[Reference] Expert Opinions on This Investigation

Supplementary Explanation and Scientific Endorsement
Concerning the TNFD Disclosure by NISSIN FOODS Group

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[Supplementary Explanation]

1. Evaluation Metrics for the Risks and Impacts of Business Activities on Biodiversity

There are various metrics used to evaluate the relationship between corporate activities and biodiversity. Among them, the importance of biodiversity and the integrity of nature and biodiversity (intactness) are commonly used indicators to understand the interaction between corporate activities and nature and their impact on nature.
The former is referred to as a bottom-up global biodiversity significance metric, and the latter as a top-down intactness metric (Reference #1).
The significance of biodiversity is calculated by focusing on the extinction risk of individual species, the rarity of the habitat areas of endangered species which require attention for conservation action (Reference #2), or by applying advanced spatial conservation prioritization algorithm (Reference #3).
In conservation planning science, the Zonation algorithm is considered the most sophisticated tool for spatial prioritization. It uses spatial biodiversity data—comprehensive layers of wildlife habitats and distributions—to rank locations from least important (0) to most important (1), based on their relative conservation value (References #4,5). Sites with a high concentration of rare or endemic species are deemed irreplaceable, as their loss would result in significant conservation impact. These sites are

assigned high priority scores close to 1. Conversely, sites with only common species and no unique biodiversity features are considered highly replaceable and receive low priority scores close to 0.
The integrity (intactness) of nature and biodiversity is rated on a relative scale of 0 to 1 based on the level of anthropogenic land alteration. The index is 0 if no nature remains at all due to human destruction, and 1 if pristine and complete nature remains. This is also referred to as the degree of naturalness, and a representative indicator is the Mean Species Abundance (MSA), which estimates the percentage of biodiversity loss due to land alteration compared to the population of species in pristine nature (Reference #6).
Therefore, by combining the importance of biodiversity of the location where business activities are conducted and the percentage of biodiversity loss that may be caused by the business activities (evaluated by biodiversity integrity), biodiversity risks related to the business activities can be understood. Specifically, by taking the importance of biodiversity of the location of business activities on the horizontal axis and integrity (intactness) of nature and biodiversity on the vertical axis, and by creating a scatter plot of the two values for various business activity sites, areas where pristine nature remains and where biodiversity is of high importance can be visualized on the graph. This allows for the identification of locations that require attention when conducting business activities, that is, material locations (Reference #7).
Furthermore, by multiplying the area of land use change caused by business activities (such as commodity production and procurement) by the Mean Species Abundance (MSA), which represents the proportion of biodiversity loss (risk indicator) associated with land conversion and further multiplying it by the conservation priority score (Z-score) of the area where the activity took place, it is possible to quantitatively assess the impact that commodity production and procurement have on biodiversity. This approach complements conventional, non-spatially explicit Life Cycle Assessment (LCA) and is also referred to as a "Beyond-LCA" approach (Reference #8).

2. Biodiversity Loss Risks Associated with Individual Raw Material Items

The biodiversity impacts (loss risks) associated with the production (land use) of selected three raw materials—palm oil, cacao, and wheat —were quantified using the Mean Species Abundance (MSA) and compared across the three materials. As mentioned earlier, the Mean Species Abundance (MSA) is an indicator that quantifies the degree of habitat degradation caused by anthropogenic land use as a proportion of biodiversity loss, compared to the biodiversity in pristine natural ecosystems. For example, data are collected on the abundance of various taxonomic groups such as mammals, birds, reptiles, insects, and soil organisms inhabiting both oil palm plantations and surrounding tropical forests. By comparing species abundances between natural tropical forests and oil palm plantations, the average proportion of species loss due to plantations can be calculated. This analysis is carried out across various palm oil production sites, as well as in cacao and wheat production areas, allowing for the assessment of biodiversity risks associated with the production of each raw material.
It should be noted that the calculation of MSA is based on data from multiple taxonomic groups (species abundance) reported in 63 peer-reviewed scientific studies. Since these studies differ in terms of target taxonomic groups, study design, and sample sizes, biodiversity loss estimates using MSA are not absolute. However, this analysis represents the most scientifically robust quantification currently available of the biodiversity impacts associated with the production of palm oil, cacao, and wheat, as it integrates all existing peer-reviewed knowledge.

Since the production regions of palm oil, cacao, and wheat are globally distributed, the environmental conditions such as climate and biodiversity status vary greatly depending on the specific production location, even for the same commodity. Therefore, even if the same commodity is produced in the same volume, its impact on biodiversity will vary depending on the local environmental conditions of the production site, and even between commodities.
However, the spatially non-explicit Life Cycle Assessment (LCA) approaches that are becoming widespread in the business sector are not capable of capturing such location-specific climate and nature-related risks. In this analysis, we examined the relationship between biodiversity loss due to the production of palm oil, cacao, and wheat based on information from peer-reviewed literature and regional environmental characteristics, including climate conditions (such as temperature, annual amount of rainfall), land use (such as urban, agricultural, and forest areas), soil properties (such as topsoil pH, organic matter content, and texture), and regional species richness (gamma diversity). The analysis revealed a consistent pattern across all three commodities, where biodiversity loss increased significantly in areas with higher annual precipitation. This indicates that the risk of biodiversity loss is greater in high-rainfall areas. Among the three commodities analyzed, palm oil production, which is concentrated in tropical regions, was identified as having the highest potential impact on biodiversity. These findings underscore that production activities involving the conversion of tropical rainforests areas with exceptionally high biodiversity and ecological value can result in significant degradation of natural capital.

3. Sustainability of Palm Oil Production Under Climate and Biodiversity Dependencies

Palm oil, like many other crops used as raw materials for our food, cannot be cultivated just anywhere; each crop has suitable growing regions that depend on climate and natural conditions. Therefore, as global warming progresses, the suitable regions for oil palm cultivation will shift geographically, and palm oil productivity will also change depending on the state of biodiversity in those regions.Indeed, our analysis under climate change scenarios indicates that if global warming is not adequately mitigated, palm oil yields in current production regions are projected to decline by 30–40% by 2070.
Moreover, one of the key threats to oil palm plantations is the fungal disease caused by *Ganoderma*. Monoculture plantations, where oil palms are cultivated exclusively to maximize yield per unit area, may initially offer higher short-term profitability. However, as our analysis shows, as plantations age, the incidence of diseases increases, and continuous monoculture leads to soil degradation, ultimately reducing productivity over the long term. This highlights that monoculture palm oil production, focused solely on maximizing yield per hectare, is unsustainable in the long run.
Tropical forests rich in biodiversity support a wide variety of species, including pathogens, which coexist in balanced proportions. For example, in an environment capable of supporting 1,000 organisms, if 100 species are present, they can coexist by sharing space equally, with about 10 individuals per species. In such balanced ecosystems, even pathogens like *Ganoderma* cannot easily spread, as the population of host species is limited, thereby naturally suppressing large-scale outbreaks. However, monoculture plantations disrupt this natural balance, allowing *Ganoderma*, which uses oil palm as its host, to proliferate, threatening the long-term sustainability of palm oil production. This phenomenon is consistent with ecological theories such as the Janzen-Connell effect, which explains how natural diversity in tropical forests helps stabilize species richness by suppressing disease outbreaks (Reference #9). Recent academic studies have increasingly raised concerns over the

negative impacts of biodiversity loss due to monoculture farming on palm oil production (References #10, 11).

So, what solutions are available? One promising approach is the adoption of biodiversity conscious, regenerative agricultural practices. Several such methods exist, including alley cropping techniques applied to plantation floors (Reference #12) and agroforestry-based management that conserves and restores natural vegetation within the plantation landscape (Reference #13). Although these practices may lower short-term yields per unit area, they enhance biodiversity, which in turn helps to suppress the spread of diseases like *Ganoderma*, thereby improving the long-term sustainability and profitability of palm oil production.

Overall, our analysis underscores the importance of not only aiming for carbon neutrality to mitigate climate change but also urgently enhancing the resilience of palm oil-related businesses to climate and disease risks. To ensure the sustainability of businesses reliant on palm oil, it is vital to improve agricultural practices and procurement strategies in a nature positive manner that considers biodiversity, thereby maximizing profitability over the long term while contributing to sustainable development.

[Reference Literature for the Supplementary Explanation]

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[Scientific Endorsement]

Endorsement comment by Dr. Atte Moilanen / Chief Scientific Officer, Think Nature Inc.

"The publication of NISSIN FOODS Group's TNFD disclosure based on Think Nature Inc.'s work holds significance for both business and biodiversity. The analyses concentrated on the bulk items of NISSIN FOODS Group's procurement chain, focusing on the most likely sources of high biodiversity impacts, dependencies, and risks. The public release of the findings demonstrates willingness to receive feedback and suggestions for improvement. The information shared also has broader relevance beyond the interests of one company.

At NISSIN FOODS Group, it was found that especially palm oil production process has both significant biodiversity impacts and risks to the sustainability of procurement in the future. The biodiversity impacts arise from a low level of biodiversity in oil palm monoculture plantations. Business risks arise from large expected reductions in palm oil yield due to climate warming and the spread of basal trunk rot disease, which tends to spread as plantations become older. Both of these effects have an easily understandable mechanistic base.

As the palm oil analysis was largely based on parameters found in scientific literature, various improvements to analysis could be considered. With respect to statistical predictions, improved confidence bounds, and further verification of causation would usually be possible with additional effort. It might also be possible to broaden the impact metric used. For example, global and national priorities, range-size rarity, and naturalness could be integrated into the biodiversity component of the analysis. In addition, follow-up by field work might be important for the verification of predictions that have significant operational relevance.

This brings attention to an important property of the TNFD analysis of NISSIN FOODS Group: it focuses attention on what information to seek in the future to reduce uncertainties. Emphasis should be on improving estimates that are uncertain and have relatively large effects on recommended actions.

Nature-friendly actions can be used to combat negative ecological impacts and consequent risks that arise as side-effects of human activity. These should be planned to start from a balanced coverage of main effects, aiming at cost-effectiveness, and going to a high level of detail only if needed. Because of unavoidable uncertainties, adaptive management makes sense in the context biodiversity as it does for business. In practice this means that important changes in nature should be monitored to verify predictions, followed by adjustment of actions as needed. NISSIN FOODS Group is already considering further information needs.

In the case of palm oil production process, it is already clear that opportunities for improved biodiversity and business risk are interlinked. For example, combatting the basal stem rot disease by alley cropping could significantly improve the state of biodiversity locally, which would be an overall win-win identified by TNFD-motivated analysis."