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The IDF Guide on Biodiversity for the Dairy Sector

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THE IDF GUIDE ON BIODIVERSITY FOR THE DAIRY SECTOR

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FOREWORD FROM THE INTERNATIONAL DAIRY FEDERATION (IDF)

In the last three decades, global dairy production has increased by more than 50 percent, with approximately 150 million households around the world being engaged in milk production. With a growing global population and an increase in demand for dairy products worldwide, world production of dairy products is expected to further increase by 6–20 percent until 2025. Dairy production influences biodiversity and, thus, the dairy industry has a duty to mitigate its impact.

Biodiversity is complex and multivariate by nature. Dairy farming influences biodiversity through habitat modification or maintenance, fertilization and nutrient excretion and production of greenhouse gas emissions. Dairy processing can have an impact on biodiversity through habitat modification at the processing site, effluent discharge from the water treatment plant to adjacent rivers and emission of greenhouse gases.

Thanks to the expertise of the IDF Standing Committee on Environment, IDF has produced guidelines with the aim of providing principles for identifying biodiversity indicators that can be used to measure progress and to assist technical advisors of dairy industry stakeholders to improve their management of biodiversity. These guidelines outline steps for assessment of dairy production impacts on biodiversity. On behalf of IDF, I would like to warmly thank all experts that contributed to its publication.

Nico van Belzen, PhD
Director General
International Dairy Federation

June 2017

FOREWORD FROM THE WORLD WILDLIFE FUND (WWF)

Food production can have a negative impact on biodiversity. Likewise, a lack of biodiversity—from bacteria in the soil to bees that pollinate crops—can have a negative impact on food production. That is why protecting wildlife and their habitats is so crucial for the long-term sustainability of agriculture, including dairy.

Dairy farmers around the world produced 638 million tonnes of milk in 2013 and global consumption is expected to increase by 58 percent by 2050. If the dairy industry aims to meet this demand, while staying within the limits of Earth's available natural resources, then farmers, cooperatives, processors and others in the value chain must first understand how dairy production impacts biodiversity and wildlife habitats, not only on or close to the farm, but also in places where feed and other inputs are produced. Indeed, from the Northern Great Plains of the USA and Canada to the Amazon and Cerrado of Brazil, forests and grasslands are being cleared to produce crops for livestock feed.

Food production accounts for about 40 percent of habitable land, 70 percent of the water we consume, and 30 percent of global greenhouse gas emissions. It is the leading contributor to climate change, soil erosion and loss of habitat and biodiversity on the planet. The publication of this biodiversity assessment guide for the dairy industry shows that the industry is aware of these challenges and seeks to address them, with the aim of increasing efficiency while reducing the impact on wild places and species. The IDF Guide on Biodiversity for the Dairy Sector could help dairy understand how it impacts local ecological landscapes and identify ways to stay within the local ecological limits, while providing benefits to the local environment.

We hope that the dairy industry will use this Guide to keep this momentum going so that it can reduce its impact on biodiversity and wildlife, while advancing conservation efforts locally, regionally and globally.

Sandra Vijn
Director, Sustainable Markets and Food
World Wildlife Fund

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Sophie Bertrand (FR) – AT leader and previous SCENV Chair (October 2011 until September 2015)
Jude Capper (UK)
Catherine Phelps (AU)
Marta Alfaro Valenzuela (CH)
Marcin Preidl (DE) – current SCENV Deputy Chair (from December 2014)
Ying Wang (US) – current SCENV Chair (from September 2015)

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1 INTRODUCTION

1.1. Purpose of IDF guidelines on biodiversity

IDF's goal in developing these biodiversity assessment guidelines is to:

- Assist sustainability managers and leaders in improving the management of biodiversity across the dairy supply chain
- Provide guidance for assessment of the impact of dairy production on biodiversity
- Provide principles for identifying appropriate biodiversity indicators that can be used to measure progress

1.2. Background

The projected growth in global population is expected to increase the demand for dairy products, and a growing dairy sector will impact biodiversity and ecosystems. Therefore, to support the sector in its challenge of increasing dairy production while minimizing negative impacts on biodiversity, IDF is releasing this guide to help assess and manage the impact of dairy farms and processors on biodiversity.

Dairy production directly and indirectly impacts biodiversity and ecosystems through habitat modification or maintenance, use of fertilizers and other input products, light and noise pollution, nutrient excretion and production of greenhouse gas emissions. These influences can be positive or negative depending on the type of dairy farming system, the specific dairy production practices and the local ecological conditions. The environmental effects can be indirect impacts on biodiversity outside the proximity of the farm or direct impacts relating to input products such as feed and fertilizer. Enhancing on-farm biodiversity can improve production efficiency and farm profit through biodiversity and ecosystem services such as pollination, pest regulation, improved soil health, improved freshwater quality and protection against climate extremes (shade, shelter, flood protection).

Dairy processing can have an impact on biodiversity through habitat modification at the processing site, input products, effluent discharge from the water treatment plant to adjacent rivers, and emission of greenhouse gases and other pollutants.

1.3. Where do these guidelines fit in relation to other biodiversity guidelines?

The assessment of livestock impacts on biodiversity is an emerging area of work and the principles incorporated within this document are based on the Livestock Environmental Assessment and Performance (LEAP) Partnership *Principles for the assessment of livestock impacts on biodiversity* (FAO/LEAP 2015). Because of the multivariate nature of biodiversity, the LEAP biodiversity assessment guidelines recommend using broad principles to identify context-specific biodiversity indicators.

1.4. Who should use these guidelines?

The audience for these guidelines is dairy industry stakeholders with an interest in supporting improved biodiversity outcomes across the industry supply chain. These stakeholders will primarily be sustainability advisors and company sustainability managers. The guidelines include principles and approaches to help dairy sustainability managers assess and manage the impacts of dairy production on biodiversity, with the aim of enhancing biodiversity over time.

1.5. What is in the guidelines?

This guide describes principles and indicators, and outlines steps that guide the user through a biodiversity assessment.

The principles include advice on how to identify biodiversity hot spots and how to understand which management practices can positively influence biodiversity through a process of continuous improvement.

The indicators support the user with:

- Identification of the pressures that a farm or processing plant puts on biodiversity (*pressure indicators*) directly or indirectly
- Assessment of the current and changing state of biodiversity (*state indicators*)
- Identification of actions that can be taken to improve biodiversity (*response indicators*)

Seven steps are included to guide the user through a biodiversity assessment and improvement management plan development process.

The guidelines do not provide details on how to quantify the impact of dairy farming on biodiversity, as quantitative assessment of biodiversity is still an emerging area of work.

These guidelines are aligned with the LEAP Partnership *Principles for the assessment of livestock impacts on biodiversity* (FAO/LEAP, 2015) and are based on the pressure–state–response (PSR) approach for the assessment of impacts on biodiversity. The rationale for selecting the PSR approach, as opposed to the life cycle assessment (LCA) approach, is based on the relative simplicity and ease of use of the PSR framework, which makes it more suitable for biodiversity impact assessment at the farm scale, especially when considering the impact of different practices.

The level of biodiversity management knowledge and skills among livestock enterprise managers and their advisors is also important to take into account, as is access to biodiversity education programmes and financial support to help implement biodiversity response actions.

2 PRINCIPLES FOR THE ASSESSMENT OF DAIRY IMPACTS ON BIODIVERSITY

2.1. Definition

Biodiversity is defined in Article 2 of the *Convention on Biological Diversity* as 'Variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic systems and ecological complexes of which they are part, including diversity within species and of ecosystems' (CBD/UNEP, 1992).

The guidelines are relevant for evaluating biodiversity at an ecosystem level (terrestrial or aquatic) or at the species level (plants and animals). For the purposes of these guidelines, the genetic biodiversity within species is not included.

2.2. Key principles on biodiversity

- Biodiversity is complex and multivariate by nature and is extremely context dependent. This makes assessment of dairy production impacts on biodiversity inherently complicated if carried out at a regional or global level.
- The objectives of a biodiversity action plan should be clearly stated, and the indicators and methods chosen to reflect these objectives.
- An action plan on biodiversity should identify and recognize designation frameworks for biodiversity at the habitat and species levels (e.g. IUCN red list).
- The effects of dairy production on biodiversity can be both positive and negative, direct and indirect, therefore assessment methods need to be capable of reflecting beneficial as well as detrimental impacts.
- Off-farm feed production (national or international) should be included in the system boundary and follow a life cycle approach, because it often has a significant impact on biodiversity.
- It is important to identify and describe the choice of reference state (the level of biodiversity that is used as the baseline for comparisons) and to interpret the results accordingly.

2.3. Biodiversity indicators

A framework for using LCA approaches to biodiversity assessment is described in *Principles for the assessment of livestock impacts on biodiversity* (FAO/LEAP, 2015). The LEAP document specifies the principles for two different but complementary approaches to biodiversity assessment. These are the LCA and PSR frameworks. The LCA approach is recommended for assessments at a larger spatial scale, for example, when the aim of the assessment is to reveal supply chain or spatial hot spots. The PSR approach is more suitable for assessment of biodiversity at a smaller scale or when the aim of the assessment is to determine the relative impact of different management practices on biodiversity. As noted in the LEAP principles, the comprehensive scope of the LCA approach is important and useful in avoiding problem shifting, for example, from one phase of the life cycle to another or from one region to another.

The biodiversity indicators included in this guide use the PSR framework (figure 1).

Figure 1: Generic framework (environmental cause-effect chain) for assessing biodiversity performances of livestock production (FAO/LEAP, 2015)

The PSR framework is based on the selection of appropriate indicators that relate to changes in biodiversity at both the ecosystem and species level. The three categories of indicators are pressure indicators, state indicators and response indicators.

2.3.1. Pressure indicators

Pressure indicators (tables 1 and 2) support the user in identifying the pressure of the operation on biodiversity and ecosystem services, which usually has a negative impact on the health of biodiversity and ecosystems. These indicators are closely related to farm management practices used by the farmer and can provide the user with the potential degree of impact. Pressure indicators can also be used to monitor beneficial biodiversity impacts or an improvement in biodiversity performance. Pressure and benefit are often two sides of the same gradient. Because they are closely related to management decisions, data required to evaluate pressure indicators may be readily available.

Scoping and hotspot analysis should be used to define the shortlist of pressures and benefits to be quantified. At least one indicator should be quantified for each pressure.

Main drivers and sub-categories	Mechanisms	Example indicators: Territory level	Example indicators: Farm level
Habitat change			
Habitat loss	Deforestation and fragmentation Grassland, wetlands, savannas and tundra to cropland conversion	Rate of conversion Patch size/isolation Connectivity/fragmentation Decline in species richness/ abundance	Patch size/isolation Connectivity/fragmentation Decline in species richness/ abundance
Habitat degradation	Overgrazing Land degradation Noise and light pollution	Normalized difference vegetation index (DVI) Erosion/compaction Soil pH/salinity Soil organic matter Rainfall use efficiency	Normalized DVI Erosion/compaction Soil pH/salinity Soil organic matter Rainfall use efficiency
Intensification	Higher use of inputs in feed crops Grassland improvement, fertilization, higher stocking rates	Output oriented (milk/ha) Input oriented (inputs/area) Stocking rates Percentage of semi-natural habitats Habitat diversity	Output oriented (milk/ha) Input oriented (inputs/area) Stocking rates Percentage of semi-natural habitats Habitat diversity
Landscape simplification	Configuration (loss of connectivity) Composition (loss of habitat diversity)	Percentage of semi-natural ha-bitats Habitat diversity	Percentage of semi-natural habitats Habitat diversity
Pollution			
Nutrient pollution	Soil and water pollution (acidification and eutrophication)	Nitrogen/phosphorus balance Nutrient concentrations in receiving waterways Frequency and extent of algal blooms Percentage of riparian zones protected with buffers	Nitrogen/phosphorus balance in waterways Blooms Percentage of riparian zones protected with buffers
	Atmospheric pollution	Nitrous oxide and ammonia emissions	Emissions
Eco-toxicity	Eco-toxic products such as pesticides and veterinary products (including, antibiotics, anthelmintics)	Quantity and type of pesticides applied Molecule concentration of eco-toxic pesticides in the environment	Quantity and type of pesticides applied
Other drivers			
Invasive species	Overgrazing Invasive species/pest management	Presence/number of invasive species	Presence/number of invasive species
Climate change	Frequency of extreme events Changes in average temperature/rainfall	Decline in species richness/ abundance	Decline in species richness/ abundance

Table 1: Pressure indicators (impacts) (source FAO/LEAP, 2015)

Main drivers and sub-categories	Mechanisms	Examples of indicators: Territory level	Example indicators: Farm level
Habitat change			
Habitat restoration	Improved grazing management (e.g. extensive/rotational grazing, silvopasture, stocking management)	Normalized DVI Erosion/compaction Soil pH/salinity Soil organic matter Rainfall use efficiency	Normalized DVI Erosion/compaction Soil pH/salinity Soil organic matter Rainfall use efficiency
Landscape connectivity	Habitat diversity maintenance Spatial connectivity maintenance	Percentage of semi-natural habitats Habitat diversity Enhancement of wildlife/ biodiversity corridors	Percentage of semi-natural habitats Habitat diversity Enhancement of wildlife/ biodiversity corridors
Pollution			
Prevention of nutrient pollution	Riparian protection Fertilizer/manure management	Nitrogen/phosphorus balance Nutrient concentrations in receiving waterways Frequency and extent of algal blooms Percentage of riparian zone protected Nitrous oxide and ammonia emissions	Nitrogen/phosphorus balance in relation to soil health/capacity Percentage of riparian zone protected

Table 2: Pressure indicators (beneficial) (FAO/LEAP, 2015)

2.3.2. State indicators

State indicators describe the three dimensions of biodiversity (table 3):

- Composition, which includes ecosystem diversity and species richness/diversity
- Structure, which includes population structure and landscape structure (landscape spatial organization)
- Function, which includes functional diversity (e.g. pollination) and ecosystem services

Composition, structure and function provide information for understanding the context, at both the ecosystem and species level. They can be computed over time or at a specific point in time. Habitat area/land cover is generally straightforward to assess and can be an informative state indicator for farmland biodiversity.

Level and dimension	Description	Example of indicators
Species		
Composition	Describes the type and variety of species	Abundance (number of individuals), richness (number of species) and diversity (combining abundance and richness). Can be computed for specific groups of species (e.g. birds) or groups with particular conservation value (e.g. IUCN Red list of threatened species)
Structure	Spatial structure in the landscape Structure in age classes	Information on age structure of the population, especially for species of high conservation value
Function	Functional groups (i.e. groups of species sharing the same function)	Description of functional groups for flora (e.g. legumes, grasses, herbs)
Ecosystem		
Composition	Describes the identity and variety of ecosystems	As for species, the abundance (extent), richness and diversity can also be computed at the ecosystem level, either over time or as a snapshot At smaller spatial scales (e.g. farm-scale), the area, type and quality of habitats/native land-cover is an important farm-scale state indicator.
Structure	Vegetation structure Soil structure Water quality	Architecture of the vegetation Dominant vegetation species of trees Habitat fragmentation across landscape Soil health indicators including pH, nutrient status, density, organic carbon and salinity Water quality indicators such as turbidity, pH, salinity, nitrates, phosphates, temperature and dissolved oxygen
Function	Ecosystem processes and functions, which may translate into ecosystem services from the human point of view	Quantification of ecosystem function or services (e.g. biomass production, pollination, water filtration, air filtering). This quantification can be done in specific units (e.g., tons/ha/year of carbon sequestration) or monetized in order to sum the different types of ecosystem services

Table 3: Overview of levels and dimensions of biodiversity to inform selection of state indicators (FAO/LEAP, 2015)

The indicator based on composition (i.e. the abundance of species) is the most common state indicator used because it is the easiest to quantify. However, it should be kept in mind that information on abundance is not enough to drive conclusions because the structure and the function are also very important for biodiversity, although a lot more difficult to identify.

2.3.3. Response indicators

Response indicators describe the decisions and actions that can be undertaken by stakeholders to mitigate pressures and improve the state of biodiversity. Decisions and actions cover laws, incentives, certifications, biodiversity management plans or practices.

Response indicators should be based on scientifically sound and verifiable evidence that details a clear link between adoption of the response indicator and the expected biodiversity outcome. Response indicators can be general (e.g. whether a biodiversity action plan is in place or not) or more specific, such as the level of expenditure on conservation of native grasslands or the decision to preserve an endangered species. Specific indicators can be determined by the scoping review and hot spot analysis.

A key role for response indicators is to monitor progress, both in pressure indicators and in state indicators. Examples of farm-scale dairy response indicators include:

- Percentage of riparian zone protected from livestock
- Reduction in invasive species
- Planting of wildlife/connectivity corridors
- Existence of a biodiversity action plan, regularly reviewed and amended accordingly
- Participation in industry/community biodiversity education programmes

An understanding of the effectiveness of the existing biodiversity regulations and policies at a national or regional level is essential when prioritizing non-regulated response indicators against regulated response indicators. Countries may have regulations for biodiversity protection and conservation (such as banning deforestation, halting land conversion and protecting threatened species and their habitat), but these regulations could be ineffective or not enforced. Some countries may have minimal regulation with respect to biodiversity, but have effective stakeholder-initiated biodiversity programmes. When selecting biodiversity response indicators, existing government and stakeholder indicators should be assessed for effectiveness and, where appropriate, additional response indicators included to achieve the required outcomes.

2.4. Quality criteria for biodiversity indicators

As a general rule, indicators should be:

- **Rigorous:** Based on clearly defined, verifiable scientifically acceptable data, which are collected using standard methods with known accuracy and precision or based on traditional knowledge that has been validated in an appropriate way.
- **Widely accepted:** The power of an indicator depends on its broad acceptance. Involvement of the policymakers, major stakeholders and experts in the development of an indicator is crucial.
- **Easily understood:** Indicators should be measurable and easy to interpret in an accurate and affordable way.
- **Sensitive:** Indicators should be sensitive enough to show trends and, where possible, permit distinction between human-induced and natural changes.
- **Representative:** The set of indicators should provide a representative picture of the pressures, biodiversity state, responses, uses and capacity (coverage).
- **Small number:** The smaller the total number of indicators, the more communicable they are to policy makers and the public.
- **Meaningful:** Indicators should be relevant to users and them help understand the impacts of practices on biodiversity

3 A STEP-WISE APPROACH TO THE DEVELOPMENT OF A BIODIVERSITY ACTION PLAN

Key actions in relation to the use of PSR indicators for biodiversity assessment are:

1. Goal definition
2. Scoping and hot spot analysis
3. Setting the boundary
4. Benchmarking to set the reference state
5. Engagement with stakeholders and experts
6. Identifying and prioritizing indicators
7. Effective communication

Each of these actions is discussed in the following subsections.

3.1. Goal definition

When designing, or implementing a biodiversity assessment it is important to clarify the purpose or objectives. A farmer may wish to assess the farm biodiversity natural capital for personal reasons, to meet customer requirements or as part of a community biodiversity programme. An industry stakeholder may want reassurance that their suppliers are meeting required standards with respect to biodiversity. Government stakeholders may require biodiversity information as part of a 'license to operate' or to allocate payments associated with participation in stewardship schemes.

Each of these different objectives influences the type of PSR indicators selected to measure performance and their improvement over time. For example, a community may be concerned about algal blooms in an estuary and their impact on ecosystem function (state). The relevant pressure indicator is pollution, the mechanism eutrophication and response indicators could be changes in on-farm nutrient management and protection of riparian zones. Although this is a relatively simple example it illustrates the importance of defining the goal of the biodiversity assessment because the goal will inform the selection of indictors, the scope and the stakeholders that need to be involved.

3.2. Scoping and hot spot analysis

The purpose of a scoping analysis is to identify the important biodiversity issues and their drivers within the geographical areas influenced by the dairy farming system. Given the multivariant nature of biodiversity, these issues vary depending on the geographical context, types of management practices being used and the biodiversity reference state.

The scoping analysis should also include indicators associated with off-farm feed production and its end impacts, which extend past the farm boundary (e.g. impacts on waterways) but within the control of a farmer or processor. For example, a pasture-based dairy farming system is likely to exert nutrient pressure on aquatic biodiversity in adjacent waterways through nutrient and sediment run-off and then, eventually, on the final receiving body (e.g. Gulf of Mexico). Total mixed ration (TMR) dairy farms with full nutrient capture and water recycling could have limited contributions to nutrient pollution because nutrients can be recycled within the system. However, depending on where the feed for the TMR system is sourced, there could be significant biodiversity impact of the TMR farming system on pressures such as habitat degradation in geographical locations some distance from the farm gate. This is also relevant for processors in terms of sourcing inputs. Processors should include the impact on biodiversity of the production of any raw materials they source, not just milk.

Qualitative hotspot analysis identifies the relative importance of different drivers of biodiversity change, and should prioritize those drivers that can be controlled or influenced by the land manager (or user). Categories or drivers under the control of the land manager are not confined to the selected area but include pressures that impact surrounding or connected areas (e.g. invasive species). When conducting hotspot analysis, particular attention should be paid to pressures potentially affecting protected areas and species.

3.3. Setting the boundary

There are significant differences between dairy farming systems and landscapes at a regional, national and global scale. Different dairy farm systems can often be found within the same landscape. For example, TMR farming systems can be found adjacent to low-input pasture systems or intensive, irrigated farming systems. With heterogeneity of dairy farm systems within landscapes and between landscapes, the most appropriate boundary for assessing the biodiversity footprint of a dairy farm is the impact of their practices on biodiversity assets both within the farm boundary and outside the farm boundary. Examples of external biodiversity assets are wetlands or estuaries that could be impacted by excess nutrient runoff into adjoining waterways.

The boundary should include:

- Land used for dairy production, including off-farm feed production
- Waterways and wetlands included within the dairy production area or connected to the dairy production area
- Biodiversity conservation areas or refugia included within the dairy production area or connected to the dairy production area

Although a dairy farm business may not be able to directly influence the biodiversity impacts of off-farm feed production it should be able to account for the biodiversity impacts of feed imported onto the farm and, where feasible, mitigate these impacts as much as possible. Examples of mitigation are purchase of feed that is certified as sustainable, or buying from a farmer in the area that manages biodiversity well (based on documentation, etc.)

3.4. Benchmarking to set the reference state

Where possible, a reference state for biodiversity should be established for biodiversity assessments involving monitoring of progress over time. The reference state should be relevant to the indicator, for example the percentage of protected riparian zone, the extent of habitat fragmentation or the number of landholders participating in conservation programmes. There are different possibilities for the reference state (20 years ago, prior to the action plan, average of the area, etc.), depending on the goal of the action plan.

Knowledge of reference states or baseline conditions is important when selecting response indicators. Because response indicators reflect actions and decisions implemented by stakeholders, an understanding of the social, cultural, economic and biophysical assets is also required. For example, a key economic barrier is security of land tenure; land managers with no land tenure may have limited potential or incentive to implement biodiversity response indicators, in contrast to family or corporate-owned, intensive livestock farming systems.

3.5. Engagement with stakeholders and experts

Stakeholders play an important role in the prioritization of issues, identifying appropriate actions and ongoing monitoring. Experts can assist through the provision of technical information and, if relevant, conduct some of the assessment practices, such as habitat surveys.

Some more information about stakeholder engagement can be found in the Dairy Sustainability Framework (DSF) *Implementation guide to delivering the Dairy Sustainability Framework* (GDAA, 2015). The DSF guide defines a stakeholder as follows: 'Stakeholders are individuals or groups who have an interest in any decision or activity undertaken by an organization'. As highlighted in the DSF guide, it is not possible to describe how many stakeholders should be involved. The first step is to draft an overview of all stakeholders and prioritize according to their influence on the issue. As stated in the DSF guide, 'engaging your stakeholders is about having two-way discussions on how best to work together' and is an ongoing process. This step is particularly crucial for biodiversity issues because it is such a complex and challenging area. Involving stakeholders will help them understand the complexity of the action plan and avoid criticism after implementation.

3.6. Identifying and prioritizing indicators

The selection of indicators is defined by the goal, scope and boundary of the assessment. Pressure, state and response indicators are complementary and, where possible, they should be used in combination. Response indicators provide recommendations for management practices to address major biodiversity issues; state and/or pressure indicators can be used to determine whether the changes have been successful. There can be long time lags between the implementation of a practice and a change in the associated state indicator. For practices where the outcomes may not be apparent as a result of time or distance delays, a good understanding of the underlying cause and effect relationship is important, as many of the influencing factors on biodiversity state are outside human control and, even more dramatically, outside dairy farmer control.

How important the different biodiversity issues are also depends on the biodiversity conservation value of the landscape. The biodiversity functions and services of production landscapes maybe more resilient to intensive dairy farming than landscapes of high biodiversity value. Farmers need to understand the capacity of the local ecosystem to absorb impacts such as nutrient loads. A minimum set of practices regarding soil health, air emissions and water impact is needed to maintain biodiversity, even for landscapes of low conservation value. Conversely, dairy farms located in production or low value biodiversity landscapes may have greater potential to enhance local and regional biodiversity through management practices than farms located in landscapes with high levels of existing biodiversity. These location and system factors make selection of comparable dairy farm biodiversity indicators at a local, regional and global scale difficult.

For companies or other organizations that use supplier sustainability assessments globally or regionally, it is important to understand that each dairy business should assess its own biodiversity impacts and develop its own action plan for biodiversity that is context-specific and most relevant to its own business, based on an assessment of:

1. Relative pressures on biodiversity in their surrounding landscape, including hot spot analysis
2. Practical strategies available to them to mitigate these pressures
3. Biodiversity management strategies (with key performance indicators, milestones etc.) that will have the greatest impact on the desired goal

The assessment process should include the biodiversity impacts of off-farm feed production to account for 'leakage' of impacts. An example of how to identify appropriate PSR indicators is provided below (table 4), based on the International Union for Conservation of Nature and Natural Resources (IUCN) Guidance manual for TEEB country studies (TEEB 2013).

STEP 1: Identify the key pressure indicators that have the potential to impact farm and landscape biodiversity	STEP 2: Identify which biodiversity services (state indicators) are important to the functioning of the dairy farm production system at the farm and landscape scales	STEP 3: Identify the biodiversity management strategies (response indictors) that will have the greatest biodiversity benefits at the farm, regional, national and global levels, both current and future
These may be: Negative • Habitat loss/degradation as a result of land clearance for dairy production or overgrazing • Nutrient pollution • Intensification • Over-exploitation of natural resources such as water • Climate change • Invasive species Beneficial • Habitat restoration • Landscape connectivity	These may be: • Soil formation • Biological control (predator control by prey species) • Pollination (fodder crops) • Water quality • Habitats for local species, including locally harvested species • Protection from climate extremes	These may be: • Shelter belt establishment • Agro-forestry • Fencing of stock from riparian areas • Managing invasive species • Maintenance of indigenous species (e.g. grasses) • Provision of species refugia or linkages to wild life corridors • Erosion control, sediment retention (prevention of soil loss) • Retention of remnant vegetation • Retention or establishment of native vegetation around farm dams, wetlands and riparian zones • Precision irrigation and fertilizer application

Table 4: Steps to identify appropriate PSR indicators (TEEB, 2013)

This step may be followed by a measuring and managing step, if needed, to assess the improvements in biodiversity based on the actions taken. This content may be developed in a more practical user's guide.

3.7. Effective communication

The Dairy Sustainability Framework implementation guide (GDAA, 2015) gives general recommendations on communication about sustainability issues that are relevant for biodiversity. Please refer to the guide for more details on effective communication.

3.8. Conclusion and Summary

Most biodiversity initiatives in the livestock sector rely on PSR indicators, and response indicators in particular, rather than LCA approaches. As noted in the LEAP *Principles for the assessment of livestock impacts on biodiversity* the 'LCA approach for biodiversity assessment needs substantial improvements as it is unable to grasp the real and complex dynamics of ecosystem interactions' (FAO/LEAP, 2015). For these reasons, in the short term, it is likely that biodiversity assessment approaches will continue to be based on the PSR framework.

Many sector and supply chain assessments rely on Biodiversity Action Plans as a means of assessing the contribution of livestock enterprises to biodiversity. Biodiversity Action Plans enable continuous improvement through regular reviews based on key performance indicators to assess biodiversity, and cater for the range of dairy systems and geographic locations. Some case studies from different parts of the world are presented in Appendices 2–5.

The following list summarizes the main elements a Biodiversity Action Plan for livestock systems should include, as outlined in the LEAP guide (FAO/LEAP, 2015).

- Identification of biodiversity goals
- Clear statement of the method and outcome of scoping and hotspot analyses
- Recognition of off-farm impacts
- Approaches that recognize and differentiate between habitats of high conservation value and more common farmland habitats
- Selection of quantitative indicators
- Practical management strategies undertaken by farmers
- Implementation of a well-designed monitoring programme
- Valid and objective analysis of data
- Use of data to confirm success or the need to further improve management
- Successful knowledge transfer to farmers
- Wider communication of the biodiversity benefits and achievements in agricultural sustainability

For examples of biodiversity assessments see Appendices 2–5.

APPENDICES

Appendix 1: Glossary of terms

Benchmark: A standard or point of reference against which any comparison can be made.

Biodiversity: Variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic systems and the ecological complexes of which they are part, including diversity within species, between species and of ecosystems (CBD/UNEP, 1992).

Boundary: Set of criteria specifying which unit processes are part of a product system (life cycle) (IDF, 2015).

Characterization factor: Factor derived from a characterization model that is applied to convert an assigned life cycle inventory analysis result to the common unit of the category indicator (ISO 14044:2006).

Conservation: Changing needs or habits with the aim of maintaining the health of the natural world, including land, water, biodiversity and energy (Gibb et al., 2013).

Ecosystem: The complex of a living community and its environment, functioning as an ecological unit in nature (FAO, 2017).

Ecosystem resilience: The level of disturbance that an ecosystem can undergo without crossing a threshold into a different structure or with different outputs (UNEP, 2007).

Ecosystem services: The benefits people obtain from ecosystems. These include provisioning services, such as food and water, regulating services, such as flood and disease control, cultural services, such as spiritual, recreational and cultural benefits, and supporting services, such as nutrient cycling, that maintain the conditions for life on earth. Sometimes called ecosystem goods-and-service (UNEP, 2007).

Eco-toxicity: Environmental impact category that addresses the toxic impacts on an ecosystem, which damage individual species and change the structure and function of the ecosystem. Eco-toxicity is a result of a variety of different toxicological mechanisms caused by the release of substances with a direct effect on the health of the ecosystem (FAO/LEAP, 2015).

Environmental impact: Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization’s activities, products or services (ISO/TR 14062:2002, 3.6).

Erosion/compaction: The process of removal and transport of soil and rock by weathering, mass wasting and the action of streams, glaciers, waves, winds and underground water (FAO, 2013).

Eutrophication: A process whereby water bodies receive excess nutrients that stimulate excessive plant growth. In turn, this enhanced plant growth reduces dissolved oxygen in the water and can cause other organisms to die (Gibb et al., 2013).

Grassland: Land on which the vegetation is dominated by grasses, grass-like plants or forbs (FAO, 2005).

Greenhouse gases (GHGs): Gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds (ISO 14064-1:2006, 2.1).

Habitat: The particular environment or place where an organism or species tends to live; a more locally circumscribed portion of the total environment (FAO, 2013).

Habitat fragmentation: Set of mechanisms leading to the discontinuity in the spatial distribution of resources and conditions present in an area at a given scale that affects occupancy, reproduction, and survival in a particular species (FAO, 2013).

Habitat restoration: Rehabilitation of degraded or lost habitat.

Hotspot: Areas that support natural ecosystems that are largely intact and where native species and communities associated with these ecosystems are well represented. They are also areas with a high diversity of locally endemic species, which are species that are not found or are rarely found outside the hotspot (DEE, 2016).

Indicator: Signals - of processes, inputs, outputs, effects, results, outcomes, impacts, etc. - that enable such phenomena to be judged or measured. Both qualitative and quantitative indicators are needed for management learning, policy review, monitoring and evaluation (Choudhury and Jansen. 1999).

Invasive species: Species that are non-native to a particular ecosystem and whose introduction and spread cause, or are likely to cause, socio-cultural, economic or environmental harm or harm to human health (FAO, 2015).

Land tenure: the relationship whether legally or customarily defined, among people, as individuals or groups, with respect to land. Land tenure constitutes a web of intersecting interests (Gibb et al., 2013).

Life cycle: Consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal (ISO 14044:2006, 3.1).

Life cycle assessment (LCA): Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle (ISO 14044:2006, 3.2).

Normalized difference vegetation index (DVI): This is a simple graphical indicator that can be used to analyse remote sensing measurements, typically but not necessarily derived from data collected by satellites. It gives an indication of vegetation health and thus potential crop yield (Rojas and Ahmed, 2016).

Environmental pressures: Pressures refer to developments in the use of natural resources (materials, energy, water, land) as inputs to human activities, as well as the release of substances on the output side (waste, GHG emissions, air and water pollution). These pressures exerted by society are transported and transformed in a variety of natural processes and cause changes in environmental conditions (Miedzinski et al., 2013).

Environmental impacts: Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services (ISO 14044:2006; 3.4).

Riparian zone: Land adjacent to a stream (UN, 2001).

Savanna: A lowland, tropical or subtropical grassland, generally with a scattering of trees or shrubs (FAO, 2005).

Semi-natural habitat: Any habitat where human-induced changes can be detected or that is human managed, but which still seems a natural habitat in what species diversity and species interrelation complexity refers (National Institute of Biodiversity in Costa Rica).

Soil organic matter (SOM): The measure of the content of organic material in soil. This derives from plants and animals and comprises all of the organic matter in the soil exclusive of the matter that has not decayed (Manfredi et al., 2013)

System boundary: Set of criteria specifying which unit processes are part of a product system or the activities of an organization (ISO 14044:2006).

Total mixed ration (TMR): Method of feeding dairy cattle that involves mechanical mixing of forages with concentrate feedings without densification.

Tundra: Tundra is the global biome that consists of the treeless regions in the north (Arctic tundra) and high mountains (alpine tundra). The vegetation of tundra is low growing, and consists mainly of sedges, grasses, dwarf shrubs, wildflowers, mosses and lichens.

Water quality: Physical (e.g. thermal), chemical and biological characteristics of water with respect to its suitability for an intended use by humans or ecosystems (ISO 14044:2006).

Waterways: A river, canal or other body of water serving as a route or way of travel or transport.

Wetland area: An area of land covered either permanently or temporarily with water, covered by plants (including trees) that grow out of the water, or mixed with areas of open water (Gibb et al., 2013).

Appendix 2: Example of Biodiversity Action Plan – Australian dairy sector

Figure 2: Web view of the Dairy Australia Biodiversity Action Plan

The Dairy Australia Biodiversity Action Plan is a web-based platform (http://biodiversity.dairyaustralia.com.au/#/) that allows farmers to identify and map their farm's biodiversity assets, prioritize actions to enhance biodiversity and track progress (figure 2).

Map the farm and identify biodiversity assets, both on the farm and adjacent to it (figure 3).

Figure 3: Mapping of the farm and identifying biodiverity assets

Develop a biodiversity action plan by identifying priority actions through a process of self-assessment (figure 4).

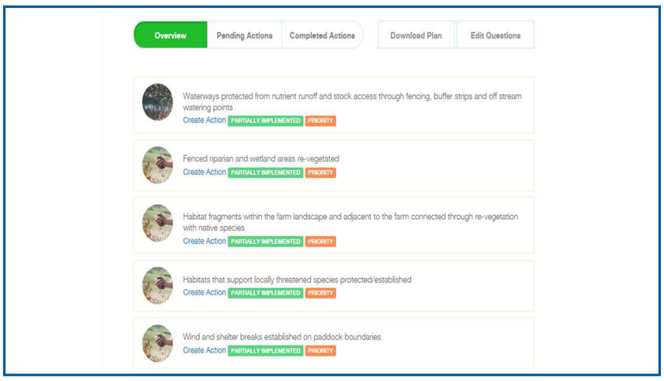

Figure 4: Identification of priority actions

The self-assessment questions cover four areas: aquatic biodiversity, habitat restoration and building ecosystem resilience and building skills and capacity to manage biodiversity (table 5).

	Relevant	Partially implemented	Fully implemented	Priority
Improving aquatic biodiversity				
Waterways protected from nutrient runoff and stock access through fencing, buffer strips and off-stream watering points				
Ground cover maintained at 95% to prevent soil erosion				
Fertilizer matched to plant/soil needs				
Effluent is applied in accordance with nutrient management (Fert$mart) plan				
Habitat restoration				
Fenced riparian and wetland areas re-vegetated				
Habitat fragments within the farm landscape and adjacent to the farm connected through revegetation with native species				
Habitats that support locally threatened species protected/ established				
Wind and shelter belts established on paddock boundaries				
Wetlands and farm dams protected from livestock (for farm dams - fence half the dam)				
Remnant vegetation is protected through fencing, removal of invasive species (e.g. weeds, rabbits)				
Overgrazing by native wildlife managed through appropriate fencing				
Foxes, cats and domestic dogs either controlled or managed to prevent predation of native fauna				
Building ecosystem resilience				
Consideration is given to maximizing species diversity and function when selecting species for re-vegetation				
Soil fertility enhanced through: Whole farm nutrient management planning Conservation tillage Amendment of soil pH and salinity constraints				
Carbon storage project eligibility under the Emissions Reduction Fund considered when designing biodiversity plantings				
Resilience to increased fire intensity and climate variability considered when selecting species for re-vegetation				
Building skills and capacity to manage biodiversity				
Species list recording on-farm sightings of native fauna and flora maintained				
Government, NGO or processor funding support accessed for biodiversity activities including riparian fencing				
Experience and knowledge of managing native flora and fauna acquired (e.g. wallaby fencing)				
Member of *Landcare* or farm discussion groups				

Table 5: Self-assessment questions for the development of a biodiversity action plan

Create actions and track progress

The action planning process enables land managers to prioritize actions, set reminders, track document success and upload before and after photos.

Figure 5 : Example of Mallala Action Plan

Appendix 3: Example of Biodiversity Action Plan – French dairy sector

Background

Context

The lack of a global and simple approach prevents farmers from taking into account biodiversity in their daily practices, which make it difficult to preserve the specific biodiversity richness of the territory managed by French dairy farms. It is not possible to quantify directly this richness. However, it has been scientifically demonstrated that indirect indicators such as agricultural practices and semi-natural habitat density, connectivity and quality give a good idea of the state of biodiversity of the area. These indirect indicators are easy to assess and understand.

Objectives

- To produce a reduced set of scientifically validated indicators, based on indirect indicators related to semi-natural habitats and agricultural practices
- To describe the mechanism and causal relationship of agricultural practices on taxonomic responses (species biodiversity on the dairy farm)
- To help dairy farmers identify levers of action to improve the impact of the farm on biodiversity (table 6)

Methodology

- Action 1: Identify and select pressure and state indicators of biodiversity (literature review) relevant to the situation in France
- Action 2: Establish the link between the effect of agricultural practices, semi-natural elements on the farm and the biodiversity state on the farm. Measure state indicators, measure pressure variables and analyse the link between them
- Action 3: Study the aggregation of existing methods for their use with the identified indicators
- Action 4: Test the tool on a sample farm

The relative importance of the management practices on-farm and the associated semi-natural habitats, and the impact they have on the state of biodiversity on the farm, have been analysed at two levels. Real measurements on a dairy farm have been carried out to validate the link.

- First level (grassland level). The link between the nature of the hedges, the pressure from grassland management and the impact it has on the biodiversity of the flora and fauna in the grassland have been measured.

- Second level (territory level): The link between the landscape heterogeneity around the farm and the pressure from the agricultural area on the territory and the impact it can have on the fauna biodiversity on the farm have been measured

Results

The BIOTEX tool (Institut de l'Élevage, 2014) measures the semi-natural habitats of the area around a farm (hedges, grassland, walls, etc.), on the farm (density, connectivity, organization) as well as the agricultural practices (fertilizers, animal density, etc.). The BIOTEX tool gives an indication about the levels of biodiversity of the area, especially its specific richness, making possible to estimate the global level of biodiversity on the farm. The tool uses indirect indicators associated with semi-natural habitats and pressure indicators associated with agricultural practices.

The BIOTEX tool is based on three main indicators:

- Territory and farm land use diversity
- Spatial organization of semi-natural habitats at landscape and farm level
- Grassland management

Lessons learned

- The BIOTEX tool takes into account both management practices and semi-natural habitat density to explain the biodiversity on the farm, which is very new and robust scientifically
- The tool takes into account the influence of the territory on the state of biodiversity on the farm, which is also very new and robust
- The tool is easy to use at the farm level, with no direct measurements needed, and helps to identify improvement actions
- The limit: it is not a chain approach

Identify priority actions

	Applicable	Current practice	Priority
Improving aquatic biodiversity			
Matching fertilizer to plant/soil needs to reduce nutrient loss			
Integrated pest management to reduce pesticide use			
Habitat restoration			
Revegetation of riparian zones			
Vegetation planting to connect habitat fragments within the farm landscape and adjacent to the farm			
Establishment of wind and shelter breaks around pasture			
Establishing/protecting habitats that support locally threatened species			
Building ecosystem resilience			
Implementing integrated pest management			
Enhancing soil fertility through: Whole farm nutrient management planning Conservation tillage			
Building skills and capacity to manage biodiversity			
Accessing government, NGO or processor funding support for biodiversity activities			
Learning from other farmers in the area who have made changes to protect and enhance biodiversity			

Table 6: Identification of priority actions for the development of a biodiversity action plan for the French dairy sector

Appendix 4: Example of Biodiversity Action Plan – New Zealand dairy sector (Fonterra)

Background

Supply Fonterra is Fonterra's programme of on-farm initiatives that is working to improve milk quality while reducing dairying's environmental footprint. *Supply Fonterra* is a toolkit and support service designed to help farmers meet industry, regulatory, compliance and market requirements associated with risk areas. *Supply Fonterra* incorporates Fonterra's approach to on-farm biodiversity and water quality enhancement.

In addition to the *Supply Fonterra* programme, Fonterra has partnered with central government via the Department of Conservation on the *Living Water* programme, which is a ten-year partnership with the vision that 'a sustainable dairying industry is part of healthy, functioning ecosystems that together enrich the lives of all New Zealanders'. The *Living Water* programme is working in five sensitive catchments across the country where intensive dairying exists, with the aim of improving biodiversity and water quality.

Context

The *Supply Fonterra* programme is implemented on all Fonterra farms and includes the following elements related to biodiversity and water quality: farm dairy and environmental assessment (FDEA), effluent management, nitrogen management and waterway and riparian management. *Supply Fonterra* works directly with stakeholders to define a prioritized set of interventions to tackle the most critical environmental issues, where freshwater biodiversity is one of the most material issues. In addition to providing farmers with clear minimum standards and assessment processes, Fonterra's Sustainable Dairying Advisors and Area Managers offer one-to-one advice and support to help farmers identify risks and future-proof their systems.

The *Living Water* programme supports *Supply Fonterra* to significantly lift environmental performance and farm profitability in five sensitive priority catchments. This is undertaken by focusing on the interconnectedness of ecosystem resilience and farming practice, running trials on new and innovative ways of addressing the negative impacts of dairying on biodiversity and water quality, and working at the catchment/landscape scale on building ecosystem resilience through partnerships with key stakeholders and the community.

Biodiversity-related objectives

Supply Fonterra (all Fonterra farms)

1. Minimise the impact that Fonterra supplying farms have on surface water quality through improving farm practices in effluent, riparian and nutrient management
2. Protect water resources through the promotion of responsible, effective and efficient water use on-farm
3. Improve farmer understanding and awareness of the requirement to minimize the impacts of dairy farming on water quality

Living Water (five sensitive catchments across the country)

1. Protect aquatic values by maintaining and enhancing the water regime and water quality
2. Maintain or restore indigenous ecosystem conditions
3. Maintain and enhance indigenous species diversity and threatened species
4. Use integrated catchment management principles and best practice methods to improve catchment health and achieve sustainable production
5. Recognize and provide for the values of Mātauranga Māori by working with iwi, hapu and whanau
6. Achieve engagement and participation of stakeholders, landholders and community
7. Promote conservation, sustainable farming and the outcomes from the *Living Water* programme

Methodology

Supply Fonterra

- Communication of clear environmental standards to farmers (the standards can differ depending on location in NZ)
- Provision of good practice examples and techniques to farmers
- Advice and support from the Sustainable Dairying Advisory team
- Measure progress and analyse data
- Recognition of the good work farmers are doing to reach sustainability targets

Living Water

- Understand catchment scale environmental ecological services, high value ecological areas and species, and catchment pressures (current state)
- Identify priority pressures to address on-farm and off-farm impacts
- Undertake detailed biodiversity assessments on-farm (current state) and identify enhancement opportunities
- Identify priority off-farm actions to enhance biodiversity at the catchment scale
- Identify priority on-farm actions in consultation with farmers (over and above supplier standards and/or environmental regulations)
- Identify and implement landscape level ‘step change’ ecological resilience and farm practice activities

- Implement off-farm actions in partnership with catchment stakeholders and communities
- Assist farmers to implement on-farm biodiversity actions over time
- Combine biodiversity assessment information and actions with *Supply Fonterra* programme assessment information and actions to create one integrated 'action plan' for the farmer
- Design and implement on-farm and off-farm monitoring programmes, including repeat biodiversity assessments using key indicators
- Share innovative approaches and practices that improve ecosystem resilience and farm profitability with others

On-farm assessments

Supply Fonterra environmental assessments include:

- Identifying any environmental risks associated with the management of effluent, waterways, water use and nutrient management
- Collection of data to assess the current state and identify gaps for future requirements
- Mapping and verification of waterway management practices on-farm, including stock exclusion, stock crossings and riparian enhancement
- Providing tools and information on how to improve environmental management practices at the time of assessment, and provide support and technical advice from sustainable dairying advisors

Living Water biodiversity assessments include:

- Describing and mapping terrestrial and aquatic vegetation and habitat types
- Recording vascular plant and fauna species, and identifying threatened species
- Capturing photographic point records for current versus future state analysis
- Describing biodiversity values
- Assessing ecological significance of sites based on representativeness, diversity and pattern, rarity and special features, naturalness, size, shape and buffering
- Identifying threats to existing biodiversity
- Identifying and prioritizing opportunities and management options for biodiversity enhancement

Examples of management interventions/actions

1. Improving aquatic biodiversity and habitat:
   - Protection of waterways from nutrient runoff and stock access through fencing, riparian planting and provision of alternative water sources
   - Riparian planting to stabilize waterways, prevent sediment runoff and moderate water temperature
   - Installation of silt traps to capture sediment runoff
   - Nutrient management planning and matching fertilizer to plant and soil type to reduce nutrient loss

- Creation of artificial wetlands
- Restoration of fish passage
- Best practice waterway/drain management methodologies

2. Restoring terrestrial biodiversity and habitat:
    - Pest and weed management
    - Protection of existing remnant vegetation and wetlands from stock access through fencing
    - Revegetation of existing remnant areas
    - New plantings to connect remnant fragments on and off farm

3. Implementing integrated catchment management approach:
    - Working in partnership with local government, NGOs, iwi/hapu, schools, individual landowners and community organizations
    - Landowners and managers sharing experiences and best practice
    - Working with research agencies to increase knowledge/information and work on innovative solutions to complex challenges
    - Connecting landowners to additional funding and/or grants for biodiversity enhancement

Appendix 5: Example of Biodiversity Action Plan – Dutch dairy sector (FrieslandCampina)

Mission: ***'Good farming for protection of natural capital'***

The mission of the Dutch dairy farming sector is recovery of biodiversity in dairy agriculture. In order to achieve this, the dairy cooperative *FrieslandCampina* is developing the Biodiversity Monitor for Dairy Farming in cooperation with the Rabobank, the World Wildlife Fund and the Louis Bolk Institute.

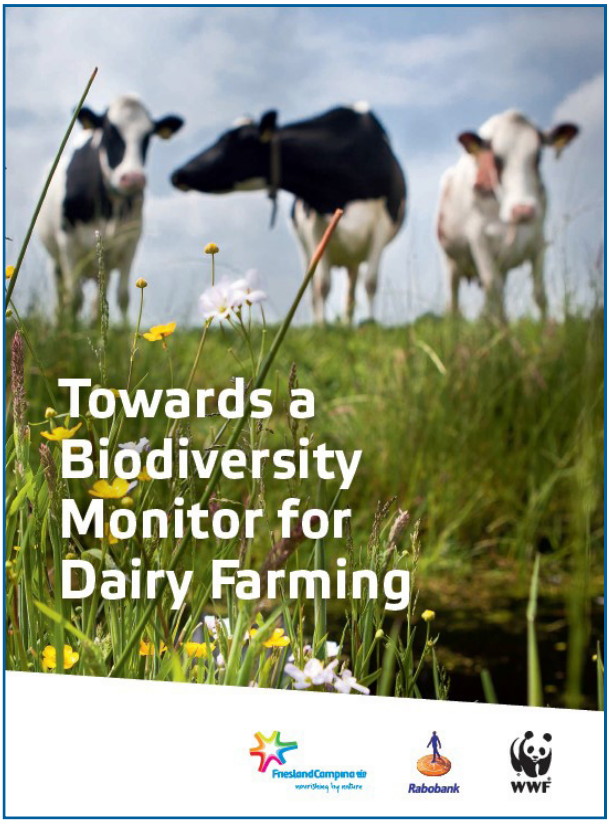

Figure 6: Cover of the document "Towards a Biodiversity Monitor for Dairy Farming" edited by FrieslandCampina

The Biodiversity Monitor for Dairy Farming (figure 6) provides insight into the actions of dairy farmers, with the aim of strengthening biodiversity. This involves biodiversity at the farm, on and around the farm yard, soil parcels, and beyond. In connection with this, the influence of a farm on the region and on neighbouring nature reserves is measured and monitored.

The dairy farmers can play a major role in preserving and strengthening biodiversity. Data from the WWF show that agricultural areas, which account for two thirds of the land surface of the Netherlands, form the largest habitat for plants and animals. Consequently, the way in which the dairy sector treats this landscape has a significant impact on the habitat of flora and fauna.

Dairy farmers are dependent on fertile soil, sufficient clean water and minerals. Availability of these all start with the soil, in particular that of grassland. Proper management of grassland is by far the best way to improve the quality of soil, both for storage of carbon and for nutrients. Healthy soil makes dairy farmers less dependent on a supply of fertilizers and more resistant to changing weather conditions, such as heavy rain or extreme heat, and pests. These are all interrelated (figure 7).

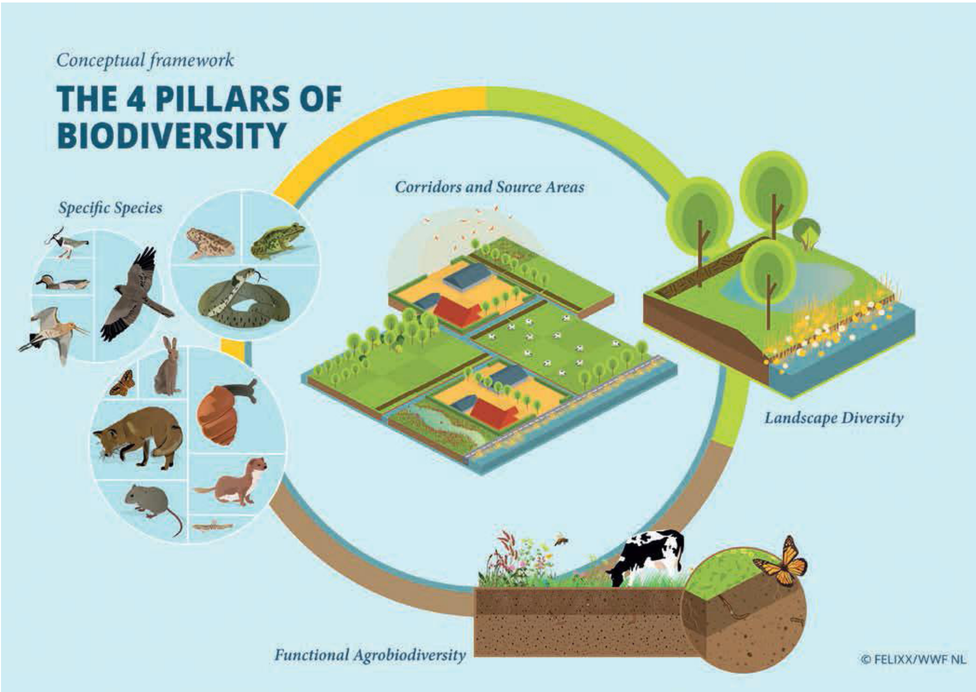

Figure 7: The conceptual framework of the four pillars of biodiversity

Farmers can easily take various measures that have a positive effect on the soil. It is important to strive for as little grassland renewal as possible. A good example is to stop tearing or ploughing the grassland. This makes reseeding unnecessary, which has a favourable effect on the quality of the soil. Avoiding tearing also prevents release of adsorbed carbon. Additionally, grasslands that are used by a farmer for outdoor grazing remain more in balance and, therefore, do not need spraying.

However, biodiversity in agricultural areas is steadily declining. As a result of scale increase, desiccation, eutrophication and land reparcelling, the population sizes of breeding birds, mammals and butterflies in agricultural areas decreased by 40 percent between 1990 and 2013. This is also true of prey for foxes and birds of prey. In addition, grassland is being used more intensively. Grass is being cut earlier and more often and the diversity in types of grass and herbs is decreasing. The Biodiversity Monitor for Dairy Farming aims to prevent this.

Biodiversity Monitor for Dairy Farming

The monitor is an instrument consisting of a number of indicators: species management, landscape management, land use, emission of greenhouse gases, herb-rich grassland, emission of ammonia, soil management and loss of minerals. The indicators have been selected so that they keep each other balanced and exclude ‘escape routes’. This approach prevents farmers from shifting the environmental impact. A situation in which a dairy farmer mainly focuses on extensive grassland management, with a lot of herbs and flowers, and at the same time purchases large quantities of soy, is to be avoided. The same holds for farmers who focus on the emission of greenhouse gases and therefore grow a lot of maize, which is bad for soil quality and thus increase the need for pesticides.

The approach is based on that of the Natural Capital Protocol, a framework of the Natural Capital Coalition, which is to become the international approach for the protection of natural capital. The indicators also correspond with the IDF Biodiversity Guide of the International Dairy Federation and the LEAP project of the Food and Agriculture Organization. The biodiversity monitor enables the conversion from global descriptions to an action perspective for dairy farmers (figure 8).

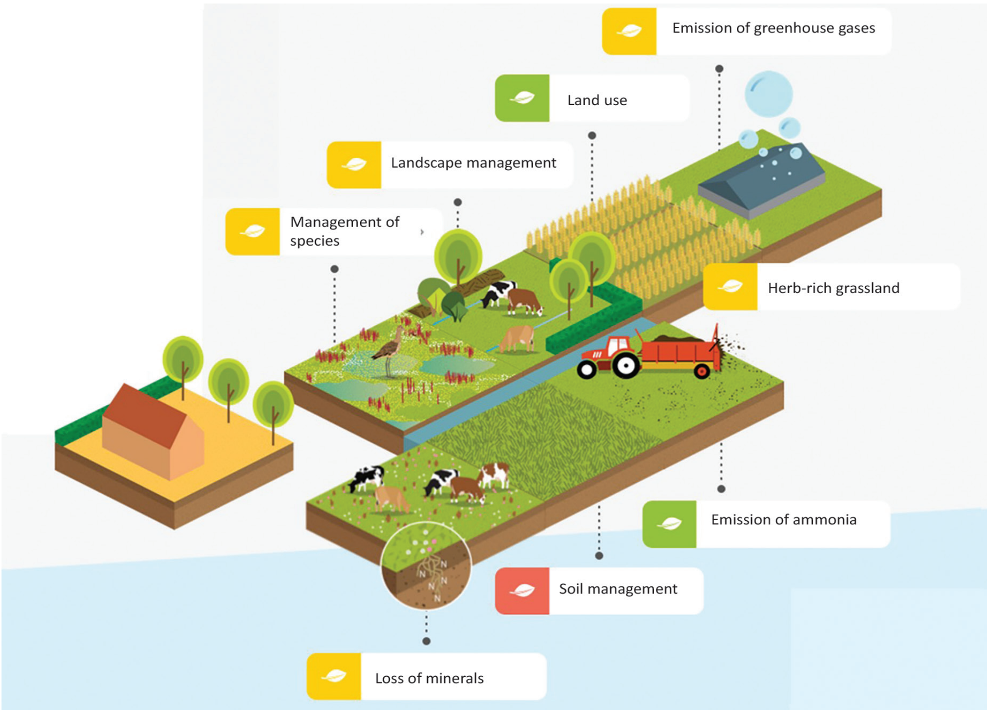

Figure 8: Overview of the prototype for one farm

Revenue model

A revenue model could help win over dairy farmers and make sure that the motivation comes from the dairy farmers themselves. It is important that dairy farmers are motivated to run their farms in a way that increases their efficiency and improves their business management through protection of natural capital.

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THE IDF GUIDE ON BIODIVERSITY FOR THE DAIRY SECTOR

ABSTRACT

These guidelines aim at providing principles for identifying biodiversity indicators that can be used to measure progress and assist technical advisors of dairy industry stakeholders in improving biodiversity management.

Keywords: *: biodiversity, ecosystem, dairy impacts, dairy farm.*

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  - Title of paper (or chapter, if the publication is a book);
  - If the publication is a journal, title of journal (abbreviated according to 'Bibliographic Guide for Editors and Authors', published by The American Chemical Society, Washington, DC), and volume number;
  - If the publication is a book, names of the publishers, city or town, and the names and initials of the editors;
  - If the publication is a thesis, name of the university and city or town;
  - Page number or number of pages, and date.

Example: 1 Singh, H. & Creamer, L.K. Aggregation & dissociation of milk protein complexes in heated reconstituted skim milks. J. Food Sci. 56:238-246 (1991).

Example: 2 Walstra, P. The role of proteins in the stabilization of emulsions. In: G.O. Phillips, D.J. Wedlock & P.A. William (Editors), Gums & Stabilizers in the Food Industry - 4. IRL Press, Oxford (1988).

Abstracts

An abstract not exceeding 150 words must be provided for each paper/chapter to be published..

Address

Authors & co-authors must indicate their full address (including e-mail address).

Conventions on spelling and editing

IDF's conventions on spelling and editing should be observed. See Annex 1.

ANNEX 1

IDF CONVENTIONS ON SPELLING AND EDITING

In the case of native English speakers the author's national conventions (British, American etc.) are respected for spelling, grammar etc. but errors will be corrected and explanation given where confusion might arise, for example, in the case of units with differing values (gallon) or words with significantly different meanings (billion).

"	Usually double quotes and not single quotes
? !	Half-space before and after question marks, and exclamation marks
±	Half-space before and after
micr<u>oo</u>rganisms	Without a hyphen
Infra-red	With a hyphen
et al.	Not underlined nor italic
e.g., i.e.,...	Spelled out in English - for example, that is
lit<u>re</u>	Not liter unless the author is American
ml, mg,...	Space between number and ml, mg,...
skimmilk	One word if adjective, two words if substantive
sulfuric, sulfite, sulfate	Not sulphuric, sulphite, sulphate (as agreed by IUPAC)
AOAC <u>INTERNATIONAL</u>	Not AOAC<u>I</u>
progra<u>mme</u>	Not program unless a) author is American or b) computer program
milk and milk product	rather than "milk and dairy product" - Normally some latitude can be allowed in non scientific texts
-ize, -ization	Not -ise, -isation with a few exceptions
Decimal comma	in Standards (only) in both languages (as agreed by ISO)

No space between figure and % - i.e. 6%, etc.

Milkfat	One word
USA, UK, GB	No stops
Figure	To be written out in full
1000-9000	No comma
10 000, etc.	No comma, but space
hours	Ø h
second	Ø s
litre	Ø l

<u>t</u>he Netherlands

Where two or more authors are involved with a text, both names are given on one line, followed by their affiliations, as footnotes

for example A.A. Uthar[1] & B. Prof[2]
[1] University of ....
[2] Danish Dairy Board .....

IDF does not spell out international organizations

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