carbon also depends on grassland management style and soil type. Extensive grassland management (high grass and herb species diversity, little to no use of fertilizers and agrochemicals; also called herb-rich or seminatural grasslands) has a more positive effect on SOC than intensive grassland management (low species diversity, conventional application of fertilizers and agrochemicals).

Peat soils require specific grassland management to positively impact soil organic carbon. As heavily drained peat soils may have a net loss of carbon, increasing water tables in grasslands on peat soils is essential to maximize SOC (this is relevant for certain areas in the Netherlands, Germany, and the UK). It is recommended to consider soil typespecific grassland management conditions when further developing this FFDI farm-level monitoring quidance.

Once grassland is considered 'permanent', it's not allowed to be converted (EU CAP regulation) and thus becomes unavailable for arable crop production. It should be considered that from a nature-impact perspective, ideally dairy cows are fed with grass and other low-opportunity cost feed (not competing with human food) as much as possible. These conditions are covered in section 5.4 about Sustainable feed.









#### Metric

On-farm natural habitats and ecosystems provide shelter, feed and breeding ground for wild species (plants, animals, fungi, etc.). As biodiversity in Europe's agricultural landscape is severely under pressure, these spaces are crucial for biodiversity conservation and restoration. Especially mosaic landscapes designed and coordinated by a region of farms / land owners can function as biodiversity corridors and allow for connectivity between protected areas of larger conservation value. In contrast, intensive agricultural landscapes often lack connectivity for species, creating isolated habitats that are too small to support viable populations in the long term.

There is a strong synergy with SOC and carbon sequestration as soils and plant populations in these habitats are left undisturbed. Moreover, landscape diversity can increase the resilience of agricultural production areas through e.g. natural pest suppression and climate change adaptation.

The metric % of high-biodiversity landscape elements (productive or non-productive) as a share of the total agricultural area is proposed here. This regards landscape elements with high-

biodiversity value - in other words with benefits for wild organisms to settle, feed and breed. It may include both productive and non-productive areas at the farm property. Non-productive areas regard land permanently set aside from agricultural production, such as hedgerows, buffer strips, non-productive trees, wetlands, and ponds. Productive areas with high-biodiversity value are usually more extensively managed to provide habitat for specific species while remaining (lower rates of) agricultural production. On dairy farms, this mainly regards extensive herb-rich permanent grasslands, which can be used for grazing or mowing while providing habitat for multiple plant species, soil organisms, insects and meadow birds.

Next to the abundance of natural habitat, other highly relevant factors for conservation and restoration effectiveness are the (location-specific) type of natural landscape elements and the orientation of those in the landscape. Especially connectivity of natural habitat is essential for enabling migration, interbreeding and resilience of populations. For simplicity, we exclude these factors for now but recommend including them in future refinements of the FFDI farm-level monitoring guidance.



#### Threshold and aspirational target



**Threshold:** >10% non-productive high-biodiversity landscape elements.



**Aspirational target:** >20% high biodiversity landscape elements, of which at least 10% non-productive.

Although there is consensus on the need to increase natural habitat in European agricultural landscapes to conserve and restore biodiversity, conclusions differ about the amount of natural habitat required. Estimates range from 26%- 33% at landscape level, 10%-14% of agricultural area, and >10% of every farm (BIOGEA, 2020; Langhammer et al., 2017; Pe'er et al., 2014; Traba & Morales, 2019; Walker et al., 2018).

The EU Biodiversity Strategy aims to ensure at least 10% of the EU agricultural area under high-diversity landscape features by 2030 (European Commission, 2021). Also nature organizations advocate for a dedication of at least 10% non-productive areas and landscape features under conditionality on every farm in Europe (BirdLife International, 2020; WWF et al., 2021). All agree that these areas should have non-production purposes and include landscape features such as hedgerows, buffer strips, fallow land, non-productive trees, wetlands and ponds. Hence, we suggest to set the threshold at 10% high-biodiversity non-productive area of total agricultural area.

Next to non-productive areas, semi-natural productive areas can also have value for biodiversity. For example, extensively managed grasslands are essential for the conservation and restoration of typical Northwest European meadow bird populations. Hence for the aspirational target, we suggest to aim for a larger share of high-biodiversity areas to meet scientific advice and international agreements, where productive areas can also be taken into account. The EU is committed to the Kunming- Montreal Global Biodiversity Framework to protect 30% of its territory by 2030, of which 10% strictly protected area. As agricultural land is normally categorized as non-strictly protected area, it makes sense to contribute to the global targets with a fair share of 20% agricultural land dedicated to conserve, protect and restore biodiversity. We acknowledge that there are trade-offs between agricultural land primarily used for productivity versus multifunctionality including conservation-purpose. The inclusion of high-biodiversity landscape elements within agricultural production landscapes can actually boost yields, whereas the optimal boost lays around 20% natural habitat share. Also considering other ecosystem services, the 20% share is considered as a minimal amount to effectively support the provision of nature contributions to people at a landscape level (Brauman et al., 2020).

As scientific estimates also suggest a total landscape share of about 26%-33% high-biodiversity landscape elements, we propose to set the aspirational target at 20%. We recommend that this 20% includes at least 10% high-biodiversity non-productive areas (which is the threshold) and the other 10% may also include high-biodiversity productive areas.







# Data collection, verification, and analysis

We recommended investing in the development of automated data collection approaches using satellite image and remote sensing. In the short term, companies could select metrics they already capture which are already considered as a high biodiversity landscape element (f.e % extensive permanent grassland). When using satellite data however, it remains important to have farm managers or field technicians perform reality check to ground truth the data. Involving governmental bodies is also relevant in that topic to facilitate the connection between data and landscape.

The types of relevant landscape features and conditionality likely differs across participating countries/regions. While the initial list of high-biodiversity landscape elements can be generic, we suggest developing more location-specific lists where relevant. These can potentially also include conditionalities regarding e.g. management, spacing/location on the farm, combination with other landscape features, and connectivity. These lists are ideally matching EU agri-environmental schemes and are defined in collaboration with local experts.

The list of landscape features and conditionalities can

be complemented with a weighting or a % scoring system, which compares different landscape features relative to their ecological value. The advantage is that it may stimulate the use of features with high-ecological value, rather than large areas of low-value features which are maybe easier to implement. Such a percentage system could be developed in the future, under the condition that the importance of certain elements can never be >1 as that can create skewed outcomes.

For farms closer to preserved nature areas



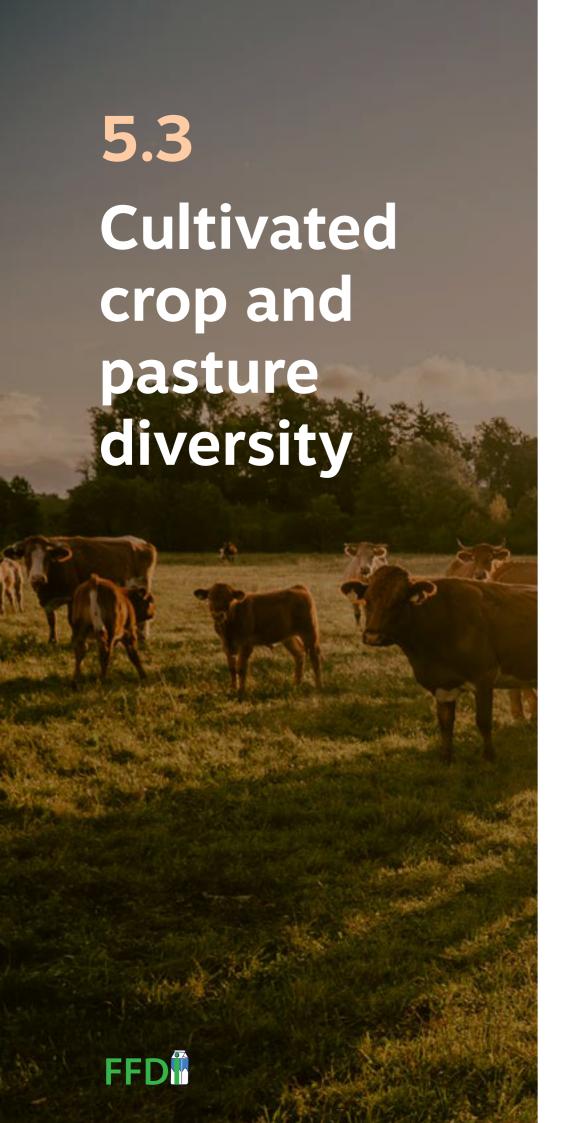
#### **Future development**

(Natura2000), or key connectivity areas and corridors, we could consider setting higher thresholds and aspirational targets. The reasons that justify this differentiation is that the proximity to a high-biodiversity cluster will enhance the efficiency of any hectare of natural habitat, and hence should be prioritized as a biodiversity buffer.

 Another development for the future would be to measure the actual effectiveness of preserved hectares, rather than focusing on the size of it. This would reflect into indicators of species diversity

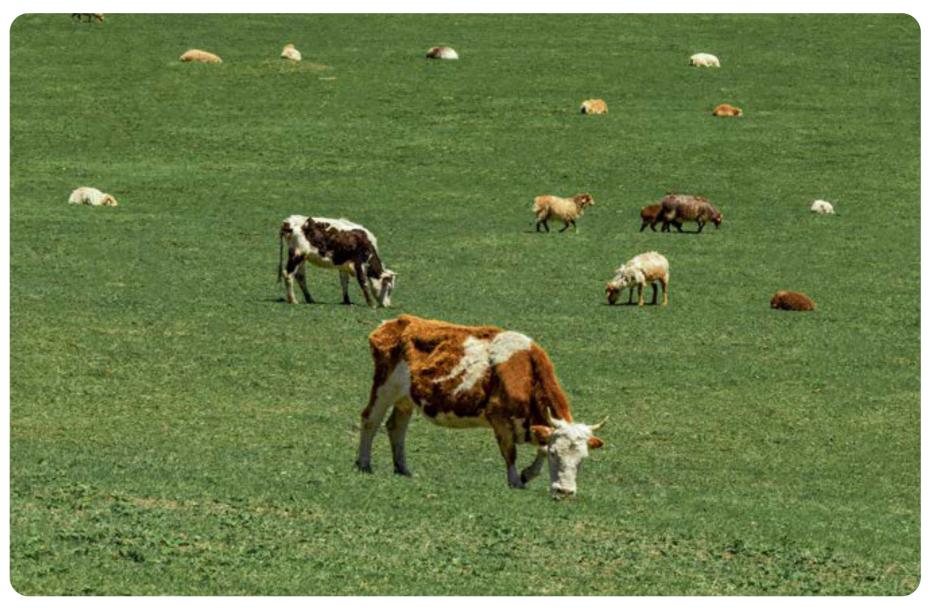
- and abundance, or could extend the monitoring to practices that are a proxy for it such as herb-rich grassland and crop diversification (e.g. number of species in a rotation).
- Include conditionality for location-specific types of high-biodiversity landscape elements and the orientation of those in the landscape, especially regarding connectivity with habitat on other nearby farms and nature areas in the region.
- Consider a more refined differentiation between biodiversity areas such as (1) cultivated area, dominated by a sown crop, (2) (semi)natural land with low conservation value, (3) (semi)natural land with moderate conservation value and (4) (semi) natural land with high conservation value. You could increase the importance if the area is near nature reserves or in a corridor. You can set different aspirational targets for each category, e.g. % of area left uncultivated for wild plant species to colonise and serve as potential habitat for other species. You could also have habitat-specific aspirational targets, such as water table increase for fens, and extensive grazing for natural grasslands.
- The primary aspirational target should be not to lose any habitat which is already there. So incentive conservation over restoration.





Although we didn't perform any deep-dive research for this indicator, we list here some initial metric ideas to monitor cultivated crop and pasture diversity:

- Multi-species or herb-rich grassland (% of total grassland)
- Crop species and cultivar diversity (cultivated in a rotation)
- Livestock species and breed diversity (addition to SAI Platform RTP, which doesn't mention livestock diversity)



# 5.4 Sustainable Feed



This topic is not part of the SAI Platform RTP framework but was added and prioritized by FFDI due to its relevance for the dairy sector. This highlights that SAI Platform RTP outcomes should better consider the overall footprint of farms beyond their own land (aligned with SBTN), because things like imported feed have impact on land use and ecosystems health elsewhere.

Dairyfarming's environmental footprint and biodiversity loss largely occur before the cow's life and extend beyond the farm, particularly during feed production. Some of these impacts are more preventable than others. The type and origin of the feed alone already have a major impact on its environmental impacts, but so far these are invisible to farmers, causing an unrealistic expectation for action. By quantifying and visualizing these impacts and highlighting room for improvements, farmers are incentivized and empowered to make more environmentally friendly decisions.



#### Metric

Here we focus on three unsustainable facets of feed production in which big improvements can be made within the farmer's sphere of influence: **natural land conversion-free feed, self-produced or local feed**, and low opportunity-cost feed. All indicators are measured in % **of protein intake**, as it avoids unequal emphasis on feeds with low nutritional value. In this guidance, all components of an animal's diet fall under the category of 'feed', including grazed grass.

## Natural land conversion-free feed (% protein intake)

Impacts of feed production can make up most of the total climate and biodiversity impact of a dairy product, largely due to its associated land-use and land-use change. In combination with the increasing demand for dairy products, this results in dairy supply chains having a high risk of driving natural land conversion, both due to pastures and feed crop expansion. When cows are not grass-fed, many of these impacts are also 'invisible', outsourced to areas with less regulations. However, since feed types and production locations differ strongly in their land use (change) footprint, big improvements can be made by changing feed types, suppliers or engaging with suppliers themselves. While deforestation-free feed is becoming more mainstream (and obligatory by law in EU for certain imported commodities, such as soy), SBTN (Science Based Targets Network) prescribes conversion-free feed from all natural ecosystems types - so not only forests but also natural grasslands, wetlands, etc. Hence, natural land conversion-free feed is included as an indicator for sustainable feed.

Generally, farms and companies do not have primary information on whether and how much natural land transformation is associated with their operations. Antideforestation certifications and laws have increasingly ensured no-deforestation associated with high-impact commodities such as soy and palm oil. However, landuse change is not a single crop- or ecosystem-issue. Because of this, suitable methodologies for mapping and assessing all kinds of natural land conversion are growing. Complying with SBTN and SBTi methodologies, a commodity is associated with land conversion if it is grown on land that has been converted from natural to agricultural land since a cut-off date no later than 2020.

# Self-produced or local feed (% protein intake)

High use of imported feed is related to local nitrogen pollution, as the nitrogen accumulates through deposition of excreta in an area much smaller than where they were produced. When feed, animals and manure are in proximity, for example by exchanging feed from arable farms for manure from dairy farms, or preferably even exchanging feed and manure between fields within one farm, it becomes easier to close nutrient cycles and can reduce risks for local nitrogen pollution. Moreover, transport-related pollution is also reduced.

Feed produced on the same farm as where the animals live creates many options to close nutrient cycles on a small scale. Many dairy farmers already do this, by keeping several fields for feed crop production (e.g. maize) and others as grassland for grazing and mowing. This enhances autonomy and circularity with the feed produced for dairy cows, and the manure used as fertilizer in crop/feed production. On top of this, self-produced feed also brings multiple socioeconomic benefits with more control on costs. As the agriculture market is undergoing significant shifts, impacting feed costs and dairy profitability, farmers are required to adapt to evolving conditions. Between 2019 and 2024, milk production costs rose by an average of 14% across the top eight dairyproducing regions (California, the Upper Midwest, Argentina, Australia, China, Ireland, New Zealand, and the Netherlands), according to a recent survey by RaboResearch (2025). Over 70% of this increase occurred after 2021 due to rising feed and fertilizer costs, transportation expenses, the Russia-Ukraine war, weather patterns, global trade disruptions, labor

shortages, and higher interest rates. Feed costs, the primary driver of these increases, surged by 19% during this period. Given these challenges, gaining more control over feed expenses has become a crucial strategy for dairy farmers to maintain profitability, as fluctuations in grain and soybean meal prices continue to shape the industry's economic landscape.

Local feed production also increases the degree of transparency, making it easier for farmers and processors to identify and use local waste streams, showing a synergy with the other two feed sustainability aspects. It will be much easier to identify waste streams, achieve traceability and ensure land conversion-free feed when the latter is locally sourced. Because of this we see provisioning local feed as an enabler for sustainable feed, rather than a way of ensuring sustainability per se.

The range of 'local' is debatable. One could argue that this depends on the type of feed and/or type of transportation. Here however, the exchange of local feed with manure is conditional, and hence the limiting factor is manure transportation without risking nutrient leaching. In The Netherlands, where farms are relatively close to each other, a range of max. 20 km for exchange between neighboring farms was suggested by Commissie Grondgebondenheid (2018). In reality, the term 'local' depends on the average distance between farms (which is related to farm size) and the diversity of farm types in a landscape (arable versus livestock with complementary crops/manure). Hence, the range of 'local' should be refined to match the country- or region-specific context. The guiding principle is that the feed should be as local as possible.





# Low opportunity-costs feed (% protein intake)

Over 40% of global arable land is used to produce feed (van Zanten et al., 2018). This is a highly inefficient use of agricultural land, raising concerns about food security in the light of increased demand for food, finite land, and the already alarming levels of land transformation. Currently 20% of the total feed is considered 'high-opportunity cost', which is food competing with human food. Meanwhile, food and crop waste streams remain an untapped resource. Hence, a highly promising transition exists in moving from feed that competes with food (high-opportunity cost) towards using animals to transform waste streams and inedible biomass like grass (low-opportunity cost) to high nutrition products, thus recycling nutrients back into the food system. It should be noted that switching from e.g. soy-based feed to waste streams might impact feed efficiency and availability throughout the year, so attention should be paid to locally-specific and realistic solutions.

For this metric, we propose to use the definition of Van Zanten et al. (2018). They classify low-opportunity cost feed into 4 categories: grass, co-products, crop residues and food waste. Whereas grass, crop residues and food waste are easy to distinguish, co-products can be trickier to define. In some cases the co-product value is so high that it can be considered a co-driver of the crop production.

According to the "PEFCR Feed for food producing animals", which outlines the methodology to be used for conducting life cycle assessments for animal feed,

**Figure 3.** List of co-products that can be considered low-opportunity cost:

- Rapeseed meal
- Rapeseed cake
- · Maize gluten
- Beet pulp (dry/wet)
- Wheat husk
- Soya hulls
- Malt culms
- Brewer's grain (dry/wet)
- Potato pulp
- Feed fat
- Palm kernel meal
- · Maize silage residue

economic allocation should be used to determine the impact assigned to the feed produced by processing crop by-products (FEFAC, 2018). In practice this means that a product is only a by-product if no significant economic value is derived from it, i.e. the main product derived from the growing of a crop is the main driver for its production, rather than the by-product. This is an important consideration in the case of soy, where the meal and the cake are of considerable economic value, although technically the oil is the main product. Here the meal and cake are significant drivers of production and therefore of the environmental impacts associated with it, and cannot be considered low opportunity cost feed.



#### Threshold and aspirational target



**Threshold:** 100% feed (protein) is either low opportunity-cost or natural land conversion-free; grasslands must be conversion-free.



**Aspirational target:** 100% feed (protein) is low-opportunity cost; grasslands must be conversion-free.

Self- and locally-produced feed is excluded from the threshold and aspirational target, as it is considered rather an enabler for sustainable feed than a desired outcome in itself. Hence the threshold and aspirational target focus only on % of protein from low-opportunity cost and natural land conversion-free feed sources.

Since it is technically feasible for farms to only work with low-opportunity cost feed, we propose to use 100% low-opportunity cost as an aspirational target. The by-products and waste-stream products within this category do not require additional conversion-free status. However, grasslands also need to meet conversion-free as they are associated and responsible for land transformation, as well as easily traceable.





# Data collection, verification, and analysis

#### Natural land conversion-free feed

Waste streams and by-products can be excluded from these calculations. Even though they can be associated with land conversion, responsibility is generally attributed to the main product in terms of economic value. However, there are two exceptions. Firstly, grasslands, as they are known to be both associated and responsible for land transformation, as well as easily traceable. And secondly, soya, which is by default processed into different products (soy oil, soy meal, soy hulls, etc.) and thus attributing impacts to the main product is not appropriate.

To quantify the percentage of land-conversion free protein, we propose a multi-level approach, depending on the visibility of the supply chain, which is associated with the degree of data certainty (Table 7). The only data farmers need to supply is information about the type of feed and its suppliers. Subsequently, this data will be split into 4 groups, each with their own assessment method. When source farm location is known and visibility is high, local maps can be used to check whether recent land transformation has occurred, and a percentage can be calculated. Feed with certificate can be assumed to be conversion free. When feed type and supplier country is known, LCA can be used to estimate its association with land transformation. When only feed type is known, its origins need to be modeled first, after which the same LCA approach can be taken. A threshold LCA factor value that is considered 'conversion-free' will need to be defined. The resulting percentage of feed protein from the four visibility levels can then be aggregated, returning a total percentage

of land-conversion free protein. It is important to note that when visibility is medium or low, the result is not a real percentage but rather a probability, which might be higher than actual conversion. Improving the proportion of high visibility feed is a good way to achieve 100% land-conversion free feed.

**Table 7.** Different levels of feed information have a different degree of visibility (which is related to data certainty), requiring a different method for calculating the associated land conversion.

Level	Visibility	Method
Feed from own farmland or located local farms	High	Comparison of location with local cadastral maps
Feed with certification scheme	High	Per definition conversion-free
Feed with information on sourcing region	Medium	Country/region specific land transformation probability of feed x country combination
Feed without additional information	Low	Country-specific feed sourcing probability + country/region specific transformation probability of feed x country combinations

#### Local feed

Based on the farm feed composition inputs and sources, it can be calculated how much of the feed comes from the own farm or local farms.

#### Low opportunity-costs feed

For this indicator, a clear list is needed of which feed types are considered low-opportunity cost. After inputting a farm's feed composition, the % of total protein that is low-opportunity cost can then be easily calculated.



#### **Future development**

#### Natural land conversion-free feed

- Use maps instead of LCA to assess association with transformation (according to SBTN step 3).
   We also suggest to do a hierarchisation list of low risk regions and municipalities with guidance from FEFAC to know the land-conversion risk, as an alternative to LCA data which is very data intensive.
   One concern about such list is that it might only look at deforestation, and not all types of natural land conversion.
- For farmers to be able to improve their score, it will also be necessary to provide them with lists of feed types that have low land transformation risks.

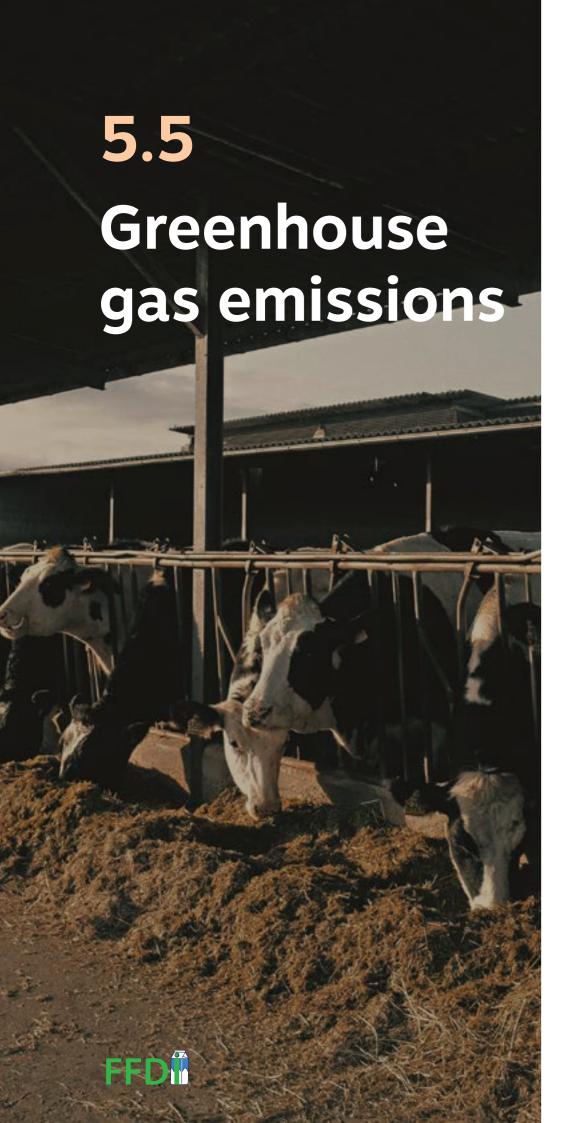
#### Local feed

· Make the definition of 'local' crop-specific.

#### Low opportunity-costs feed

· Create a list of products considered waste.







#### Metric

The dairy sector is known to have high GHG emissions, both per animal and per product. Hence, GHG emission accounting is a crucial aspect of establishing and achieving sustainability objectives in the sector. It is important to note that for the Forest, Land, and Agriculture (FLAG) sector, a substantial part of the GHG emissions is related to land use more specifically from land use change - nitrous oxide and methane from enteric fermentation, biomass burning, nutrient management, fertilizer use and manure management, but also CO2 emissions from machinery. Basically, everything up to the farm gate is considered FLAG emissions. Globally, such emissions account for approximately 25% of the total global emissions. To achieve the goal of limiting global temperature rise to 1.5 degrees Celsius it is necessary to reduce FLAG emissions by half before the year 2050 (IPCC, 2019), despite a projected 50% increase in global food demand. This poses a great challenge to the sectors involved.

CO2-equivalent (CO2-eq) is a measurement that captures the global warming potential of various greenhouse gases, including methane which has a major climate impact in dairy production, as well as nitrous oxide, converting them into a standardized unit based on carbon dioxide (CO2). The choice of units in which to express CO2-eq emissions depends on the objective and the scale of analysis. At a company-level, it is appropriate to consider the total absolute CO2-eq value, which is the case for existing SBTi (Science Based Targets initiatives) commitments. All companies enrolled in the Future Fit Dairy Initiative have commitments to set and

achieve absolute CO2-eq reductions in line with SBTi and the GHG protocol. In the context of monitoring dairy farm performance, the common indicator used to quantify the greenhouse gas impacts of dairy products is CO2-eq per kilogram of Fat and Protein Corrected Milk (FPCM).

We therefore recommend using CO2-eq per kg FPCM as a farm-level Indicator to reward farms that lower emissions per kg of milk. However, to ensure also meeting the company-level SBTi commitments, a reduction of total absolute emissions is also necessary. This prevents increased efficiency from leading to increased production, a phenomenon known as Devon's paradox, which could nullify total emission reductions. In practice this means that farms can increase production when lowering their CO2-eq per FPCM, but only to a certain extent. Hence, we recommend monitoring greenhouse gas emissions both as CO2-eq/kg FPCM and as absolute reduction of total CO2-eq.

Threshold: Below-company average CO2-eq/kg FPCM



#### Threshold and aspirational target



AND no absolute increase in CO2-eq



**Aspirational target:** Company-specific CO2-eq/kg FPCM needed to achieve absolute SBTi target **AND** no absolute increase CO2-eq

We propose thresholds and aspirational targets that depend on the company-wide SBTi commitments, as opposed to a more uniform or

country-specific indicator. This has multiple reasons. Firstly, it allows us to synchronize company targets with farm targets. Secondly, commitments to SBTi targets are subject to a strict GHG protocol, ensuring that different company aspirational targets will reflect the same level of ambition and calculation methods. Lastly, using company-specific aspirational targets indirectly considers differences between dairy production systems between countries, ensuring a level of fairness in the expectations from farmers.

To be SBTi compliant, each company will have to estimate their baseline total GHG footprint and commit to a required pace of emission reductions to achieve the Paris Agreement's goal of limiting global temperature increase to 1.5 degrees Celsius. As of April 2023, landuse-intensive sectors such as the dairy sector need to set targets for both their direct operations emissions and FLAG emissions (everything up to the farm gate). For the latter, this is a commodity-specific absolute reduction by 2030, in addition to a no deforestation commitment by 2025. Commodity-specific reduction targets are calculated per region, but a company may opt for the global pathway if it is more ambitious. The global commodity-specific pathway for dairy entails a reduction rate of 3.10% per year between 2020 and 2030. See the SBTi FLAG Guidance document for more specific information on how to set companywide aspirational targets.

As a threshold, we propose to convert each company's baseline absolute FLAG emissions to an average CO2-eq/kg FPCM, rewarding farms that perform below average (lower emissions is better). As an aspirational target, we propose to convert each company's absolute FLAG emission 2030 target to an average CO2-eq/

kg FPCM, rewarding farms that are contributing to meeting the SBTI company target, and thus limiting global warming to 1.5 degrees. For both the threshold and aspirational target, the prohibition of absolute increases in CO2-eq at the farm level per year is taken into account to prevent production efficiencies from eventually causing higher total emissions.

We are aware that different farms might have different potentials to reduce this indicator to the aspirational target level either financially, technologically, or geophysically. However, it is important to remember that this FFDI farm-level monitoring guidance does not expect every farm to meet this aspirational target. Rather, the aim is to accurately map in which dimensions each farm is lacking or excelling and to acknowledge and reward effort on each dimension individually.

Companies have the option to utilize the FLAG tool



# Data collection, verification, and analysis

or another tool that conforms to the GHG protocol to establish company-wide FLAG emissions baselines and targets. These baseline- and target FLAG emissions can then be divided by total produced Fat and Protein Corrected Milk to achieve a baseline-and aspirational target CO2-equivalent per kilogram of Fat and Protein Corrected Milk (CO2-eq/kg FPCM).

Farms' value of CO2-eq/kg FPCM can be calculated from farm data (about e.g. manure management, stall properties, and feed composition). Currently, all companies employ tools (CoolFarmTool, ANCA, or ClimateCheck) that facilitate or will soon facilitate the

estimation of FLAG CO2-eq calculations. These tools work with primary data and with models – such as life cycle analyses (LCA) – relying on national data such as trade data to calculate all direct and indirect emissions. However, it is important to note that additional data collection efforts may be required to ensure compliance to the new FLAG set by the Science-Based Targets Initiative (SBTi). In case requirements are not met, Agri Footprint is an LCA database focused on food products that has made its most recent version compliant with SBTi FLAG guidance.

Include carbon sequestration



#### **Future development**

Include an aspirational target to phase out the use of fossil fuels









#### Metric

Ammonia emissions are the most relevant and impactful air pollutants emitted from dairy farms in Northwest Europe. Ammonia emissions are linked to the outcome 'Improve manure management', because they mostly occur as animal excreta are broken down during storage or on-field. Ammonia is volatile and precipitates in the near surroundings, causing similar eutrophication issues in terrestrial ecosystems as nitrates in aquatic systems, leading to a dominance of nitrogen-loving species and resulting in a simplification of biodiversity. This is one of the main reasons for ecosystem degradation in Northwest Europe and represents a severe threat for biodiversity and habitat conservation. In addition, air pollution from ammonia emissions is causing serious human health problems. According to the EU habitats directive, Member States must take appropriate measures to protect the state of natural ecosystems which makes them indirectly obligated to manage nitrogen pollution. Because 87% of ammonia emissions from agriculture to the atmosphere are caused by livestock production (European Commission, 2024), they are an important part of the solution, emphasizing the importance of this indicator. Additionally, the EU National Emission Ceilings (NEC) directive has set member-state specific emission reduction targets for ammonia. This requires member states to develop and implement national programs and measures to achieve the emission reduction targets for ammonia. Measures are mainly focused on housing and feeding of livestock, as well as the storing and spreading of manure.

Ammonia emissions can't be measured directly, but can best be modeled using farm data, mainly regarding manure management. Based on whether the farm is pasture-based or not, they can be expressed per animal (landless systems) or per ha (pasture-based), as long as the thresholds and aspirational targets are expressed in the same unit.



#### Threshold and aspirational target



Threshold: Translation of the national NEC target to a value per ha and animal, and applying this target to every farm.



#### **Aspirational target:**

- Within 500m of Natura2000 area: calculate allowable emissions per animal or per ha, based on the Nitrogen Critical Load (NCL) of the respective protected area.
- Not within 500m of Natura2000 area: adherence to national/regional policies.

The allowable ammonia emission per animal or hectare depends on factors like regional animal population and nearby habitat vulnerability This complexity makes it impractical to establish fixed, unyielding thresholds and aspirational targets for ammonia emissions. In light of this, we recommend adopting a more adaptable approach for both.

Our proposal is to align the threshold with the national ammonia reduction goals outlined in the NEC Directive. Member states have translated these national targets into sector-specific emission targets, resulting in emission targets per animal and per hectare of agricultural land. We propose to use these values as the baseline threshold. Although the countries in question are in fact (almost) meeting their NEC targets, that does not mean that each dairy farm is reaching it. Hence, by proposing it as a threshold, this FFDI farm-level monitoring guidance is incentivizing future-fit farms to perform above-average and in line with regulations.

As an aspirational target we propose a two-option approach:

- 1. For farms located within 500m from a protected Natura2000 area: Given that ammonia emissions primarily affect areas within this proximity, emissions need to be reduced to the NCL values of the respective protected area to ensure good ecological status. This can be calculated by dividing the NCL by the number of animals or farmed ha within this radius, also considering other farms within the range.
- 2. For farms located beyond 500m from a protected Natura2000 area: Many countries supplementary conservation policies regulating ammonia emissions, often in accordance with the Common Agricultural Policy (CAP) or the Habitat Directive. These policies are often region-specific and more stringent than the NEC targets. To streamline compliance for farmers who would otherwise need to navigate multiple different regulations, we propose to devise aspirational targets for each country, in alignment with these regional regulations.



#### Data collection, verification, and analysis

The ANCA - BEA model is an example of tools to calculate ammonia emissions, along with other nutrient cycle indicators (Vries et al., 2020). The model equations depend on farm-specific input data and model parameters (Figure 1). Our recommendation is to either start from this ANCA-BEA model, or encourage any other tools modelling ammonia and other nutrient emissions, and adapting it to the context of farm archetypes.







#### Metric

The disturbance of the nitrogen biogeochemical cycle has already surpassed its planetary boundaries, with significant implications for aquatic and terrestrial ecosystems. In such systems, Nitrogen acts as a limiting nutrient. Exceeding nitrogen levels therefore fundamentally disrupt their functioning, leading to biodiversity loss. Within the EU, the ecological status of water bodies is concerning, with only 57% of rivers, 44% of lakes, 40% of coastal waters, and 66% of transitional waters achieving a good ecological status. Nitrogen pollution, specifically by nitrates, plays a significant role in this issue, and minimizing nitrogen pollution to water and soils is crucial to ensure healthy ecosystems across Europe (Poikane et al., 2019).

Dairy farming systems contribute notably to nitrogen pollution to soils and water, as nitrogen-rich farm inputs - particularly feed and synthetic fertilizers - accumulate on and around farm soils and water bodies. Over 80% of EU agricultural nitrogen emissions to aquatic systems are caused by livestock production (European Commission, 2024). Dairy farming in Northwest Europe involves substantial application of manure and synthetic nitrogen fertilizer to fields, which can lead to losses of nitrates and ammonia to the environment. Nitrates can end up in surface and groundwater bodies through leaching and run- off.

Also ammonia, a gaseous nitrogen compound, is released into the atmosphere through a process called volatilization, and causes nitrogen pollution to soils when depositing in the surroundings. As ammonia is primarily related to air pollution, it's considered as a separate indicator (see section 5.6 about Ammonia emissions). The desired outcome discussed here is to reduce water and soil pollution from excess nitrogen.

None of the participating companies directly monitors water and soil pollution from excess nitrogen, but even when measuring nitrogen levels in soils and water, attributing them to specific sources and time can be challenging. Hence, we landed on an indicator in direct relation to the main source of water and soil pollution from dairy farms: Soil nitrogen balance (SNB), expressed in kg N/ha or kg N/animal.

When the application of nitrogen to the soil exceeds its utilization by crop/grass growth, then a positive soil nitrogen balance or surplus occurs, which means that there are potential nitrogen losses to the environment. The magnitude of this surplus, in conjunction with rainfall levels and soil type, determines the risk for nitrogen leaching into soils and eventually ground-and surface water. Therefore, the soil nitrogen balance can serve as an indicator for water and soil pollution caused by nitrates.

It should be noted that water pollution is very difficult to model accurately. For example, even when nitrogen surplus in surface waters seems okay, it can still cause problems when ending up in the ocean because a lot of water with a little bit of nitrogen accumulates in a bay. Also soil type and rainfall patterns have a big influence on the leaching potential of nutrients through soils and runoff to surface water. Improving models to better capture systems dynamics between soils, nutrients and water is an attention point for future developments.

The Soil nitrogen balance (SNB) can be expressed in kg N/ hectare or in kg N/animal. This is suggested to provide options both for pasture-based and landless farms.



#### Threshold and aspirational target



**Threshold:** Conversion of 50 mg/L NO3 (or 11.3 mg/L NO3-N) to regional kg N/ha or kg N/animal



#### **Aspirational target:**

Conversion of 11.06 mg/NO3 (or 2.5 mg/L NO3-N) to regional kg N/ha or kg N/ animal

From a regulation angle, the EU Nitrate Directive mandates member states to develop action programs that effectively tackle nitrate pollution. While member states have flexibility in implementing these programs, the directive establishes a maximum threshold of 50 mg/l NO3 (nitrate) for drinking water. Where this threshold is not met, the EU has identified nitrate vulnerable zones where specific regulations are in place to address the adverse impacts of excess nitrogen and encourage sustainable farming practices. In these zones, farmers must maintain records and comply with rules regarding the use of nitrogen-based fertilizers and the storage of organic manures. For example, a critical rule in dairy farming is the maximum application of 300 kg of nitrogen per hectare, with a maximum of 170 kg allowed from organic manure. Belgium, Germany, the Netherlands, and Denmark have established their entire nations as nitrate vulnerable zones.

As a threshold, it is recommended to use the EU policy-based Nitrates Directive threshold of 50 mg/L NO3 (or 11.3 mg/L NO3-N) for good ecological status of groundwater and to meet human health norms in drinking water. Because expressed in a different unit to SNB, a conversion is needed to assess the land-based

(regional, kg N/ha) or animal-based (kg N/animal) allowable SNB. Ros et al. (2023) did exactly this for Dutch farms, which resulted in allowable nitrogen surpluses of 80-120 kg N/ha, depending on the soil type, and given a certain rainfall level (Equation 1). The study also revealed that most dairy farms in the Netherlands, except for dairy farms situated on sand/loss soils, did not exceed the allowable SNB based on the 50 mg/L NO3.

For the aspirational target, we recommend using the

$$N_{\text{Surplus allowable}} = 0.01* F_{\text{W}} * [NO_{3}N]_{\text{Threshold}} * fN_{\text{out}}$$

**Equation 1.** With 0.01 being a conversion factor to go from the nitrate-nitrogen per liter to kg nitrogen per m-3, Fw the nitrogen surplus (mm per year) and fNout being the leaching fraction on a given soil.

EU policy-based Water Framework Directive value of 11.06 mg/L NO3 (or 2.5 mg/L NO3-N) for good ecological status in surface waters. The same logic and formula as suggested to convert the threshold, can be used to calculate the allowable SNB target in kg N/ha.

Note that the threshold and aspirational target for SNB are based on water policy only, and not on regulations related to soil pollution. This is because the initial research scope was 'water pollution' and the link with soil pollution was made only afterwards, when the indicators were linked with SBTN pressure categories (which includes soil and water pollution).



# Data collection, verification, and analysis

Various tools exist to model soil nitrogen balance, along with other nutrient cycle indicators. An example is the ANCA-BEN tool, developed by Wageningen University (Vries et al., 2020). The ANCA-BEN model equations depend on farm-specific input data and model parameters to calculate all the nitrogen in- and outputs (Table 2), the difference between which is the SNB. Our recommendation is to select an appropriate and accessible tool that fits the company-, country-and/or farm type-specific context. It is important to note that additional farm data collection efforts may be required for calculations.



#### **Future development**

- The threshold and aspirational target are now based on policies related to water pollution only, and not to soil pollution. It's recommended to do extra research which also considers soil-related performance ranges.
- For the aspirational target, we acknowledge that surface water quality depends not only on nitrogen excess but also on other factors such as phosphorus, chlorophyll-a and other parameters, also depending on regional circumstances. More accurate assessment of surface water quality can actually be done by holistic monitoring of farm practices.
- Identify an alternative approach for landless dairy farms
- Continue to update model parameters





#### Note about Soil nitrogen balance (SNB) versus Nitrogen use efficiency (NUE)

It's important to acknowledge the difference between Soil nitrogen balance (SNB) and Nitrogen use efficiency (NUE), and why we're suggesting monitoring both indicators to steer towards the outcome 'Reduced Water and Soil Pollution'.

NUE is one of the core outcomes of the SAI Platform RTP framework, and hence adopted in the FFDI farm-level monitoring guidance. SNB is also included because of its complementary insights and more direct link to pollution risks.

In terms of definition, NUE is the relative difference between the amount of N applied (fertilizer, manure, etc.) and the amount of N removed (harvest), expressed in %. SNB is the absolute difference between N applied and N removed, usually expressed in kg N/ha. Both NUE and SNB provide information about the potential losses of N to the environment, whereas in general a high

NUE and low SNB are considered 'good'. However, this is not always true. Actual losses of N to the environment are context specific, and depend on e.g. soil type, weather and production level. For example, on fields with high production levels, both the input and output of N is high. Even though the NUE might be high (relatively small loss), the absolute losses of N to the environment may still be too high and negatively impact nature. NUE is a good indicator to consider the balance between N pollution and productivity, but when considering pressure on water bodies, SNB is a better indicator as it really monitors the absolute potential losses of N to the surroundings.

The inclusion of both SNB and NUE as indicators to the FFDI farm-level monitoring guidance, ensures holistic monitoring of environmental impacts while capturing productivity trade-offs.



# Outlook on the next steps

Arla Foods, Danone, and Friesland Campina, as the three dairy companies participating in the FFDI, are currently refining their selection of metrics, and developing relevant thresholds and aspirational targets based on the farm-level monitoring guidance V1. The selection may differ across companies, depending on current data availability as well as company priorities. Those selections will inform company-specific programs to continue testing this guidance.

Insights from the first tests will inform baselining and may also refine the FFDI farm-level monitoring guidance version 2. We expect this process to inform the selection of (farm type-specific) interventions to initiate the transition, equivalent to SAI step 3 (practice adoption). From 2026, companies are aiming to extend and refine their set of metrics.

Regarding this FFDI farm-level monitoring guidance, we strongly recommend continuing research & development to establish a more refined, robust, and holistic monitoring guidance in the near future, building on the ideas from the Chapter 5 (FFDI indicators: Deepdive / Section future developments) and the reality of the baseline. For future developments, it is essential to continue the iterative and inclusive approach initiated, engaging in deeper R&D and knowledge exchange with dairy farmers (and/ or representatives), relevant industry platforms, environmental NGOs, and academic experts to fill the identified gaps, and inspire similar action elsewhere.

Besides the continuation work on this farm-level monitoring guidance V1 (Pillar 1), we will deploy other activities in 2025 to support a systemic change, not only at the technical level. The focus will be on:

- Conducting a study to identify hurdles, costs, and benefits associated with the transition to futurefit dairy. To this end, we are seeking to collaborate with universities and financial institutions in Northwest Europe, interested to get a deeper understanding of the regenerative business case.
   We will use the learnings to identify priorities and to develop farm transition support solutions through public/private partnerships later in the year (Pillar 2).
- Progressively building a strong farmer engagement program and knowledge exchange community (Pillar 4). The current program engages farmers across 9 countries in Northwest Europe, collecting their insights to adjust our approach with their reality and bring the right support in the transition. Our objective is to grow the number of farmers involved, strengthen this community of practice, and enhance testing and learning plans. To do so, we're seeking training partners and welcome any farmers or companies interested in sharing learnings and joining the program.
- Once the key concepts of Pillar 1 and Pillar 2 are clear, we aim to engage other value chain stakeholders to accelerate an industry-wide adoption of the FFDI approach. This will also provide a strong case for engaging with policymakers and public institutions, advocating for adequate policies and comprehensive subsidies (Pillar 3)



#### **Call to Action**

We warmly encourage other companies to connect with FFDI member organizations if they are interested in joining this initiative. Our goal is to inspire broader action, and we are committed to maintaining an open and transparent approach. Participation in FFDI is accessible to all—no competitors or individual farms are excluded from adopting this approach. Whether you seek support in adapting farm-level monitoring guidance, wish to explore the costs and benefits of the transition, or are looking to collaborate with stakeholders across the value chain while aligning with policymakers and public institutions, your involvement can be tailored to fit your objectives.





# Appendix: Anti-trust disclaimer

To achieve transformative change in the dairy sector, both technically and economically, we must share extensive knowledge across various countries, contexts, farm types, and soil types to ensure inclusiveness.

The Future Fit Dairy Initiative arises from the necessity for collaboration with diverse stakeholders to meet sustainability goals. This collaborative approach is crucial for overcoming obstacles, as the farm-level monitoring guidance's inclusiveness and the financial analysis of farm transition costs and benefits require multi-stakeholder inputs. Participants recognize challenges they can't address alone, reinforcing the need for cooperation. This includes inspiring broader action, involving more value chain stakeholders, and aligning with governments for adequate policies and comprehensive subsidies.

Directly or indirectly, the initiative contributes to the following sustainability objective:

 Environmental objectives, including climate change mitigation and adaptation, the sustainable use and protection of landscapes, water, and soil, and the protection and restoration of biodiversity and ecosystems.

The FFDI farm-level monitoring guidance described in this paper sets thresholds and aspirational targets, but does not impose specific technologies, production methods, or practices. In addition, this will eventually lead to tangible and measurable results thanks to the agreed quantitative indicators and metrics. If it isn't yet possible to quantify the results obtained in numerical terms, they should be observable and describable. To comply with antitrust regulation, thresholds align

at least with the most ambitious binding regulatory requirements from European and/or national governments (when this is available), incentivizing future-fit farms to perform above-average and in line with regulations. When neither science-based guidance nor policy regulations were available, expert judgments (a.o. from listed reviewers) were used to suggest thresholds. This implies that thresholds are either based on existing national regulation translated to farm-level (e.g. ammonia emissions), non-binding policies (e.g. on-farm habitats and ecosystems), or on existing regulations complemented with extra/higher requirements using scientific insights (e.g. SOC/permanent grassland).

The FFDI farm-level monitoring guidance in itself is not an upper limit. Participants (companies and farms) can decide individually to apply higher standards than the thresholds and aspirational targets.

The participation in the initiative is voluntary, not restricted (with no competitor or individual farm being prohibited from implementing the guidance), and transparent, ensuring that no competitively sensitive information is exchanged. The farmers' choice of not participating in this program will not impact the existing relationships with the dairy companies. In future studies on the hurdles, costs, and benefits of transitioning to future-fit dairy farming, the initiative will ensure GDPR compliance and maintain the confidentiality of farmers' and competitors' data to prevent the exchange of competitively sensitive information. Similarly, any follow-up discussions on addressing the results with financial transition support will be approached with a focus on compliance with competition law.



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