Nordic Council of Ministers
Nordic Environmental Footprint

Report

Review of recommendations from the Agriculture Working Group on biodiversity impacts

Nordic Environmental Footprint Group

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Nordic Environmental Footprint Group
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1. Foreword

The memo is an evaluation from a Nordic perspective of the potential consequences and impact of the proposals described in the TAB-document, focusing on a) the robustness of methods, b) the application of the methods in EF compliant datasets and c) the application in PEF studies of products. The review was financed by Nordic Environmental Footprint and carried out in the first half of January 2024 and thus has important time constraints.

The purpose of this memo is to evaluate the proposals in the document "Environmental Footprint Initiative Agricultural Working Group 2022-2025, Milestone 5: Biodiversity Impacts" dated the 9th of November 2023 (from here on referred to as the TAB-document). The goal of milestone 5 was to characterize not yet covered biodiversity impacts as a distinct impact category within the EF. Additionally, it involves revisiting the relevant impact categories in the EF, particularly those associated with land use. The TAB-document also seeks to explore the medium- and long-term requirements for other methods, including climate change, ecotoxicity, eutrophication, and more.

With the present paper, the NEF-group would like to contribute to milestone 5 for biodiversity impacts.

The discussion paper has been drafted on a consultant basis by Hanne Møller and Anna Woodhouse, NORSUS and Serina Ahlgren and Karin Morell, RISE.

The NEF Group hopes the discussion paper may contribute to a dialogue among European stakeholders.

2. Summary of key findings and methodologies in the TAB-document

The work in the AWG milestone 5 is based on 11 selected biodiversity methods. The method selection was based on Damiani et al. (2023), which included 17 LCA-based methods and 6 beyond-LCA and were further evaluated based on eight macro-criteria and several sub-criteria. The applicability of the methods in LCA were evaluated in Sanyé-Mengual et al. (2023) where eight methods were assessed.

According to IPBES (2019) the five main drivers of biodiversity loss are land use change, climate change, invasive species, environmental pollution, and direct exploitation of organisms (Figure 1). Each of the 11 selected methods has one or more indicators for the direct drivers for biodiversity (land use and land use change, climate change, water use, as well as environmental pollution represented by ecotoxicity, eutrophication, acidification, photochemical ozone formation, and ionising radiation). Invasive species and direct exploitation of organisms are drivers that are not represented in any of the examined methods included in the TAB-document, but it is included in the Product Biodiversity Footprint (Asselin et al., 2020), one of the methods reviewed in Damiani et al. (2023).

For each of the impact categories, an assessment and ranking has been carried out of the methods regarding the evaluation criteria (Documentation, Transparency, Reproducibility; Completeness of the scope; Environmental relevance; Robustness; Temporal representativeness, and Resolution, Time horizon; Spatial resolution; Compatibility with EF method; Characterisation factors). Limitations of the method evaluation is also specified.

Based on the evaluation, two options are suggested: 1) Adopt a method covering several impact categories, 2) Hybrid approach. The recommended short-term measure is to adopt one of the methods listed in option 1, choosing a method that covers several impact categories: Impact World+, ReCiPe 2016 or LC-Impact. These are endpoint methods. Further it is recommended to follow, and collaborate with, other initiatives on evaluation of biodiversity methods as new methods are emerging.

3. Assessment of methodologies, including robustness and relevance of the methodologies

The three selected biodiversity method are endpoint methods, but Impact World+ and ReCiPe are also available as midpoint methods. However, since several impact categories are included in the assessment of biodiversity, these methods can only be used as a biodiversity method at endpoint level. The robustness of the proposed methods has been assessed by comparing characterisation factors and by carrying out a test of the methods for a specific product system. The findings are summarized as pros and cons, see the following sections.

Figure 1 is included in this report to highlight the relative importance of the impact categories as drivers of biodiversity loss as a basis for assessing the methods.

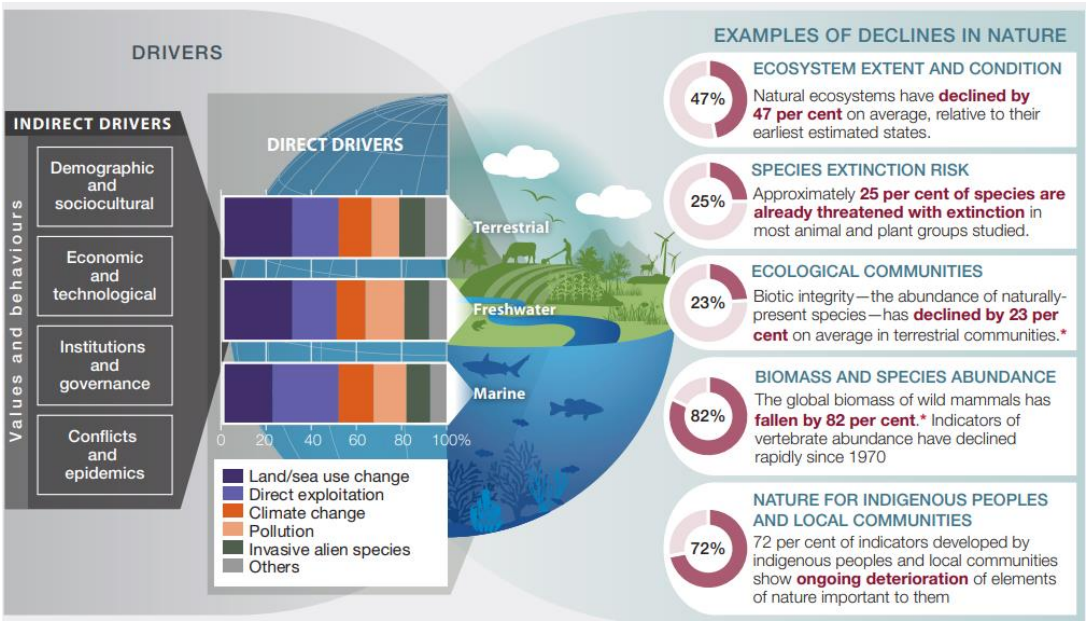

Figure 1 Examples of global declines in nature, emphasizing declines in biodiversity, that have been and are being caused by direct and indirect drivers of change (source PBES (2019)).

3.1. Assessment of characterisations factors

Table 1 shows some of the characterisation factors for a selection of substances, i.e. land occupation for the Nordic countries and GHG emissions that are relevant for terrestrial food production. IPCC 2021 is added for comparison.

The relative ratios between the greenhouse gas emissions (dinitrogen monoxide, methane) in both ReCiPe and LC-Impact roughly correspond to IPCC, while Impact World+ deviates substantially. It is not appropriate that different relative relationships are used between the characterization factors in the EF-method for the climate change midpoint impact category and for climate change as included in the biodiversity method. When comparing the order of magnitude for carbon dioxide and land occupation it also seems that for LC-Impact, climate change has a large impact compared to land occupation. However, according to IPBES (2019), the most important driver for terrestrial and freshwater systems is land occupation and transformation.

ReCiPe have the same characterization factor for all land use no matter where it takes place, which is very inappropriate as the biodiversity status and thus impact is highly geo-spatial. The characterization factors for Impact World+ for occupation of grassland is zero, which means that occupation of such areas does not lead to a loss of biodiversity. Grasslands are a course biotope group, in which there are great variations in relevance for biodiversity, e.g. dependent on (semi-)naturalness (with long-term continuity and no historical nor present input of fertilizers) and adequate management (i.e. optimal grazing intensity). While semi-natural grasslands (pastures and meadows), dependent on continuous extensive occupation of grazers, often have a high conservation value and is dependent on continuous occupation by grazers, grasslands that are human induced, e.g. grass cultivated on cropland, have low ecological relevance.

Table 1 Characterisation factors for the three selected methods for some chosen substances for land occupation and GHG emissions. Values as implemented in SimaPro. IPCC is included to enable comparisons.

	Impact World+	ReCiPe 2016 Endpoint (H)	LC-Impact*	IPCC 2021
Land occupation	Land occupation, biodiversity	Land use	Land stress, terrestrial average	
Unit	PDF.m2.yr / m2a	species.yr / m2a	PDF.year / m2a	
Occupation, annual crop, NO	0,59	8,88E-09	5,53E-17	
Occupation, annual crop, SE	0,76	8,88E-09	1,03E-16	
Occupation, annual crop, FI	0,76	8,88E-09	3,44E-17	
Occupation, annual crop, DK	0,76	8,88E-09	4,43E-16	
Occupation, grassland/ pasture /meadow, NO	0,00	4,88E-09	4,75E-17	
Occupation, grassland/pasture /meadow, SE	0,00	4,88E-09	4,76E-17	
Occupation, grassland/pasture /meadow, FI	0,00	4,88E-09	3,96E-17	
Occupation, grassland/pasture /meadow, DK	0,00	4,88E-09	1,37E-16	
Climate change/global warming	Terrestrial marg./av.	Ecosystem quality, long	Terrestrial ecosystems	
Unit	PDF.m2.yr/kg	species.yr/kg	PDF.year/kg	CO_2 eq
Carbon dioxide	0,63	2,80E-09	1,76E-15	
Dinitrogen monoxide	53,70	8,34E-07	4,66E-13	
Methane	1,69	1,01E-07	5,28E-14	
Methane, biogenic	0,53	9,31E-08	4,93E-14	
GHG characterisations factors relative to carbon dioxide				
Carbon dioxide	1,0	1,0	1,0	1,0
Dinitrogen monoxide	85,5	297,8	265	273
Methane	2,69	36,1	30,0	29,8
Methane, biogenic	0,84	33,3	28,0	27

* There are several variants of the LC-IMPACT in SimaPro, here the LC-IMPACT | average preference | all impacts | 100 years was used.

3.2. Test of the proposed methods on a case study

In this section the three biodiversity methods are tested by applying them to a product system for beef from dual purpose production, as described in Samsonstuen et al. (2024). The results are shown in figure 2, as percentage contribution of processes through the life cycle stages.

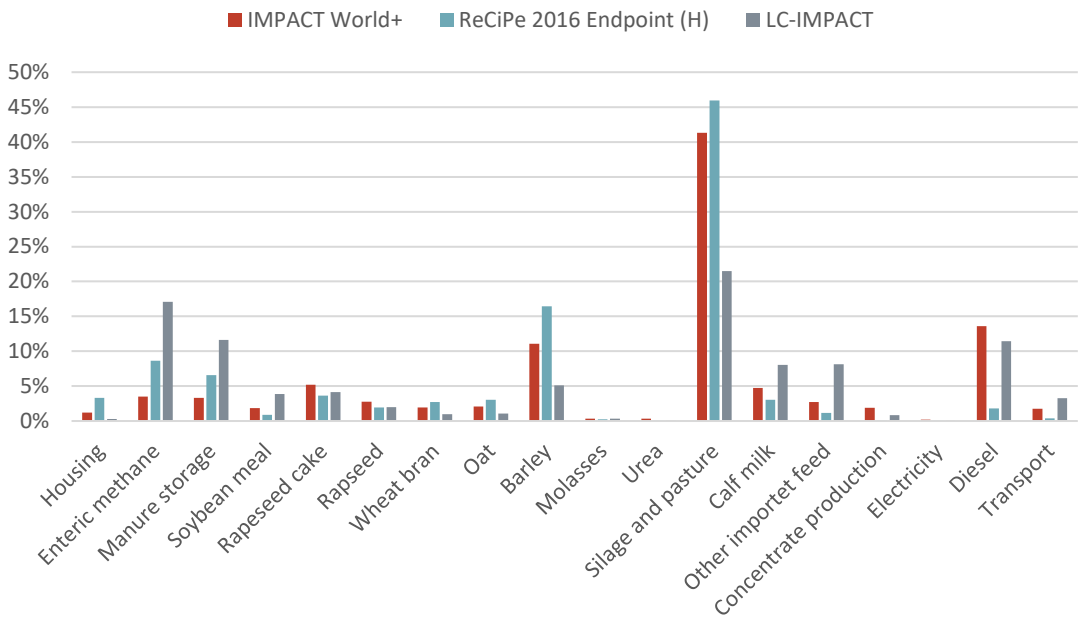

Figure 2 Results of the three biodiversity methods for applied to the life cycle model of beef from dual purpose production. Contribution of processes in percentage.

For all the biodiversity methods, it is production of silage and pasture that provides the largest contribution from the system, but there is a big difference in how big this share is. LC-IMPACT has a lower share for silage and pasture (22%) compared to Impact World+ (42%) and ReCiPe (46%). LC-IMPACT has however a lager contribution from enteric methane (17%) which is exclusively linked to climate change and manure storage (12%) that contributes to both climate change and acidification. This is in line with the findings for characterisations factors that are described in the previous section.

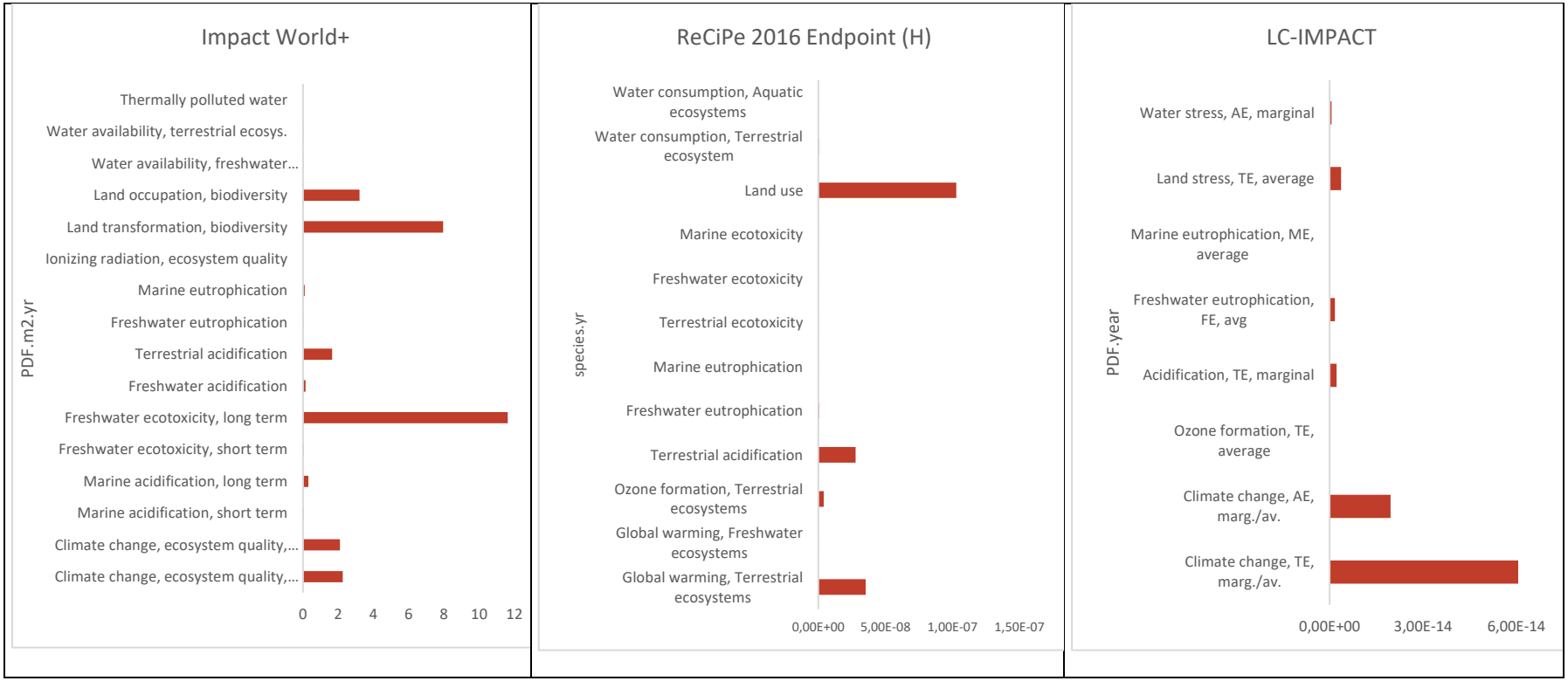

Figure 3 Contribution of impact categories using characterization of Impact World+, ReCiPe 2016 endpoint and LC-IMPACT.

Figure 3 shows the impact assessment for the same product system as in Figure 2. The three biodiversity methods do not include the same impact categories, there are substantial differences. Also, there are large differences at which impact categories contribute the most to the biodiversity impact results for the product system.

For Impact World+, the largest share of the total impact comes from freshwater ecotoxicity, long term (36%), mainly from production of mineral fertiliser. For ReCiPe, the impact to freshwater ecotoxicity is below 1%, and for LC-IMPACT this impact category is not included in the biodiversity assessment.

The second largest impact category for Impact World+ is land transformation (27%). Land transformation is weighted much higher than land occupation. In this product system, an ecoinvent process for grass seed has been used and this process includes land transformation. Land transformation is not included in the foreground processes. It is thus this background process for grass seed based on databases that accounts for this contribution. The use of database processes can have a big impact to the results, even if this is not the intention. This issue requires a lot of attention from the LCA practitioner.

For ReCiPe it is the impact category land use that contributes mostly to the biodiversity result. Land use for ReCiPe includes both land occupation and land transformation. For the LC-IMPACT method, it is climate change, TE (terrestrial ecosystems), marg./av. (69%) and AE (aquatic ecosystems), marg./av. (22%) which have the largest share of the total biodiversity impact. Land stress, which includes both land occupation and land transformation, gives only 4% of the total impacts.

3.3. Comments to the TAB-document

Table 2 includes comments and proposed changes.

Table 2 Comments to the document, some specific referring to a page and some of more general

Comment nr	***Page***	***Comment (justification for change)***	***Proposed change***	***Reference if relevant***
#1	*5*	*The impact categories ecotoxicity, eutrophication, acidification, photochemical ozone formation, ionising radiation is representing environmental pollution. It should be described clearly. Also, it should be noted that specific types of pollution are still not addressed in LCA (e.g. marine litter)*	*Should be described, e.g. by integrating it to p. 6, bullet point 4. Pollution*	
#2	*14*	*The sentence "It's crucial to emphasise that constraining the biodiversity impact category to a single pressure, such as land use change, would unduly limit the scope of biodiversity assessment to terrestrial ecosystems exclusively" is certainly relevant, but it is important to note that some of the main drivers of marine ecosystems (direct exploitation and invasive alien species) are not included in any of the proposed methods and only*	*Clarify the scope of the evaluation. "/…/ impacts attributed to fish stocks or seabed damage" (page 3) is stated not to be included. However, the method must apply to all products and*	*(Damiani et al., 2023)*

Comment nr	Page	Comment (justification for change)	Proposed change	Reference if relevant
		one method (Product Biodiversity Footprint) that includes this according to Damiani et al. (2023).	*not just agricultural products, and therefore there is a need to also include marine systems*	
#3	*15*	*Conclusion and recommendation: It is appropriate to choose one of the evaluated methods that score highest on the criteria. It is urgent to include biodiversity in the EF method, to avoid underestimating this compared to other impact categories. However, none of the suggested methods can be recommended because they all have significant weaknesses.*	*Clarify the weaknesses of the methods. These are described in section 3.4 and 3.5 in this memo*	
#4	*6*	*Regarding the sentence "The drivers/impact categories can intersect and their effects can accumulate", it is also important to note that ecosystems are affected to varying degrees by drivers.*	*Add a sentence that ecosystems are affected to varying degrees by drivers.*	*(IPBES, 2019)*
#5	*6-10*	*Instead of alphabetic order, the impact categories can be grouped linked to the order of relevance for biodiversity, as well as grouping the environmental pollution-related categories. Environmental pollution accounts for between 5-15% of the total impact (see figure 1) and is represented by 5 impact categories (ecotoxicity, eutrophication, acidification, photochemical ozone formation, and ionizing radiation).*	*It is important to point out in the TAB-document, that not all impact categories are equally important drivers of biodiversity loss.*	
#6	*7*	*The effects on acidification are more well-known, as well as severe, in aquatic/marine ecosystems, LC-Impact only covers terrestrial ecosystems. Impact World+ seemed to have a greater coverage? Maybe the top-rank is explained in the Excel, but just reading the report the conclusion seems confusing. A table summarizing the ranking could be clarifying.*	*Add motivation/information on for why LC-impact was top-ranked here, and a table showing e.g. mean-score for each model per impact category*	
#7	*7*	*In two places it is referred to "environmental coverage", do you mean "ecosystem coverage" or is this something else?*	*Please clarify*	
#8	*9-10*	*Replace Chaudrey with Chaudhary*	*Replace Chaudrey with Chaudhary*	
#9	*11*	*Aggregation of diverse impacts is one of the limitations which seems particularly important to highlight. The models examined combine a range*	*Please add more regarding the consequences of using an*	*(Sanyé-Mengual et al., 2023)*

Comment nr	Page	Comment (justification for change)	Proposed change	Reference if relevant
		of environmental impacts into a limited set of overarching endpoint categories and the models are conceptually different for separate impact categories within a method. This merging can result in loss of information and make it difficult to interpret results. It is also difficult to follow how the impact categories representing drivers are weighted together to form an overall characterisation of biodiversity.	*endpoint method and how that will complicate the interpretation of results.*	
#10	*13*	*It is stated that ReCiPe haven't been updated since 2016. Have you contacted the developers and ask if they have anything up-coming?*	*Check with the ReCiPe developers*	
#11	*14*	*Figure 3 may be moved to chapter 3, as it includes all methods and is a quite good overview/summary and shows the weighting of the categories, while chapter 4 only covers the three selected methods*	*Editing the TAB document*	
#12	*16*	*RISE and the CircHive project, in which we have 10 industrial partners representing forestry, retailers, food/agriculture, cities and finance might be interested in collaboration. In the project we will perform case studies linked to biodiversity footprinting/natural capital accounting, which tangent with this, would be interesting to benchmark/compare methods.*	*Contact RISE for further information*	
#13	*general*	*Sufficient granularity of the land use types is not sufficient to address biodiversity impacts of detailed cultivation practices and distinguish between production systems. Should extensive production with a lower yield will have a higher impact (loss of biodiversity) than intensive production with less land occupation per functional unit? On the one hand, intensive production can lead to more area being saved for conservation purposes, while on the other hand, light area use can lead to low impact and possibly also positive impact.*	*The granularity of land use and land occupation should be addressed.*	
#14	*general*	*The methods tend to favour high-input intensive agricultural systems and less intensive agroecological systems such as organic agriculture can be inadequately assessed due to a narrow perspective on functions of agricultural systems; and inconsistent modelling of indirect effects.*	*Should be addressed*	*(van der Werf et al., 2020)*

Comment nr	*Page*	*Comment (justification for change)*	*Proposed change*	*Reference if relevant*
#15	*general*	*Invasive species and direct exploitation of organisms are drivers that are not represented in the methods. These drivers are especially important for marine systems and has received little focus in method development*	*See comment #2.*	*(IPBES, 2019)*
#16	*general*	*Genetic diversity is not assessed in the selected methods, according to Damiani (2023). LCIA approaches are mainly limited to assess species biodiversity and partly ecosystem diversity*	*Should be noted*	*(Winter et al., 2017) (Sanyé-Mengual et al., 2023)*
#17	*general*	*When choosing a biodiversity method, it is important to clarify the goal and scope, but when a general method is to be chosen that should be suitable for all types of product systems, this is not possible. Value chains in LCA are often global, but at the same time there may be a need to make assessments at a regional or local/farm level between different management practices or comparing conventional and organic production. This may apply in particular to food production. Often, a global method will not have sufficient granularity to differentiate at management level. We therefore propose to assess whether a tier system as used in IPCC can be adopted by using a decision tree linked to goal and scope.* *Tier 1: global endpoint method that provides an overview of the value chain.* *Tier 2 (optional): more specific method which considers management practice in the foreground system and requires more specific data. The tier 2 method may focus only on some of the drivers/impact categories that are linked to local impacts, such as land occupation, ecotoxicity and direct exploitation.*	*Can be considered as one possible option.*	

3.4. Evaluation of the presented proposals, presented as the pro and cons

Table 3 shows the pros and cons for the three biodiversity methods.

Table 3 Pros and cons for the three selected methods

Method	Pros	Cons
Impact World+	The characterization factor for occupation of grassland is zero, see table 1. Extensive occupation of areas such as grazing can make a positive contribution to biodiversity by keeping the landscape open.	The characterisation factor for GHG emissions deviates substantially from IPCC. It is not appropriate that different IPCC models are used for the characterization factors for climate change midpoint and climate change endpoint as included in the biodiversity method. The EF-method for the climate change midpoint uses the Global Warming Potential IPCC 2021 for 100 years timeline.
	Agree with the report that the method is covering the highest number of taxonomic groups (15) than all methods, as well as marine, freshwater and terrestrial ecosystems.	Not very well-established, need for more case-studies
	The most recent method among the three chosen methods in the recommendation.	
ReCiPe 2016 Endpoint (H)	The method is well established, and extensive testing and application has been carried out. This is decisive and more important than the fact that the method has not been recently updated, seen in a short-term perspective.	The method has not been updated since 2016.
	Approximately same relationship between land occupation and climate change as in IPBES (2019), see table 1 and figure 1.	ReCiPe have the same characterization factor for all land use no matter where it takes place, which is very inappropriate.
	The relationship between methane and biogenic methane is as in IPCC 2021, see table 1.	The impact category land use does not include transformation to/from annual crop.
LC-IMPACT		It is unfortunate that "Ecotoxicity" is not included in biodiversity but as a separate damage category.

Method	Pros	Cons
		Climate change has a (too) large impact compared to land use (table 1) which is the most important driver for terrestrial and freshwater systems (IPBES, 2019).
	The relationship between methane and biogenic methane is as in IPCC 2021, see table 1.	Too little difference between cropland and pasture.

3.5. Questions to milestone members/Technical Advisory Board Members

Below we address the questions asked in the TAB-document:

1. From the proposed methods: Impact WORLD+, LC-IMPACT, and ReCiPe 2016, which one would you recommend?
    - It is difficult to recommend one of the methods as they all have both strengths and weaknesses. Rigorous testing in case studies is necessary. Although important and thorough work has been done in Sanyé-Mengual et al. (2023), there is a need for further testing as shown in the example in section 3.2.

2. Would you highlight any strength or limitation not included in the analysis?
    - It must be made clearer that the proposed biodiversity methods are endpoint! A more in-depth analysis of midpoint methods is missing. It could definitely be an alternative to add a few midpoint methods (land use, ecotox, invasive species) instead of ONE endpoint method.

3. Do you miss any key action to be taken within 2024 under this milestone? If yes, could you provide your feedback?
    - An analysis of consequences of using endpoint in EF-method when the other impacts categories are based on midpoint. A mix of midpoint and endpoint can make interpretation of results difficult. Is there a risk that some impacts will be double counted?
    - Case studies to evaluate the three proposed methods, and also include midpoint methods. How do the methods differ, what can they/can they not evaluate? What information is added/lost when comparing midpoint/endpoint methods?

4. Conclusion and recommendation

It must be made clear that the proposed methods for biological diversity are endpoints, while all other impact categories in the EF method are midpoints. The PEF methods use mid-points, not end-points. The same should apply for the biodiversity methods. A more in-depth analysis of midpoint methods is lacking. The consequences of mixing midpoint and endpoint must be investigated in more detail. There is also a risk that if the method only is showing the end-points then a lot of information will get lost or could be hidden.

The cause for selecting the three biodiversity methods isn't clear and there have over later years evolved better methods. The selection of methods could be criticized.

It is difficult to recommend one of the methods as they all have both strengths and weaknesses. Consideration should be given to using a few midpoint methods (land use, ecotoxicity, invasive species) instead of choosing one endpoint method. Another alternative is to introduce tier 1 (global perspective) and tier 2 (regional/farm perspective) when the goal and scope requires that. Value chains in LCA are often global, but at the same time there may be a need to make assessments at a regional or local/farm level between different management practices or comparing conventional and organic production. Often, a global method will not have sufficient granularity to differentiate at management level. We therefore suggest assessing whether a tier system can be adopted.

The methods developed must live up to the intention of PEF, i.e. when an environmental impact is significant, then data must reflect the specific situation as far as possible. The data quality requirements should also apply for these methods. This means that these requirements for specific data that have a high granularity must also be captured by the method, i.e. distinguish between intensive or extensive and conventional or organic farming. Therefore, we propose further testing of the methods.

5. References

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NEF - Nordic Environmental Footprint

Nordic Environmental Footprint (NEF) was established in 2015 by the working group for Sustainable Consumption and Production under Nordic Council of Ministers (NMR).

The aim is to coordinate the Nordic countries authority work of common interest regarding Environmental Footprint work, Eco-Design for Sustainable Products Regulation and Green Claims and in common keep an up to date overview regarding the development in the EU PEF and OEF of special Nordic interest within these policy areas.

The participants of the group include national representatives and are organized in a Steering Committee and a Technical Advisory Board

The NEF group will initiate debate and analyses of issues of common Nordic interest. Activities of common interest are initiated by NEF who will disseminate knowledge regarding PEF to Nordic stakeholders. Information about the NEF conferences can be found under

https://www.nordic-pef.org/