BIODIVERSITY MONITOR FOR THE DAIRY FARMING SECTOR

A new tool for standardised quantification of biodiversity-enhancing performance in the dairy sector

Rabobank

FrieslandCampina
nourishing by nature

WWF

SUSTAINABLE DEVELOPMENT GOALS

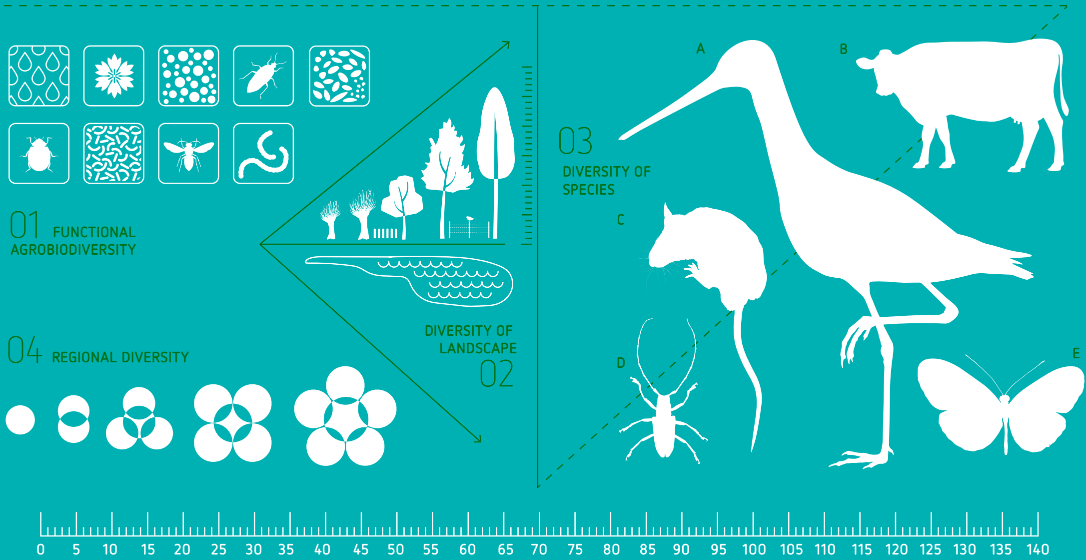
Sustainable Development goals: Global goals for sustainable developments

The Sustainable Development Goals (SDGs) are designed to eliminate poverty, inequality, injustice and climate change.

The 193 Member States of the United Nations adopted this Sustainable Development Agenda for 2015-2030. The Agenda includes a total of 17 Goals. Known formally as the 'Sustainable Development Goals', they are often abbreviated to 'SDGs' and apply to all nations and to all people.

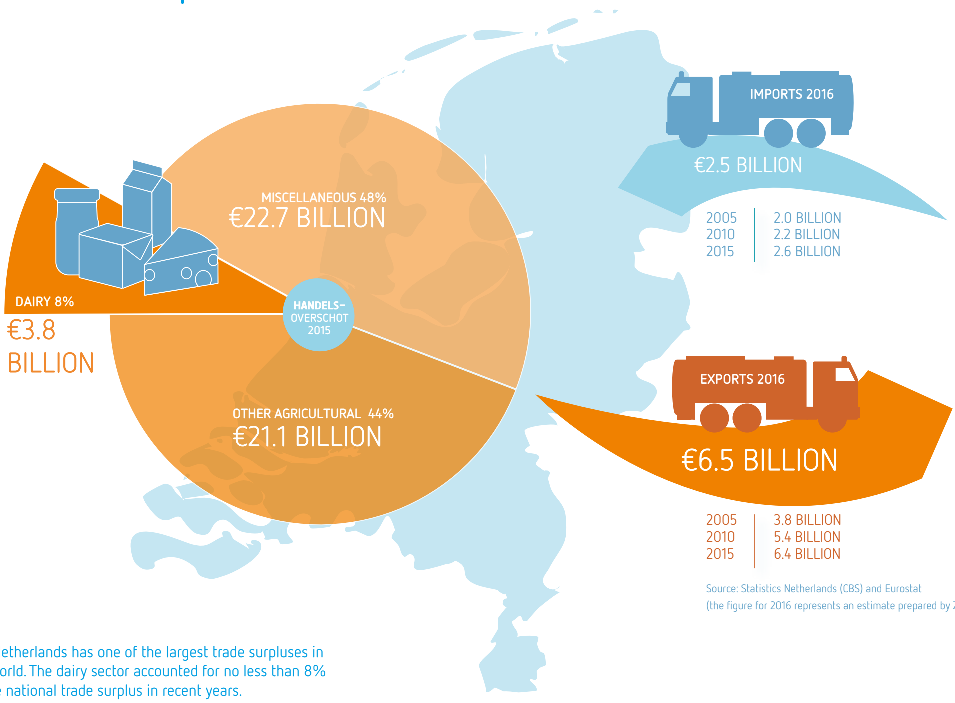
The Biodiversity Monitor will enable the Dutch dairy farming sector to achieve the following goals:

BIODIVERSITY MONITOR FOR THE DAIRY FARMING SECTOR



A new tool to quantify biodiversity-enhancing efforts in the dairy farming sector using a standardised method.

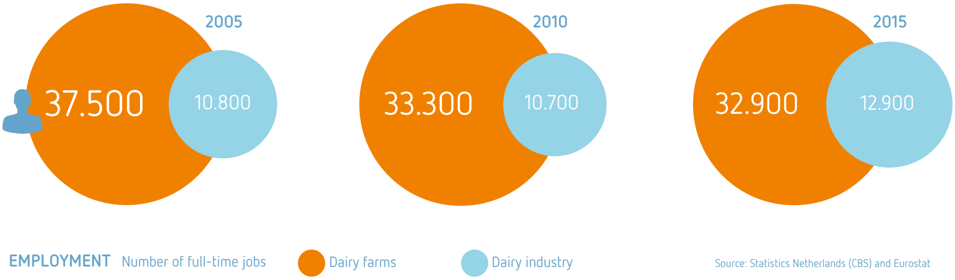
Dutch trade surplus



Source: Statistics Netherlands (CBS) and Eurostat
(the figure for 2016 represents an estimate prepared by ZuivelN

The Netherlands has one of the largest trade surpluses in the world. The dairy sector accounted for no less than 8% of the national trade surplus in recent years.

Employment in the dairy sector



Source: Statistics Netherlands (CBS) and Eurostat

OUR GOAL

FrieslandCampina, Rabobank and WNF (the Dutch chapter of the World Wide Fund for Nature/WWF) are all seeking to help restore biodiversity in agriculture, each coming from their own background and context. They aim to promote this goal by developing new revenue models in the supply chain. A second objective is to develop a metric to quantify any efforts by dairy farmers to improve biodiversity both on their own farms and beyond. The three partners are currently developing the 'Biodiversity Monitor for Dairy Farming' for this purpose.

This innovative approach aims to create a tool which makes it possible to quantify biodiversity results and, as such, can also be used to reward dairy farmers through supply chain partners and other stakeholders. In addition to FrieslandCampina and Rabobank, these may include other individuals and entities such as lease-holders and government agencies. The idea behind this initiative is that a standardised tool which is endorsed by three partners with a large support base or customer base is more likely to be picked up on a wider scale.

This memo describes the process of developing the Biodiversity Monitor for Dairy Farming.

Authors

Guus van Laarhoven (FrieslandCampina)
Jeen Nijboer (Rabobank)
Natasja Oerlemans (WWF Netherlands)
Richard Piechocki (Rabobank)
Jacomijn Pluimers (WWF Netherlands)

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SCTN_1 Nature and agriculture and inextricably linked

Accounting for two-thirds of the country's land surface, agricultural land provides the largest habitat for plants and animals in the Netherlands (World Wide Fund for Nature, 2014). The diversity of these species is referred to as 'biodiversity' and is determined by a variety of factors, including the diversity of the landscape.

This biodiversity, in turn, also benefits the agricultural industry in a number of ways. For the reasons outlined below, biodiversity is relevant to dairy farming, and vice versa (Melk, 2016).

1 The dairy farming sector is the largest consumer of land in the Netherlands[1]. This means that the way the dairy farming industry treats this landscape has a significant impact on the habitat of flora and fauna. Pressure on revenues has compelled individual farms to increase the size of their farms in order to offset these lower revenues. This has an impact on the structure of the dairy farming sector and, indirectly, on its impact on nature and the environment.
Effective management of the landscape and the natural environment by dairy farmers can significantly increase the chances of survival of species which are dependent on the agricultural landscape. This must

1) Based on Felixx, 2016: http://bit.ly/2zvCTnR

also include bringing about a reduction of environmental pressures by the dairy farming industry on nature reserves in the Netherlands and elsewhere in the world.

2 Increasing biodiversity also has a direct impact on farms. Dairy farmers depend on natural resources, including fertile soil, sufficient and clean groundwater, and the availability of minerals. The promotion of, in particular, functional biodiversity such as an abundance of soil organisms contributes to living, healthy soil and facilitates optimum productivity. 'Farming with Nature' helps to protect the natural capital essential to the farm's future and reduces dependence on external inputs such as fertilisers, crop protection products and medication.

The challenge

The income of dairy farmers is highly impacted by a volatile market, while expenses continue to rise. They also find it challenging to meet environmental targets, including those for phosphate and nitrogen production and greenhouse gas emissions. Biodiversity in agricultural areas continues to show a steady decline, as evidenced, among other things, by the fact that the population size of breeding birds, mammals and butterflies fell by 40 percent between 1990 and 2013[2].

The main causes of the decline in biodiversity in agricultural areas are scale increase, desiccation, eutrophication and land reparcelling, causing small-scale landscape elements (such as hedgerows) to disappear. In addition, grassland is used more intensively, the grass is cut earlier and more often, and diversity in the types of grass and herbs in the grassland is declining (EEA, 2015).

There is a growing interest among politicians and the public in these changes in the landscape and the decline in biodiversity, including, for example, the decline in the population of meadow birds. The challenge for the dairy sector is to ensure the continuity of farming – also in terms of the availability of natural resources – while at the same time reducing the burden on the environment and strengthening the landscape in order to retain to retain social acceptance and be viable in the long term.

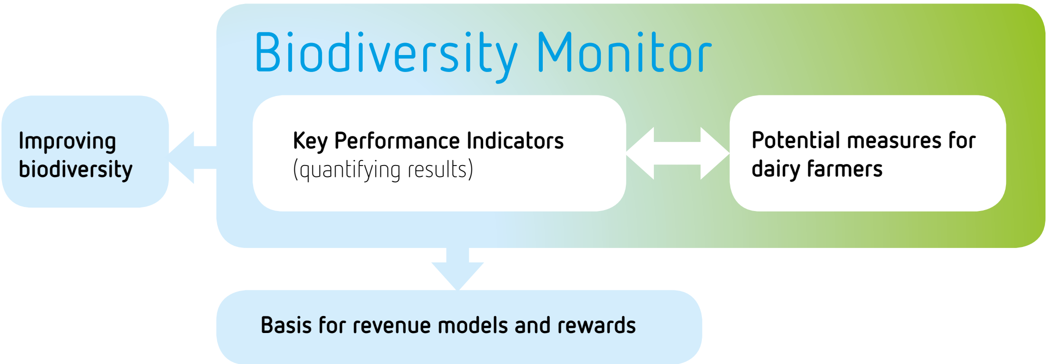
2) World Wide Fund for Nature, 2015 and **Compendium voor de Leefomgeving**, 2016. http://bit.ly/2ihGqCg

SCTN_2 Basic principles of the Biodiversity Monitor for Dairy Farming

By virtue of their farming operations, dairy farmers exert influence on their environment and, by implication, on biodiversity both locally and globally. KPIs are variables used to measure the performance of farms.

The Biodiversity Monitor for Dairy Farming uses Key Performance Indicators (KPIs) to measure the influence of individual dairy farms on biodiversity on the farm and beyond. This makes it possible to monitor the role of dairy farmers in the preservation of the landscape and the environment using a standardised system. In addition to providing a metric for assessing the impact on the environment (both positive and negative), the Monitor proposes specific measures dairy farmers can take to improve biodiversity. These include measures such as increasing the amount of permanent grassland in the building plan, overseeding clover in the grassland, and postponing the first mowing. This ensures that the Monitor provides an action perspective for dairy farmers. This approach is illustrated in the chart below.

Key criteria in the selection of KPIs are integrality and measurability. This means that the set of KPIs can be used to collectively quantify the performance of dairy farmers in an integrated manner with the objective of



improving biodiversity. This relates to biodiversity on dairy farms and their immediate environment, preservation areas throughout the Netherlands, and biodiversity outside the Netherlands. It is also important that the KPIs are measurable or can become measurable in the near future. This makes it possible to compare dairy farms with each other and compare farms over an extended period of time. It is important that the performance reflected in the KPIs is ultimately checked against tangible results for biodiversity in and around dairy farms. Furthermore, it is important that the Biodiversity Monitor is user-friendly; this can be achieved by restricting the number of KPIs as much as possible in order to ensure an accurate, integrated representation of performance based on biodiversity.

KPIs should ideally satisfy the following criteria:

1. The KPI must have a clear and demonstrable relationship to biodiversity.
2. The KPI must be measurable and available (in the immediate future) at all dairy farms.
3. The KPI must be comparable between farms.
4. The KPI must be reliable and it must be possible to safeguard it.
5. It must be possible to influence the KPI quickly by implementing specific measures.
6. Registration for calculation of the KPI does not involve any additional administrative expenses or requires only a minimum effort to obtain.
7. The KPI is in line with current measuring and monitoring tools.
8. The KPI meets the need for integrality and cohesion of the underlying measures.
9. The KPI has a baseline measurement or benchmark, or one can be assigned.

SCTN_3 Development of the Biodiversity Monitor

The process of developing the Biodiversity Monitor for Dairy Farming centred on the input and interaction between theory and practice. During the development process, FrieslandCampina, Rabobank and WNF worked closely with dairy farmers, researchers and agricultural environmental organisations and preservation societies (including groups of such organisations).

In addition, a series of feedback meetings were scheduled to gather input from other stakeholders in the supply chain, including other dairy farms.

This development process includes the following milestones:

- Development of a ‘Biodiversity for Dairy Farming’ conceptual framework, in which the term ‘biodiversity’ is operationalised for dairy farming.
- Exploration of potential KPIs in order to measure the contribution of dairy farmers to improving biodiversity.
- Continued development and arguments/supporting evidence for the most high-potential KPIs.
- Stakeholder dialogue.
- Development of a prototype of the Biodiversity Monitor for Dairy Farming.

The development process has resulted in a table showing the initial selection of the integrated set of KPIs for biodiverse dairy farming.

About the milestones

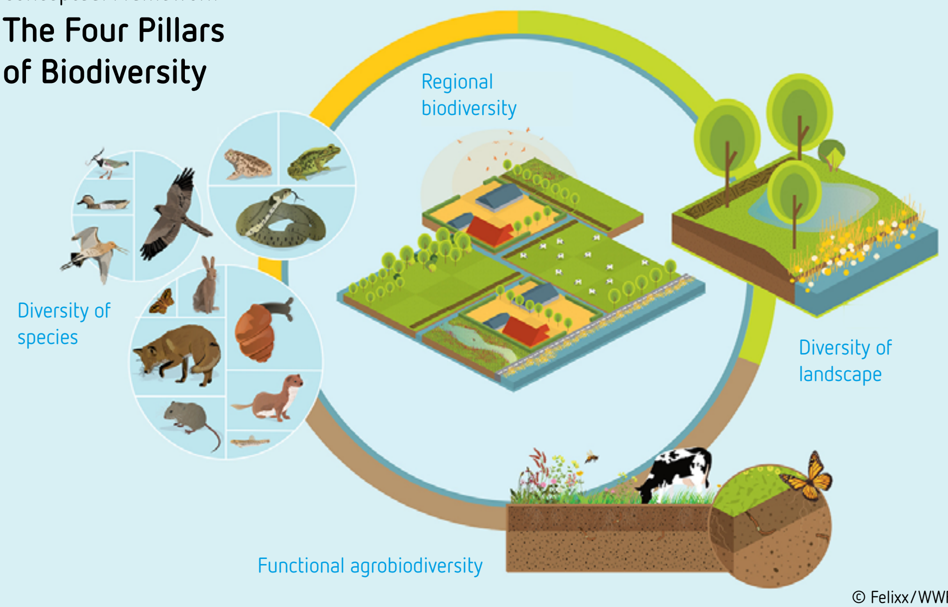
In the *Conceptual Framework for Biodiversity* (Erisman et al., 2014), the term ‘biodiversity’ has been redefined to apply to the dairy farming sector. It serves as the basis for assessing and quantifying biodiversity. This conceptual framework explains four interrelated pillars.

The four pillars of biodiversity in dairy farming are as follows:

1 ***Functional agrobiodiversity:*** The dairy farming sector makes use of the benefits of biodiversity, such as the availability of fertile soil and sufficient water and resistance to crop pests and diseases. Closing the nutrient cycles on farm level is essential.

2 ***Diversity of landscape:*** Landscape elements such as hedges, trees, ditches and ditch banks bring diversity to the physical environment. This increases biodiversity, including functional agrobiodiversity. By protecting, preserving and maintaining landscape elements, conditions are created for greater biodiversity.

Conceptual Framework
The Four Pillars of Biodiversity



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3 ***Diversity of species:*** Agricultural landscapes provide a habitat for specific types of flora and fauna. Targeted management can help preserve and strengthen these specific species.
4 ***Regional biodiversity:*** Specific species and biological processes pay no heed to the borders of the dairy farm. By connecting areas and using regional management, biodiversity can be increased at the regional level.

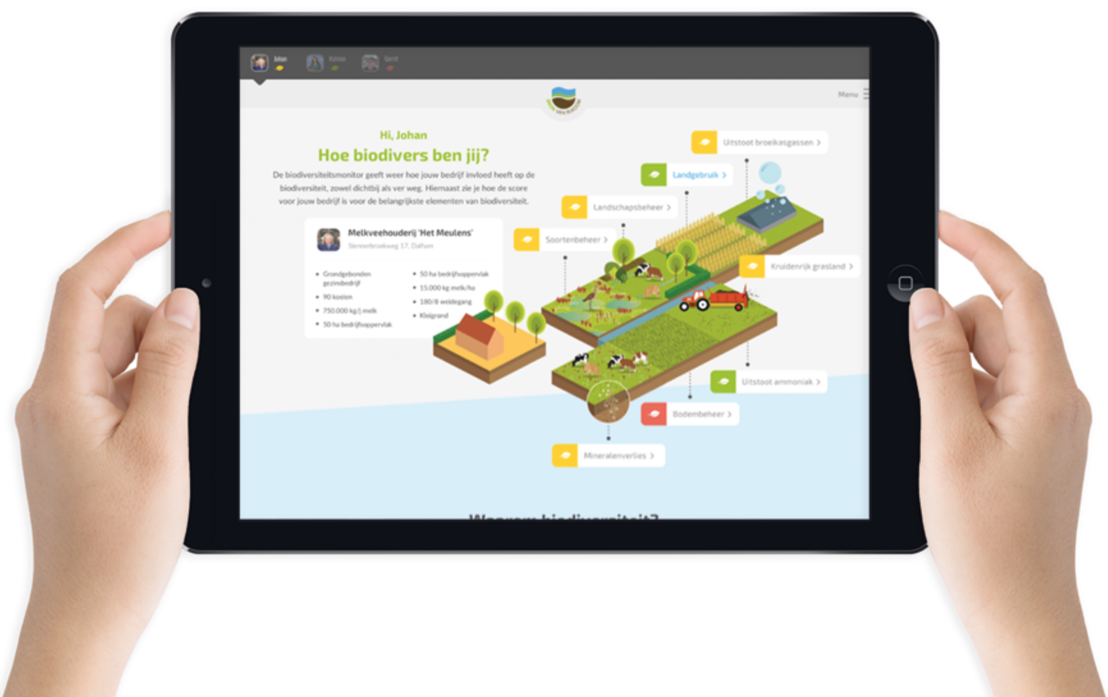
Once the conceptual parameters were in place, the Louis Bolk Institute (LBI) conducted a **survey** into KPIs which measured the performance of dairy farmers in terms of their contribution to biodiversity in relation to these pillars (Van Eekeren et al., 2015).

The LBI and Wageningen University and Research Centre (WUR) (Zijlstra et al., 2016) subsequently set out to further develop the KPIs for Pillar 1. The method used for a selection of KPIs differed from that used in the LBI study (Van Eekeren et al., 2015). The first step involved a selection of key figures available in existing databases by assessing all the key figures contained therein for their presumed impact on functional agrobiodiversity. This resulted in a list of 98 key figures. As part of the second step, a factor analysis was conducted to see whether, and how, the 98 key figures could be grouped or whether it was possible to create a single representative description per group of key figures with the correlation with biodiversity. The factor analysis produced a total of 22 factors. The third step, then, involved making a selection based on the criteria for KPIs. There were significant similarities in this selection with the KPIs identified by the LBI in the 2015 survey.

The development of the KPIs for Pillars 2 and 3 was completed as part of a practical pilot project (Zanen, 2016) in conjunction with four collectives (East Groningen, Noord-Friese Wouden, VALA and Waterland en Dijken). Based on this information, a recommendation was drafted for the realisation of KPIs and potential measures for Pillar 2 ('Diversity of landscape') and 3 ('Diversity of species'). Furthermore, potential measures, opportunities and action perspectives were further developed together with four agricultural nature management groups. Pillar 4, which centres on strengthening and improving biodiversity, will be further refined during the follow-up stage.

The **stakeholder dialogue** coincided with these studies. At the start of the development process, advisers and dairy farmers of three agricultural environmental organisations were regularly consulted, with the input focusing mainly on testing the conceptual framework, evaluating KPIs and assessing measures which impact the KPIs. At a later stage of the process, the input was formalised in a practical environment through the organisation of feedback meetings for different groups, including dairy farmers, supply chain partners and environmental organisations. During these feedback meetings, the results of studies were presented and the development of the Biodiversity Monitor – including the selection of KPIs – was discussed.

Another milestone in the development of the Biodiversity Monitor for Dairy Farming is a prototype, which visualises the application of the Biodiversity Monitor. It details the various KPIs and the interrelationship with biodiversity, presents the results for three sample farms, and describes opportunities for improving biodiversity.



SCTN_4 Integrated set of Key Performance Indicators

For the Biodiversity Monitor, the KPIs collectively provide a differentiated result of biodiversity, with the conceptual framework (along with the four pillars) serving as the conceptual basis.

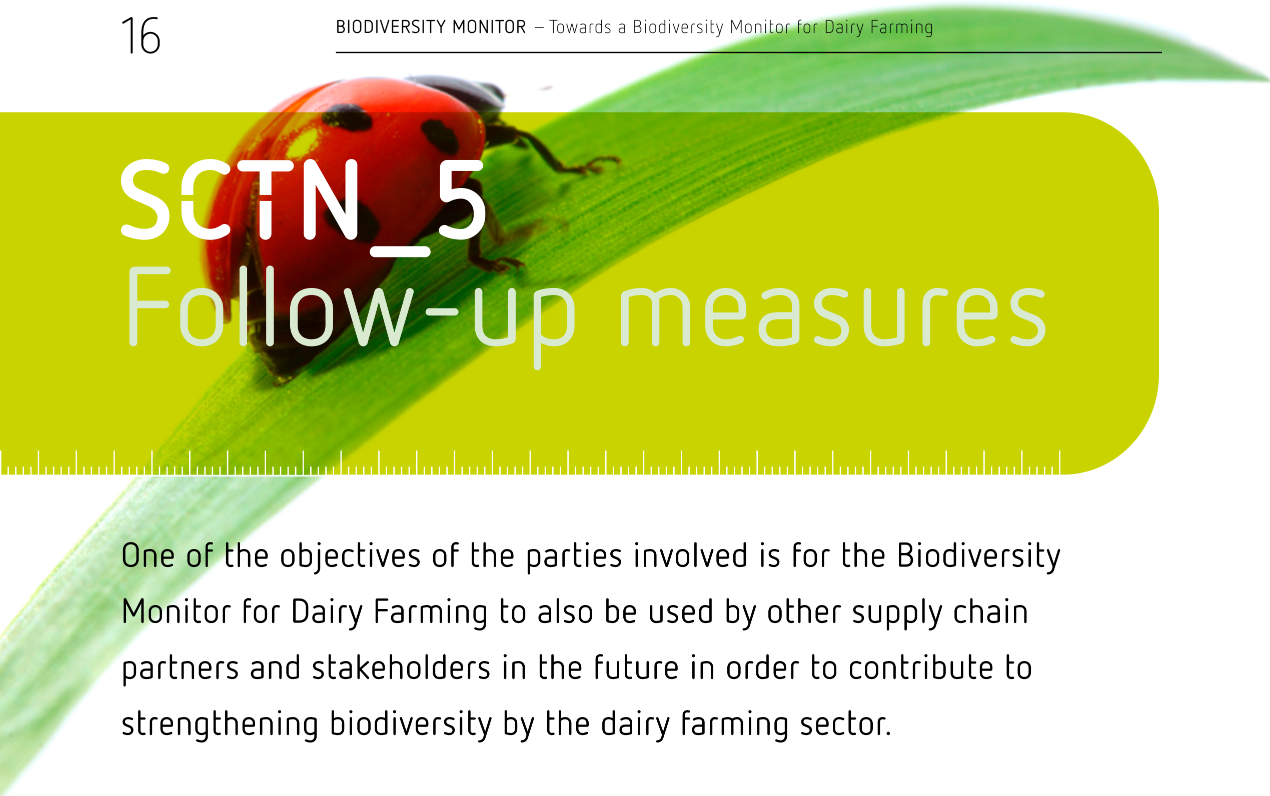
The KPIs can be used as tools to promote biodiversity in dairy farming. The KPIs indicate a farm's score on biodiversity and whether a farm is on track to meet the objectives set. KPIs are related – where possible – to the various pressure factors of the dairy farming sector on biodiversity. The KPIs constitute an integrated set which collectively reflect biodiversity performance. This means that KPIs are not applied individually; they balance each other out (and, by implication, the biodiversity result as well). By way of example: the KPI 'Percentage of protein produced on the farmer's own land' is an important KPI for Pillar 1 ('Functional agrobiodiversity'), but can also serve as an incentive to increase grassland production per hectare, when in fact this could have a negative impact on biodiversity. By including the KPI 'Nitrogen surplus in the soil' and a KPI for 'Herb-rich grassland' in the set of KPIs, this potential negative side effect is offset. Another example can be provided for the KPI 'Carbon equivalents per kilogram of milk'. For dairy farmers focusing on this KPI, efficiency-focused measures would be an obvious choice, as increasing milk production while keeping the size of the cattle population roughly the same and with the same level of emissions will improve performance. A focus on efficiency could initiate intensification, which – as indicated above – could have a negative effect on biodiversity. This is balanced out by KPIs related to the degree to which they

rely on the land, e.g. the KPI ‘Ammonia emissions per hectare’ and the percentage of protein produced on their own land.

An integrated set of KPIs was therefore chosen in order to keep the number of KPIs limited. This means a number of practicable KPIs were not included. This is offset by a strong indirect relationship to one or more KPIs from the selection. A key consideration when it comes to including or not including KPIs is whether a KPI can offset other KPIs. In the table below, for example, we have chosen the KPI ‘Percentage of permanent grassland of total acreage’, while the KPI ‘Percentage of grassland’ has been eliminated. The KPI ‘Percentage of permanent grassland’ is strongly related to the KPI ‘Percentage of grassland’, but has a larger value when it comes to improving biodiversity. Another factor is that meadow grazing is not included in this set as a separate KPI, while this does play a role in improving biodiversity and determines the results on one or more KPIs. This makes meadow grazing (or the extent thereof) a key measure which is a strong determinant for the performance of a number of individual KPIs. For example, there is a strong correlation between ammonia emissions and meadow grazing. In addition, meadow grazing is an important measure when it comes to maintaining high-quality pastures, which means it is related to the percentage of permanent grassland.

In the appendix the initial selection of the integrated set of KPIs for a biodiverse dairy sector is shown, including the substantiation (supporting evidence) and development stage and how these KPIs can be guaranteed. In addition, it also contains a description of the correlation with biodiversity and pressure factors (including emissions into the soil, water and air) and details on how the KPIs are calculated.

For application in practice, the ‘optimum environmental values’ must be determined, along with the ‘threshold values’. It is important, however, that the optimum level is determined in relation to all other indicators. Optimum environmental values show the most ideal situation from a biodiversity perspective. Threshold values indicate that a positive effect on biodiversity can be expected. Ideally speaking, all threshold values together should indicate a basic quality for a biodiverse dairy farm. The optimum environmental values will be further detailed in the follow-up to this project.



SCTN_5 Follow-up measures

One of the objectives of the parties involved is for the Biodiversity Monitor for Dairy Farming to also be used by other supply chain partners and stakeholders in the future in order to contribute to strengthening biodiversity by the dairy farming sector.

It is therefore necessary to test the Biodiversity Monitor and the prototype with dairy farmers in practice, for example through pilot projects. The prototype will also need to be further developed from both a technical and a substantive perspective into a fully fledged, usable instrument.

A key part of the substantive development is determining the values of the KPIs, which might be described as an 'environmental optimum'. It is important to provide scientific evidence for these values, including a focus on cohesion between the KPIs.

The applicability of the integrated set of indicators also needs to be assessed against the usability for dairy farmers in practice. Of particular importance is the check for a specific cohesion between the various KPIs. This is the only way to ensure that performance on the set of KPIs will actually result in an improvement of conditions for greater biodiversity. In addition to usability in practice, a comparison must be made of the performance of the KPIs and the actual level of biodiversity on and around the farm.

Another key aspect during the follow-up process is to further communicate the concept, involve other parties in the further development, and establish an organisational structure which facilitates the implementation of the Biodiversity Monitor for Dairy Farming as an independent standard. For example, it is important to focus on establishing an organisational structure which coordinates the management and use of the Monitor. Other considerations include opportunities for joining international initiatives such as the Natural Capital Protocol, the Dairy Sustainability Framework and FAO LEAP. The three initiators of the Biodiversity Monitor are exploring the various opportunities and are determining their future role in the follow-up process on this basis.

Appendix: Calculation Rules for KPIs Biodiversity Monitor for the Dairy Farming Sector

Pillar	**Pillar 1** Functional agrobiodiversity
Key Performance Indicator (KPI)	**Percentage of permanent grassland** (percentage of total acreage)
About this KPI	The larger the amount of grassland in the farming system, the more favourable the outcome for organic matter and soil biodiversity, and ultimately also for functions such as grass production (including nitrogen-generating capacity), environmental functions (including water regulation) and aboveground biodiversity (including the presence of meadow birds) (van Eekeren et al., 2008; van Eekeren et al., 2010). The share of grassland is therefore an indirect indicator of more functional biodiversity on the farm. It has a positive effect on the pressure factors of land usage, emissions into water, soil usage and use of resources. In addition to the share of grassland, the age of the grassland also plays an important role (that is to say, the age of permanent grassland increases gradually). The older the grassland, the less soil cultivation (including tearing) has been used, the more the ecosystem remains intact, and the greater the chances for biodiversity above and below the ground. This will help to create a stable belowground environment with sufficient food, while soil biodiversity will increase. Older grassland harbours a larger amount of carbon than young grassland, which means the organic dust content is higher (van Eekeren et al., 2015). This improves soil fertility and reduces net carbon emissions.
Calculation, definitions and data (for assurance)	**% permanent grassland of total acreage** = Total acreage of permanent grassland / total acreage of farm *100% Definition of permanent grassland: a plot of grassland is classified as permanent if it has not been included in the farm's crop rotation for a minimum of five years. Data on acreage of permanent grassland through combined statement (gecombineerde opgave) – Netherlands Enterprise Agency Definition of farm's total acreage: acreage used or managed by the farm. Data acreage used or managed is listed in the official Dutch government database for plots of land relating to the combined statement (see above), known as the basisregistratie percelen. (Netherlands Enterprise Agency).
References	Website of the Netherlands Enterprise Agency (available in Dutch only): http://www.rvo.nl/subsidies-regelingen/betalingsrechten-uitbetalen/uitbetaling-2015/voorwaarden-uitbetaling-2015/vergroeningseisen/ blijvend-grasland

Pillar	**Pillar 1** Functional agrobiodiversity
Key Performance Indicator (KPI)	**Percentage of protein produced by own farm/in farmer's own region** (less than 20 km)
Toelichting op de KPI	The percentage of protein produced on a farmer's own land is related to the biodiversity of the farmer's own dairy farm (grassland) and biodiversity in areas where concentrated feeds such as soy are produced. The percentage of protein produced on the farmer's own land indicates: • The level of self-sufficiency in feed production, and is related to the intensity of dairy farms, as expressed in milk production per hectare. The lower the level of self-sufficiency, the higher the level of intensity, which is generally coupled with higher levels of fertilisation, less grazing and a more intensive regimen for mowing grass, resulting in declining biodiversity (Allen et al., 2014). • The size of the footprint (i.e. land usage elsewhere) of a farm and the amount of concentrated feeds and raw materials such as soy sourced from external suppliers. This affects biodiversity in other parts of the world. • The share of grassland maintained by a dairy farm. In order to produce more protein from a farmer's own land, the farmer requires more grassland. Grassland scores higher in terms of biodiversity and its functions than agricultural land (Reidsma et al., 2006). The indicator is determined by: • The share of feed protein from externally sourced (purchased) feeds • Nitrogen generated by crops (expressed in kilograms per hectare)
Calculation, definitions and data (for assurance)	**Calculation using the method and data defined in the Cycle Guide** (Kringloopwijzer): All data is calculated using the Cycle Guide: this includes the N level in feed; this is partially shown in the digital purchase invoice. When using the Cycle Guide to perform calculations, the standards of N and P levels in the feed can be manually modified based on measurements of silage grass, silage corn and fresh grass. Percentage of protein produced on the farmer's own land/%N (1-N in purchased feed/N in total feed) *100% Purchased feed = purchase of concentrated feeds + roughage and by-products Total feed = concentrated feeds + roughage + by-products + meadow grass **Details of calculation::** Percentage of protein produced on the farmer's own land is calculated here using the percentage of N produced on the farmer's own land. Protein differs from N in that not all N is derived from protein, but the proportion of non-protein N is so small that you could interpret the N percentage as meaning the protein percentage.
References	Schröder et al., 2017. Rekenregels van de kringloopwijzer, achtergronden van BEX, BEA, BEN, BEP en BEC (Calculation Rules for the Cycle Guide, backgrounds to BEX, BEN, BEP and BEC); update of the 2015 version. Wageningen UR, the Netherlands

Pillar	**Pillar 1** Functional agrobiodiversity
Key Performance Indicator (KPI)	**Nitrogen soil surplus** (Nitrogen soil surplus in kg of nitrogen per hectare)
About this KPI	Nitrogen surpluses are one of the greatest threats to biodiversity and resilient ecosystems (Erisman, 2015). Nitrogen which runs off into the water or surface water and the deposition of nitrogen from the air contribute to the eutrophication of the water and the soil. The nitrogen surplus in the soil provides an indication of the burden on the soil and water system. The smaller the nitrogen soil surplus, the smaller the risk of run-off and drainage into the groundwater and surface water. The indicator nitrogen soil balance is determined by: • The supply of nitrogen through deposition, eutrophication, leguminous plants, mineralisation, and purchased feed • The amount of nitrogen evaporated into the air (i.e. ammonia and laughing gas, which is a greenhouse gas) Note: the soil surplus of nitrogen and NH_3 emissions are part of the nitrogen surplus for each farm, along with N_2O (laughing gas) and nitrogen (N_2). The KPIs 'Nitrogen soil surplus' and 'NH_3 emissions' are shown separately in order to prevent shifting. It is possible, for example, for the nitrogen soil surplus to be reduced while NH_3 emissions increase at the same time. This is to be avoided. Nitrous oxide emissions form part of the 'Greenhouse gas emissions' KPI.
Calculations, definitions and data (for assurance)	**Calculation using the Cycle Guide method and data:** Nitrogen soil surplus is calculated for grassland, corn land, land on which other types of roughage are cultivated and the land where marketable agricultural crops are grown. Next, the weighted average is calculated for the acreage. Nitrogen soil surplus per 'cultivation' is = nitrogen supply (including fertiliser, recording nitrogen levels and nitrogen mineralisation) – nitrogen removal (crops) – nitrogen emissions (air) [% grassland* Soil nitrogen surplus (grassland – kg N/ha) + % corn land* Soil nitrogen surplus (corn land – kg N/ha) + % land used for other roughage* Soil nitrogen surplus (land used for other roughage – kg N/ha) + % land used for arable crops* Soil nitrogen surplus (soil used for arable crops – kg N/ha)]/100%
References	Schröder et al., 2017. Rekenregels van de kringloopwijzer, achtergronden van BEX, BEA, BEN, BEP en BEC (Calculation Rules for the Cycle Guide, backgrounds to BEX, BEN, BEP and BEC); update of the 2015 version. Wageningen UR, the Netherlands

Pillar	**Pillar 1** Functional agrobiodiversity
Key Performance indicator (KPI)	**Ammonia emissions (NH_3) in kg per ha**
About this KPI	Ammonia emissions account for approximately 70% of nitrogen deposition in the Netherlands (Haan et al., 2008). A total of 75% of this share originates from Dutch sources, with agriculture being the main contributor. This nitrogen deposition has an impact on the natural world; for example, these substances can potentially make plants and trees more susceptible to illness, storm damage and drought. A change in soil conditions also changes the natural species composition of the vegetation. Examples of this include the grassification of heath and open sand dunes, which results in a decline in biodiversity. The KPI 'Ammonia emissions per hectare' is determined by (Mosquera et al., 2016): • emissions from the barn and manure storage, • emission during fertilisation, • grazing (i.e. fewer emissions when cattle is put out to pasture).
Calculation, definitions and data (for assurance)	**Calculation of the Cycle Guide methodology and data** Ammonia emissions in kg NH_3 per hectare Ammonia emissions per ha = (ammonia emissions from the barn + manure storage + grazing + fertilisation using animal manure + use of fertiliser) / total acreage of farm Definition Total farm acreage acreage used or managed by the farm. Data acreage of land used or managed and is listed in the listed in the official Dutch government database for plots of land relating to the combined statement, known as the *basisregistratie percelen* (Netherlands Enterprise Agency). The calculations of ammonia emissions are based on scientifically sound emission coefficients linked to the National Emission Model for Agriculture (NEMA).
References	Schröder et al., 2017. *Rekenregels van de kringloopwijzer, achtergronden van BEX, BEA, BEN, BEP en BEC* (Calculation Rules for the Cycle Guide, backgrounds to BEX, BEN, BEP and BEC); update of the 2015 version. Wageningen UR, the Netherlands

Pillar	**Pillar 1** Functional agrobiodiversity
Key Performance indicator (KPI)	**Greenhouse gas emissions** (kg CO_2-eq per hectare and per kg)
About this KPI	Greenhouse gas emissions have an impact on global climate conditions (Pecl et al., 2017). Climate change will have a significant impact on biodiversity, plant and animal species and their interdependence, and ecosystems. • In order to facilitate comparison between farms of different sizes, total emissions of carbon equivalents are divided by a unit, kilograms of milk produced, or total acreage in hectares. • The 'Greenhouse gas emissions' KPI is determined by: • emissions from rumen and colon fermentation, • the carbon footprint of purchases such as electrical facilities, diesel, fertiliser and feed, • emissions from fertilisation (including the use of fertiliser) and the production of roughage, • emissions from manure storage.
Calculation, definitions and data (for assurance)	**Calculation using the Cycle Guide methodology and data** The following two calculation units may apply: Emissions of carbon equivalents (expressed in kg): Per kg of milk Greenhouse gas emissions – 'to Farm gate' (i.e. the entire supply up to and including the dairy farm) is the sum of: • Laughing gas (1kg of nitrous oxide = 298kg carbon equiv.): Nitrous oxide emissions from the soil + nitrous oxide emissions from manure storage + • nitrous oxide inputs (animal feed and fertiliser) • Methane (1kg methane = 34kg carbon equiv.): emissions from rumen fermentation (approx. 75-80% of total • methane emissions) + methane from manure storage (20-25% of total methane emissions) • Carbon: emissions from direct energy consumption + indirect emissions for electricity, the purchase of animal feed and the production of fertiliser Per kg: divide by total milk production (in kg) Per hectare: divide by farm's total acreage (i.e. acreage used or managed by farm).
References	Schröder et al., 2017. Rekenregels van de kringloopwijzer, achtergronden van BEX, BEA, BEN, BEP en BEC (Calculation Rules for the Cycle Guide, backgrounds to BEX, BEN, BEP and BEC); update of the 2015 version. Wageningen UR, the Netherlands

Pillar	**Pillar 1** Functional agrobiodiversity **Pillar 3** Diversity of species
Key Performance Indicator (KPI)	**Percentage of herb-rich grassland** (percentage of total acreage) Definitions and calculation method available. Assurance not yet available.
About this KPI	'Herb-rich grassland' with multiple types of grass and herbs strengthens the soil (Gould et al., 2016), leads to more stable production and is more resistant to drought (van Eekeren et al., 2006; de Wit et al., 2013). In addition, there may be a positive impact on animal health (Wagenaar, 2012). Secondary metabolites found in herbs (including tannin) also help reduce ammonia and methane emissions by ruminants (through protein digestion) (Patra & Saxena, 2011). A diverse composition of grass also has a positive effect on aboveground biodiversity (including through nectar as food for bees and through insect composition as food for meadow birds and other birds). Grassland with a rich variety of herbs, combined with a later mowing date, allows meadow birds to breed and raise their young in safety. The 'Herb-rich grassland' indicator is correlated with: • Percentage of arable land • Frequency of renewal of grassland • Fertilisation • Botanical management
Calculation, definitions and data (for assurance)	**Percentage of herb rich grassland =** Total acreage of herb-rich grassland / total farm acreage *100%= Definition Total acreage herb-rich grassland: Herb-rich grassland is permanent grassland with a mix of at least four types of grass and herbs, but often more than 10 types (including buttercups, cuckoo flowers, daisies, ordinary sweet vernal grass, crested dog's-tail, cuckoo flowers, Greater Yellow-rattle, water forget-me-not, red clover and plantain). The share of grass is lower than for production grass. The share of grass is lower than for production grass, and it has an open and diverse structure due to the numerous herbs, with their large number of stalks and little leafage. Data acreage for herb-rich grassland is not available in database Definition Total farm acreage: Acreage used or managed by the farm. Data acreage of land used or managed and is listed in the listed in the official Dutch government database for plots of land relating to the combined statement, known as the basisregistratie percelen (Netherlands Enterprise Agency).
References	Vogelbescherming (Dutch Society for the Protection of Birds), 2016

Pillar	**Pillar 2** Diversity of landscape	**Pillar 3** Diversity of species
Key performance indicator (KPI)	**Nature & Landscape** (percentage of managed land based on management contract)	
About this KPI	Landscape diversity on the farm (e.g. hedges, hedgerows, banks of ditches, field margins, thickets, water levels, etc.) improves the quality of the landscape and people's perception of this landscape, along with biodiversity, and supports functional agrobiodiversity (Erisman et al., 2014). Pillars 1 and 2 provide a basis for diversity of species on the farm. In addition, the decision can be made to stimulate and protect specific plant and animal species, including birds, butterflies or amphibians. The type of species depends on the regional landscape, the farm's location, the presence of source areas, the location of the EHS and other requirements. Different types of grass in the meadow provide extra opportunities for different types of plant and animal species. Diversity in types of grass and herbs has a positive effect on soil life, insects, small rodents, birds and livestock. Grassland with a diversity of species can be created by changing the mowing policy, seed mixture and fertilisation (Zanen, 2017). The KPI 'Percentage of managed land' is a composite indicator for landscape management and species management.	
Calculation, definitions and data (for assurance)	$B = \sum_i (O_i \times C_i \times 100\%)/T$ B = Contribution of nature and landscape (in percentage of managed land) O = Total surface of nature and landscape elements (for type i) C = Weighting factor* (for type i) T = Total farm acreage** ***Weighting factor::** Since different elements contribute to biodiversity in different ways, a weighting factor is used to determine the amount of land used for nature and landscape elements. The elements we identify include full-scale elements (e.g. plots of land used entirely for managing meadow birds, for example), line-shaped elements (e.g. shelter belts) and point elements (e.g. ponds or solitary trees). The weighting factors per type of i element are: • Full-scale elements: C=1 • Line-shaped elements: C=2 • Point elements (landscape and nature elements less than 100 sq. m.): C = 5. These weighting factors are based on the amount of compensation paid and the effort required for management. Assurance is handled through management agreements and self-declarations (i.e. individual statements). ****Total farm acreage:** Acreage of land used or managed. Data acreage of land used or managed and is listed in the official Dutch government database for plots of land relating to the combined statement, known as the basisregistratie percelen (Netherlands Enterprise Agency).	
References	Eelerwoude, 2014	

Acronym

KPI = Key Performance Indicator

References

Allan, E., O. Bossdorf, C.F. Dormann, D. Pratia, M.M. Gossner, T. Tscharntke, N. Blüthgen, M. Bellach, K. Birkhofer, S. Boch, S. Böhm, C. Börschig, A. Chatzinotas, S. Christ, R. Daniel, T. Diekötter, C. Fischer, T. Friedl, K. Glaser, C. Hallmann, L. Hodac, N. Hölzel, K. Jung, A.M. Klein, V.H. Klaus, T. Kleinebecker, J. Krauss, M. Lange, E.K. Morris, J. Müller, H. Nacke, E. Pašalić, M.C. Rillig, C. Rothenwöhrer, P. Schall, C. Scherber, W. Schulze, S.A. Socher, J. Steckel, I. Steffan-Dewenter, M. Türke, C.N. Weiner, M. Werner, C. Westphal, V. Wolters, T. Wubet, S. Gockel, M. Gorke, A. Hemp, S.C. Renner, I. Schöning, S. Pfeiffer, B. König-Ries, F. Buscot, K.E. Linsenmair, E.D. Schulze, W.W. Weisser, M. Fischer (2014) Interannual variation in land-use intensity enhances grassland multidiversity. PNAS 111(1), p. 308-313.

Eelerwoude, 2014. Reward system pressure factor Nature and Landscape. Regulations and subsidies for reward system for dairy farmers. Commissioned by FrieslandCampina.

Erisman, J.W., J.N. Galloway, N.B. Dise, M.A. Sutton, A. Bleeker, B. Grizzetti, A.M. Leach, W. de Vries, 2017. Nitrogen; too much of a vital resource. Science Brief. WWF Netherlands, Zeist, the Netherlands.

Erisman, J.W., N.J.M. van Eekeren, W.J.M. Cuijpers, J. de Wit, 2014. *Biodiversiteit in de melkveehouderij: Investeren in veerkracht en reduceren van risico's.* Rapport 2014042 LbD. Louis Bolk Instituut, Driebergen, the Netherlands. 55 p.

GGeerts, R., H. Korevaar, A. Timmermans, 2014. K*ruidenrijk grasland, Meerwaarde voor vee, bedrijf en weidevogels.* Plant Research International, Wageningen UR, Wageningen. Available at http://edepot.wur.nl/295728

Haan, B.J. de, J. Kros, R. Bobbink, J.A. van Jaarsveld, 2008. Ammoniak in Nederland. Planbureau voor de Leefomgeving, Bilthoven, the Netherlands.

Mosquera, J., B. Philipsen, C. van Bruggen, C.M. Groenestein, N.W.M. Ogink, 2016. PASsend beweiden. Wageningen UR (University & Research Centre) Livestock Research, Livestock Research Rapport 983, Wageningen, the Netherlands

Patra A.K., J. Saxena, 2011. Exploitation of dietary tannins to improve rumen metabolism and ruminant nutrition. J Sci Food Agric. 91(1):24-37.

Reidsma, P., T. Tekelenburg, M. van den Berg, R. Alkemade, 2006. Impacts of land-use change on biodiversity: an assessment of agricultural biodiversity in the European union. Agriculture, Ecosystems and Environment 114, p. 86-102.

Pecl, G.T. et al., 2017. Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being. Science 31 Mar 2017:
Vol. 355, Issue 6332, eaai9214 DOI: 10.1126/science.aai9214

Van Eekeren, N., L. Bommelé, J. Bloem, M. Rutgers, R.G.M. de Goede, D. Reheul, L. Brussaard, 2008. Soil biological quality after 36 years of ley-arable cropping, permanent grassland and permanent arable cropping. Applied Soil Ecology. 40: 432-446.

Van Eekeren, N., H. de Boer, M.C. Hanegraaf, J.G. Bokhorst, D. Nierop, J. Bloem, T. Schouten, R.G.M. de Goede, L. Brussaard, 2010. Ecosystem services in grassland associated with biotic and abiotic soil parameters. Soil Biology & Biochemistry. 42(9):1491-1504

Van Eekeren, N., F. Verhoeven, J. W. Erisman, 2015. *Verkenning Kritische Prestatie Indicatoren voor stimulering van een biodiverse melkveehouderij.* Louis Bolk Instituut en Boerenverstand, Driebergen, the Netherlands.

Vogelbescherming (Netherlands Society for the Protection of Birds), 2016. Factsheet on Herb-rich Grassland. Vogelbescherming Nederland, Zeist, the Netherlands.

Wagenaar, J., 2012. *Koeien en kruiden; aanwijzingen dat weidekruiden koegezondheid bevorderen.* Ekoland, 9, p12-13.

Zanen, M., 2017. *Ontwikkeling van KPI's voor landschappelijke elementen en specifieke soorten* – part of Biodiversity Monitor for the Dairy Sector. Louis Bolk Instituut, Publicatienummer 2017-005LbP, Driebergen, the Netherlands.

Produced by
Margit van den Berg (editing)
Volta_thinks_visual (design)

BIODIVERSITY MONITOR FOR THE DAIRY FARMING SECTOR

The solution lies in the supply chain

We would like to stress that a supply-chain-based approach is essential. This is why Dutch dairy farmers have partnered with Royal FrieslandCampina, the World Wide Fund for Nature and Rabobank. In order to improve overall engagement levels, De Duurzame Zuivelketen (Sustainable Dairy Supply Chain) and the Versnellingsagenda Melkveehouderij (Dairy Farming Acceleration Project) are also affiliated with this initiative.

Our goal is to encourage other supply-chain partners and stakeholders to also start using the Biodiversity Monitor for the Dairy Farming Sector in the future. This type of partnership will enable the Biodiversity Monitor for the Dairy Farming Sector to become an independent standard. The tool will serve as a driving force and set in motion a trend that will improve both the biodiversity of Dutch soil and farming practices employed by Dutch farmers. Will you join us?