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Acting for biodiversity in a food value chain

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ABSTRACT

Food production ranks among the primary causes of biodiversity decline. While drivers of this decline are relatively well known, the role of food value chains in contributing to efforts to mitigate the ongoing biodiversity decline remains poorly understood. Adopting a qualitative, grounded theory research design, we explore companies' biodiversity actions across a national food value chain. Empirically, we study 37 companies operating in the Finnish food value chain via interviews aiming to capture the companies' actions on biodiversity, supplemented by sustainability reports and websites. Our analysis identified a total of 161 actions across 20 categories. The actions were either geared at land use or they were undertaken in organizational functions. Land use related biodiversity actions aimed either at sharing productive land with biodiversity or sparing land for biodiversity via efficient land use practices, although improving soil and growing conditions could be seen as relating to both aims. Further, we observed that only actions that took place in primary production and that aimed at sharing land with nature and improving soil, had direct, positive impacts on biodiversity. In contrast, while land sparing strategies were commonly cited by value chain actors, the causal mechanism through which spared land could contribute to biodiversity conservation instead of prompting other forms of intensive land use, remained unidentified. Actions undertaken in organizational functions related to supply chain management, sales and marketing, and corporate-level actions, bearing indirectly on biodiversity. In closing, our findings call companies to move beyond strategic commitments to identify and support concrete land use actions beneficial to biodiversity.

1. Introduction

Biodiversity decline is an existential threat to the functioning of food systems. Biodiversity is crucial for maintaining a variety of ecosystem services such as soil health, pollination, pest control and nutrient recycling, on which food systems rely (DeClerck et al., 2023). At the same time, food systems have a major impact on the state of biodiversity worldwide (Crist et al., 2017; Dudley and Alexander, 2017; Lanz et al., 2018). Nearly half of all habitable land on Earth is being used for agriculture, which means that halting biodiversity decline without changes in the food system is impossible (Benton et al., 2021). On a global level, food production and consumption drive biodiversity decline through land use change where natural ecosystems are converted into farmlands; intensification and monoculturalization of farming; as well as chemical loading and pollution (Benton et al., 2021; Dudley and Alexander, 2017; Food and Agriculture Organization of the United Nations, 2019).

The overwhelming majority of biodiversity impacts caused by food value chains takes place in agriculture and is thus driven by farmers' land-use decisions. Accordingly, most of the research focused on the biodiversity impacts of food production concerns farmers' management practices. A recent review by Klebl et al. (2024) identified 150 empirical studies from the European context alone, conducted between 2000 and 2022. This stream of research typically highlights the role of personal values, preferences and capacities, cultural influences, agricultural policies as well as market forces in farmers' decision-making and adoption decisions of biodiversity-friendly farming practices (Ahnström et al., 2009; Feola et al., 2015; Klebl et al., 2024; Malek et al., 2019). From these factors, the role of actions taken by other value chain actors for promoting biodiversity remains poorly understood, though farmers' decision-making is strongly affected by these parties' practices (Clapp, 2025; Glover and Touboulic, 2020; Herzberg et al., 2022).

Life cycle impact and footprint assessments are a prominent stream

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of research attempting to capture the heterogenous and tele-coupled biodiversity impacts caused by consuming food throughout its life cycle into single metrics (Crenna et al., 2019; Kyttä et al., 2023; Martínez-Ramón et al., 2024; Wolff et al., 2017). This stream of research has decisively increased our understanding of the biodiversity impacts of different kinds of foods and foodstuffs, especially regarding the footprints of animal-sourced foods in comparison with plant-based foods, while highlighting that only a small fraction of biodiversity impacts of foods consumed in the Global North take place near the consumption sites. However, as such these metrics do not capture—nor do they intend to do so—the specific actions that food value chain actors are undertaking to conserve or promote biodiversity. For this end, there is a need to explore the actions performed by food value chain actors for the sake of counteracting biodiversity decline in the first place, as well as to understand how these actions turn into concrete biodiversity impacts.

Even though sustainable supply chain management in the food value chains has been the topic of vivid empirical inquiry, Kamgang et al. (2023) found that relatively few studies exploring sustainable sourcing in food industry have addressed biodiversity and land indicators. The question of how value chain actors are acting or can act on biodiversity decline has been addressed in relation to specific production systems or parts of the value chain, such as fisheries (Cramer and Kittinger, 2021), tea production (Atupola and Gunarathne, 2023; Atupola et al., 2023), coffee retail (Wright et al., 2025) and production of native potato varieties (Tobin et al., 2018). Extant research also addresses broader phenomena in relation to biodiversity such as deforestation (Carodenuto and Buluran, 2021; Garrett et al., 2019; Green et al., 2019; Lambin et al., 2018) and the effectiveness of certification schemes (Carlson et al., 2017; Kubo et al., 2021). Biodiversity actions from the point of view of the entire food value chain have been only studied, to the best of our knowledge, by Voglhuber-Slavinsky et al. (2023), who identify mechanisms for the valorisation of biodiversity and the associated ecosystem services in food value chains. Relatedly, Beck-O'Brien and Bringezu (2021) review biodiversity management in long-distance food supply chains, yet focus on monitoring practices. Considering the major impact food systems have on biodiversity as well as their dependency on it, the lack of studies addressing biodiversity actions in food value chains is a critical gap warranting further research.

Understanding the contributions of food value chains on biodiversity is further complicated by the very nature of biodiversity itself. Biodiversity is reduced directly when more diverse habitats such as forest or grasslands are converted into intensively managed cropping systems whose biotic variability is then maintained at low levels, e.g., through physical management interventions and the use of pesticides. However, while many species – including plant species – depend on the persistence of native plant communities (Balmford, 2021; Phalan et al., 2011), human-modified agricultural environments also contribute to biodiversity. Biodiversity exists within and among food systems, not only beyond them (Emmerson et al., 2016). This tension is the source of an ongoing debate among the scientific community about the most effective strategies to address biodiversity decline taking place within food systems, caused by food production and consumption. The debate is captured by the concepts of sparing vs. sharing, wherein sparing refers to the idea of producing food as efficiently as possible within as small a land area as possible, whereas in sharing biodiversity is 'allowed' to live also within production systems, possibly making them less effective in producing food (Loconto et al., 2020; Sidemo-Holm et al., 2021). We bring this debate to the forefront of our analysis by asking, how the actions of food value chain actors relate to either sparing or sharing strategies. These strategies also relate to the question of whether the actions adopted by food value chain companies are direct or indirect, as the sparing strategy requires additional conservation actions to actually contribute to higher levels of biodiversity (Luskin et al., 2018). In this vein, we are inspired by and extend on the work of Wagner (2022), who observed that, across industries, companies' direct actions to protect biodiversity remain low as compared to indirect actions.

In this research, we explore the commitments of food value chain actors to act on biodiversity decline. As our research questions, we ask: (1) what kind of biodiversity actions are being undertaken by Finnish companies across the national food value chain? (2) how do these actions directly or indirectly contribute to halting biodiversity decline? and (3) how do these actions relate to the concepts of sparing and sharing? We consider direct actions as concrete, place-specific, positive contributions to biodiversity, as detailed in Section 4. As research on food value chain companies' actions on biodiversity decline is scarce, we adopted a qualitative, explorative, grounded theory research design (Glaser and Strauss, 1967). Our case is the Finnish food system, where we have studied 37 companies of various sizes operating in the Finnish food value chain from primary production to trade, industry, and food service providers.

Despite its northern location, Finland produces nearly as much food as it consumes with food self-sufficiency rates being around 80% (Natural Resources Institute Finland, 2023). Approximately 7.5% of the land area is used for agriculture, with the share of agricultural lands being higher in southern and western parts of the country (Natural Resources Institute Finland, 2024). Whereas one of the most important global drivers of biodiversity decline is land use change, in the Finnish food system, biodiversity decline is driven by intensification of production practices, which has led to declining biodiversity among farmland species; biodiversity loss driven by eutrophication, with the Baltic Sea being one of the world's most polluted seas; and biodiversity footprint outsourced beyond Finnish borders, as outlined in Section 2.

We contribute to the existing literature firstly through offering an empirically grounded appreciation of food system companies' biodiversity actions across a national food value chain. Second, we identify the actions that bear direct vs. indirect biodiversity impacts, as well as their foundations in sparing or sharing strategies. Third, zooming within organizations, we highlight how biodiversity actions not only depend on the company's position in the value chain, but, further, on the organizational function in question. In so doing, we offer a relational appreciation of these actions occurring in uneven power positions between value chain actors.

The paper proceeds as follows. The next section reviews companies' biodiversity work in general, and then proceeds to discussing approaches toward biodiversity conservation in the context of food value chains. The third section presents the research design and methodological choices. In presenting our findings, section four starts by presenting our conceptual framework of direct and indirect biodiversity actions in the food value chain, before moving onto an analytical categorization and overview of biodiversity actions across a national food value chain. Section five discusses our contributions to research and considers the limitations of our work. Section six concludes, while identifying practical and policy implications as well as future research directions.

2. Literature review

2.1. Companies' biodiversity work

Biodiversity refers to the variability of life on Earth (Chivian and Bernstein, 2008): the more variability there is among different ecological units, the higher the diversity, and vice versa. As an account of the variability of life, biodiversity becomes manifest in practice via the variability of taxonomic groups (Li et al., 2020), the physical structures of organisms and their assemblages in space (LaRue et al., 2023), as well as the functional networks of organisms and their environments (Mammola et al., 2021). This variability can be studied at several overlapping levels of biological organization (Díaz and Malhi, 2022): genetic diversity refers to the variability of genetic traits between organisms within or among species, species diversity to the variability of individual organisms examined at the level of species, and ecological diversity to the variability of ecological systems they form together with

the non-living nature. Changes in the state of biodiversity, including its current decline, can be seen in all of the above-mentioned dimensions. According to the latest Global Risks Report of the World Economic Forum (2024, 7,8), the decline of biodiversity ranks among the three most important long-term risks faced by humankind. Interdisciplinary reviews and international panel reports recommend transformative change in order to address biodiversity decline (Díaz et al., 2019; IPBES, 2019, 2024). Owing to the largely harmful impact of business activity on the natural environment, companies are critical actors in halting biodiversity decline (Addison et al., 2020; Dasgupta, 2021; Díaz et al., 2019). Notwithstanding, transformative change practices for business to address biodiversity loss have been called for (Booth et al., 2024; Panwar, 2023).

Companies' biodiversity work is supported by international governance, such as the 2022 Kunming Montreal Global Biodiversity Framework, outlining national governments' role in setting regulations for large companies to monitor and report their impacts on biodiversity. Paralleling legal mandates, a variety of private sector reporting initiatives have been developed to motivate companies to voluntarily disclose their biodiversity impacts, including the Global Reporting Initiative (GRI), the Taskforce on Nature-related disclosures (TNFD), and the Science-Based Targets Network (SBTN) (Lamont et al., 2023). In parallel, a variety of operationalizations of nature-positive business have been developed over the last years (Zu Ermgassen et al., 2022), while research at the intersection of biodiversity and business is emerging, as review (Teerikangas et al., 2023; Testa et al., 2025) and conceptual papers attest (Winn and Pogutz, 2013; Panwar et al., 2023; Panwar, 2023). Taking a closer look, though, this research is focused on companies' biodiversity commitments, reporting and measurement (Talbot and Boiral, 2021; Farnsworth et al., 2015; Hassan et al., 2020), while accounts of companies' actions to promote biodiversity are substantially scarcer (Wagner, 2022).

As regards business interest, the share of Fortune Global 500 companies recognizing nature in their business strategy or with nature conservation-related targets is increasing (McKinsey, 2024). However, nature-related targets tend to focus on carbon, water, or chemicals, i.e. not on biodiversity (ibidem). All the while, an analysis of Fortune Global 100 companies 2017–2021 highlights an increase in their biodiversity commitments, though with scant detail on measurable, time-bound commitments (Zu Ermgassen et al., 2022). This echoes McKinsey's (2024) report observing that while 64% of Fortune 500 companies acknowledge biodiversity as part of their strategy, only 12% have set explicit restoration or conservation targets (McKinsey, 2024). This parallels earlier findings, where studying companies' 'no net loss' and 'net positive impact' biodiversity commitments over the past two decades, De Silva et al. (2019) found that while half had made such commitments, very few had made active commitments, yet none met all the requirements. This has led Talbot and Boiral (2021) to criticize that biodiversity-related corporate commitments tend to be symbolic or evaluated based on unclear indicators. Indeed, reporting on biodiversity in companies' annual reports is either lacking (Hassan et al., 2020), or scarce and unsystematic (Hassan et al., 2022). An analysis of the sustainability reports of 100 of the world's largest businesses highlights that 2/3 engage in different kinds of ecosystem restoration activity. Nevertheless, there is a lack of rigor and transparency in restoration reporting as regards definitions, methods and outcomes, leading Lamont et al. (2023) to call for large companies to embrace principles from restoration science. A similar analysis of the world's 75 largest companies' disclosure strategies as regards their impact on marine ecosystems reveals disclosure and indicators focused on energy and greenhouse gas emissions, with lacking attention to ocean-specific impacts on biodiversity and ecosystems (Jouffray et al., 2025).

While biodiversity decline is caused by businesses across sectors (Panwar et al., 2023), the largest footprints appear in land- and energy-intensive sectors, such as agriculture, food, electricity production and transport (Wilting and van Oorschot, 2017) as well as in extractive industries (Lähtinen et al., 2016). Our case, the food system, has been estimated as the main driver of global biodiversity loss (Benton et al., 2021). In the next section, we will discuss the case for food systems, food value chains and biodiversity in more detail.

2.2. Food value chains and biodiversity

2.2.1. Food system related biodiversity in Finland

The impacts of food production on biodiversity take place for the most part via expansion of cultivated areas and intensification of production in the existing farmland, the latter entailing also increasing pollution (e.g. eutrophication and use of pesticides) and resource use (e.g. irrigation water) (Benton et al., 2021; IPBES, 2019: 794). Expansion of agricultural areas decreases the available habitats for wildlife especially in tropical areas, and it ranks among the most important causes of biodiversity decline globally (Zhang et al., 2021). Such conversion is largely driven by expansion of cattle production, production of feed, especially soy, for farmed animals and plantations of globally traded crops such as oil palm (Benton et al., 2021; IPBES, 2019; Zhang et al., 2021). Deforestation taking place due to this conversion is a major cause of food system driven extinctions, and is strongly linked to global supply chains of foods, wherein food and feed is imported from the Global South to Global North. Global trade of food has been estimated to cause 30% of projected food-system driven extinctions (Chaudhary & Brooks, 2018). From the biodiversity footprint of Finnish food consumption, as much as 85–93% has been estimated to take place beyond Finnish borders in biodiversity hotspots such as Brazil, India and Colombia (Kyttä et al., 2023; Sandström et al., 2017). This is due to Finland belonging to an ecoregion with few endemic species (Sandström et al., 2017).

Even though biodiversity in boreal areas such as Finland is generally lower than in tropical and subtropical areas, biodiversity in Finland is declining, with almost half of the habitat types in Finland being threatened (Hyvärinen et al., 2019), indicating the insufficiency of current actions to halt biodiversity decline (Kangas et al., 2023, 73). As such, global extinction potential should not be used as a pretext to divert the gaze away from domestic biodiversity (Kyttä et al., 2023)—instead, the current levels and trends of biodiversity in agricultural environments make the biodiversity impacts of the food system a major concern (Toivonen et al., 2022). The traditional focus of biodiversity policies in Finland has been on forest species, which make up the largest fraction of endangered species (Hyvärinen et al., 2019). However, unlike in tropical regions, agricultural land use is not driving the decline of forest-related biodiversity in Finland, which is driven by intensive forestry practices. Instead, in the Finnish context, food system related biodiversity decline is driven primarily by intensification of agricultural production practices, which results in specialisation and monoculturalisation, homogenisation of landscapes, loss of seminatural habitats, decreasing rates of grazing, and eutrophication of waterways (Herzon et al., 2014; Rytteri et al., 2024). For example, grazing on semi-natural grasslands but also on arable fields and especially within the organic scheme has been shown to provide biodiversity benefits (Ekroos et al., 2019; Santangeli et al., 2019). However, grazing rates in Finland are in decline especially in dairy production (Rytteri et al., 2024) due to cattle increasingly being confined indoors, as fewer farmers have enough pastures or practical possibilities to arrange grazing for large herds (Kuhmonen, 2024). Similarly, the expansion of subsurface draining systems that imply larger field blocks and less open ditches and ditch banks is one of the management practices that has contributed to the decreasing levels of biodiversity in agricultural landscapes (Saikkonen et al., 2014).

The developments taking place in Finland parallel the general development pattern observable in the rest of Europe, wherein agriculture intensifies in the favorable farming areas, but marginally productive grasslands are abandoned, with both developments driving biodiversity decline (Emmerson et al., 2016; Herzon et al., 2022). At the European level, intensification of agricultural practices has been shown

to drive decline of birds (Donal et al., 2001; Rigal et al., 2023) and is the most likely reason behind the observed decline of insect biomass (Hallmann et al., 2017). Similarly, in Finland, the populations of farmland birds are steadily decreasing (Luonnontila, 2024). Seminatural grasslands and wooded pastures, referred to as traditional rural biotopes, are boreal diversity hotspots, but their area has declined drastically in Finland mainly due to intensification of animal husbandry and abandonment of extensive grazing (Dengler et al., 2020; Raatikainen, 2018; Natural Resources Institute Finland, 2025). These developments are visible in the Finnish Red List species, wherein farmland and other cultural species comprise the second largest fraction of species after forest species (25% of all endangered species), as well as in the number of extinctions, which are the highest among farmland species (39% of all species gone extinct) (Hyvärinen et al., 2019). At the same time, afforestation of grasslands and the resulting increasing forest cover does not seem to result in higher numbers of woodland bird species (Rigal et al., 2023).

Due to the strongly context-specific drivers behind biodiversity decline, the debate on land sparing vs. sharing has reached a seeming conciliation—that a combination of approaches to promote food production-related biodiversity conservation are needed (Grass et al., 2019; Sidemo-Holm et al., 2021). Sparing land through intensive production that requires less land seems to be a beneficial strategy for meeting production targets and conserving biodiversity especially in regions rich in biodiversity and when the outputs are consumed locally (Kremen, 2015; Phalan et al., 2011). However, positive biodiversity impacts resulting from land sparing through intensive agriculture require additional policies to avoid the rebound effect and make sure that the spared land from agriculture truly contributes to biodiversity conservation, instead of incentivising further extension of farmland or providing space for some other kind of intensive land-use that leads to reduced biodiversity (Desquilbet et al., 2017; Grass et al., 2019). Essentially, solutions aiming at land sparing require accompanying measures and policies to prevent biodiversity decline, such as conservation schemes (Rudel et al., 2009). These, however, are typically beyond the radar of value chain policies.

Land sharing, which promotes biodiversity within and among farmland, is based on adopting such land use practices that tolerate or demand higher levels of biodiversity within production areas, such as organic farming or agroecology (Dudley and Alexander, 2017; Fraanje, 2018). Land sharing practices typically feature less external inputs, more regeneration, diversification and introducing semi-natural features among the farmland (Luskin et al., 2018). Land sharing promotes ecosystem services in agricultural areas and thus has a positive impact on biodiversity when the baseline is conventional, intensive agriculture (Grass et al., 2019). At the same time, due to lower yield efficiency, land sharing might also require more land use to produce the same amount of food as intensive methods within a smaller area (Fraanje, 2018). Due to this aspect, the effectiveness of land sharing as a biodiversity strategy has been questioned (Phalan et al., 2011; Collas et al., 2023). Nonetheless, the proponents of land sharing argue that for example agroecology can represent a form of sustainable, biodiversity-friendly intensification that can meet both production targets and lead to favorable biodiversity outcomes (Fischer et al., 2017; Kremen, 2015). What is more, it is clear that the consequences of such intensification prevailing in much of the agricultural areas in the Global North, are unequivocally detrimental for biodiversity.

In sum, the priorities for action on agriculture and biodiversity include 1) halting the expansion of agriculture into "intact" nature – this is especially the case in tropics and thus concerns global supply chains, and 2) reducing the input intensity and bringing more seminatural elements into farmed areas in intensively managed areas such as Europe. Reducing the input intensity requires also less input-intensive animal production. Animal production currently contributes to 65% of global land system change (Bowles et al., 2019), and in terms of land use impacts, their contribution in the current Finnish diets clearly exceeds those of plant-based foods (Kyttä et al., 2023).

2.2.2. Food value chains acting on biodiversity

Value chains of foods have a decisive role as drivers of biodiversity impacts. Many companies in the Finnish food value chain have started to address their biodiversity impacts (Peura et al., 2023; Schadewitz, 2024), but comprehensive understanding about the nature of such work is thus far lacking. However, previous research into sustainable supply chain management practices in the food system provides examples of the kind of work companies have engaged with to address their impacts. These include leveraging environmental information and measurements in the form of life cycle assessments; supplier relationships and direct investments in origin; imposing various forms of sustainability criteria on supply chains, such as standards, certifications and geographic indications; supplier management in the form of audits and codes of conduct; collaboration across supply chains including multi-stakeholder initiatives, partnerships and roundtables; and finally imposing bans and moratoria (Adams et al., 2021; Palazzo & Vollero, 2022; Rueda et al., 2017). From the point of view of promoting biodiversity-friendly practices across food value chains, Voglhuber-Slavinsky et al. (2023) identify four main mechanisms for the valorization for biodiversity and the associated ecosystem services. These include markets for voluntary biodiversity actions, labelling and certification, environmental management and corporate social responsibility and tradable permits and quotas. In the case of deforestation, Lambin et al. (2018) identify company pledges and expressions of commitment, codes of conduct and sectoral standards, price premiums as well as sanctions and moratoria as means for protecting biodiversity.

The effectiveness of value chain initiatives has been studied in the context of deforestation, where the evidence appears mixed (Lambin et al., 2018). For example, Green et al. (2019) report that despite many high-profile agricultural commodity traders having joined declarations for halting deforestation in their supply chains, their actual commitments toward this cause are highly variable. In a similar vein, Tobin et al. (2018, p. 19) note that empirical evidence about value chain actions to promote biodiversity is vague. In terms of biodiversity measurement leading action, the study conducted by Martínez-Ramón et al. (2024) indicates that the chosen assessment method for biodiversity footprint can have a substantial impact on the results and the subsequent recommendations for corporate biodiversity strategies. Certification schemes have a potential to drive impact, but for example in the case of deforestation caused by oil palm and fastwood plantations, preventing further biodiversity loss would require habitat improvement and expansion and targeting the non-certified concessions at the deforestation frontier (Kubo et al., 2021). Organic certification in agriculture has been shown to have positive impacts on biodiversity (Santangeli et al., 2019; Toivonen et al., 2022), but for example Tscharntke et al. (2021) acknowledge the limitations of organic farming as a single practice and call for wider adjustments within the farming system for increased impact.

In all, there is limited understanding about whether the actions of food value chain companies are concerted from the point of view of biodiversity conservation and to which extent they support the primary producers in making biodiversity-friendly production choices.

3. Methods

3.1. Data collection

In light of the lack of prior research on companies' biodiversity actions, particularly studying actors across the food value chain, we adopted an explorative, qualitative, grounded theory-building approach (Glaser and Strauss, 1967). We applied this methodology to gain a deeper, empirically grounded understanding of how companies in the Finnish food system address biodiversity via the actions they undertake. In grounded theory-building, access to the studied topic in as diverse

contexts as possible is essential. To this end, in selecting companies for study, we adopted a theoretical sampling approach (Eisenhardt, 1989; Glaser and Strauss, 1967), to ensure that the sample represented the diversity of commercial actors across the Finnish food system. To this end, we sought companies that (1) represented all parts of the food chain, (2) varied in size and (3) were geographically located in all parts of the country. Based on these sampling principles, the research team spent time in listing companies operating in the Finnish food sector, resulting in an overall list of over 100 companies. Out of this overall list, we started by contacting 60 companies. Some were unavailable or did not want to participate in the interviews. As we proceeded in contacting companies for interviews, we continuously controlled for diversity in the sample, as per the set theoretical sampling criteria. This iterative process, over months, led to a sample of 37 companies. We maintained openness to increasing the sample size, if needed, after the interviews had been conducted. However, during the interview process, it gradually became clear that answers started to recur, i.e. the researchers had reached theoretical saturation (Glaser and Strauss, 1967), i.e. not a set or objective measure, but rather, the researchers' subjective sense that there is little to be gained from additional data collection (unless research and interview questions are changed). In the final sample, the company size varied from microenterprises with less than 10 employees, with a turnover below 5 M€ ($n = 10$), to small (n = 10), medium ($n = 5$), and large ($n = 12$) companies employing over 250 to thousands of employees with turnovers between 20 million to billions of euros (see Table 1). Companies represented the food system from primary production ($n = 13$) to processing (n = 12), trade and retail (n = 5), and food services ($n = 7$) (Table 1). The final sample included the majority of large operators from food processing, trade and retail, many of whom have a global reach in their supply chains, and a sample of smaller actors representing different parts of the country, different business models and varying sustainability orientations.

The interviews were conducted in autumn 2022. Interviews were conducted in Finnish and one in English. Most interviews featured a single interviewee, though in a few cases, two representatives from the same company were interviewed simultaneously. The length of the interviews varied between 22 and 95 min, with the average length of approximately one hour. The interviewees were senior representatives of their companies (1) in decision-making positions who (2) had knowledge of the company's biodiversity work. The interviewees included chief executive officers, farm owners, responsibility/corporate social responsibility directors or managers, development managers, service managers, and research and development managers (Table 1).

The research team spent time devising the interview guide. Based on the societal discourse (e.g., media, ministries, professional bodies, ..), we were aware that companies were beginning to take an interest toward biodiversity, yet the extent of this work remained unknown. Hence, the semi-structured interview protocol (see Appendix, Supplementary file) included questions that were sufficiently broad to allow for the progressive emergence of different insights as regards the nature and status of the studied companies' biodiversity work. The themes of the interview guide, not the individual questions, were provided to the interviewees in advance. This was done to ensure that the interviewees were able to express their individual views openly and to avoid predetermined answers in the interviews. Following the grounded theory methodology (Glaser and Strauss, 1967), additional questions were added, if the interviewee responses probed for this. Throughout the research, we have followed the ethical guidelines of the Finnish National Board on Research Integrity (TENK). For one, a data management plan was devised and confirmed with the funder. For another, interviewees' consent for recording, verbatim transcription, time-bound and safe storage as well as use of interview data anonymously by dedicated research team members was gained prior to each interview. No sensitive data was collected in the interviews. As per the Finnish TENK guidelines, approval from the ethics board was not required.

3.2. Data analysis

Aligned with the grounded theory methodology (Glaser and Strauss, 1967), we began with an explorative, inductive content analysis of the qualitative data. To this end, the analysis started with an open-minded read-through of the interviews, which was conducted independently by two authors and led to identification of main topics from the data. This was then followed by a second, more detailed reading during which all reported biodiversity actions were coded. The coding was conducted by two authors in close collaboration. Coding was conducted using Excel. At this stage, the author team decided what was coded as a biodiversity action as follows:

1. The coded biodiversity actions were ones that the interviewees reported as effective, i.e. they were not prompted with examples of biodiversity-friendly actions. Therefore, the actions reported in the interviews represent not only what the companies are doing, but also the interviewees' perceptions of what accounts as a biodiversity-friendly action.
2. In order to move beyond a potential interviewee bias in the answers, we cross-compared the actions reported by interviewees with data from all of the available company websites and also the annual reports of the largest of the studied companies. Additional material was used for all except one company that did not have a webpage. In the case of nine companies (i.e. 2 in primary production, 5 in food processing, 2 in trade and 1 in food services), we identified actions which the company representatives had not disclosed in the interview (see last column, Table 1). As the interviews were conducted in the autumn of 2022 and the websites and sustainability reports were accessed in February 2024, it is possible that the companies might have added some of their actions after the interviews were conducted.
3. We focused on the active actions adopted by companies to address biodiversity decline. Therefore, actions were excluded if they aimed at resource use efficiency with biodiversity impacts very difficult to estimate (e.g. decreasing food waste, using sustainable packing materials), if they are already legally required (e.g. not accepting undersized fish), or they are even harmful to biodiversity (e.g. subsurface drainage systems).
4. Actions chiefly aimed at addressing other ecological problems such as climate change were omitted because the expected effects of these actions on biodiversity are very hard to assess.

This initial coding led us to identify a total of 161 biodiversity actions. Each biodiversity action was named and sorted into emerging categories based on (1) the value chain position of the company (e.g. food processing), and (2) the type of action (e.g. procurement criteria). This early-stage data analysis was grounded and inductive, i.e. data-driven. Whenever we identified a theme that connected with prior research, we started using the known, respective label for the theme. Therefore, as the analysis progressed, it began to iteratively occur via abductive loops, as the emerging findings were connected to literature and existing theoretical concepts.

In order to deepen the grounded analysis (Glaser and Strauss, 1967), we used the data structure approach for further analyzing and presenting the data (Gioia et al., 2013). Accordingly, a data structure (see Table 2) was drafted as follows. First, the recurring concepts from the interviews, which were identified during the initial coding – i.e. biodiversity actions – were used as first order concepts (e.g. certifications), leading to a final count of 20 biodiversity actions (see Table 2). Second, these first-order concepts were categorized into second-order themes representing biodiversity action types (e.g. procurement criteria). Third, these second order themes were arranged into two aggregate categories, i.e. those relating to (1) land-use decisions and (2) organizational functions. As regards land-use decisions (1), we identified three biodiversity action types based on existing literature (cf. Section 2): land

Table 1
Overview and description of collected data and sample: companies, interviewees, secondary material.

	Company size			Positioning of companies in food value chain										Interviewees	Use of secondary material	
				Primary production				Processing	Trade & Retail			Food services				
#	Company type	Total staff employed	Turnover (M€)	Agricultural inputs	Plants	Fish	Meat	Processing	Wholesalers	Retail	Alternative	Food services	Restaurants	Interviewee's role	Company website	Additional information gained
1	Micro enterprise	1–9	N/A		x			*(x)*						Owner, Farmer	x	x
2	Micro enterprise	1–9	N/A			x								Owner, Fisher		
3	Micro enterprise	1–9	>1							x				Owner	x	
4	Micro enterprise	1–9	>1		x			*(x)*						Owner, Farmer	x	
5	Micro enterprise	1–9	>1		x						*(x)*			Chief executive officer	x	
6	Micro enterprise	1–9	1–4,99					x						Owner	x	
7	Micro enterprise	1–9	1–4,99		x		*(x)*							Owner, Farmer	x	
8	Micro enterprise	1–9	N/A		x									Owner, Farmer	x	
9	Micro enterprise	1–9	N/A		x									Owner, Farmer	x	
10	Micro enterprise	1–9	N/A				x							Owner, Farmer	x	
11	Small enterprise	10–29	1–4,99		x			*(x)*						Development Manager	x	
12	Small enterprise	10–29	<1		x			*(x)*						Chief executive officer	x	
13	Small enterprise	10–29	1–4,99									x		Chief executive officer	x	
14	Small enterprise	10–29	<1					x						Chief executive officer	x	
15	Small enterprise	10–29	5–9,99						x					Manager of Farming	x	
16	Small enterprise	10–29	10–19,99	x										Director of Research and Development	x	
17	Small enterprise	10–29	1–4,99					x						Quality Manager	x	
18	Small enterprise	30–49	10–19,99									x	*(x)*	Manager of Food Products	x	
19	Small enterprise	30–49	71,68					x						Quality and environmental manager	x	
20	Small enterprise	30–49	20–49,99						x					Manager for Quality and Environment Sustainability Expert	x	
21	Medium-sized enterprise	50–99	5–9,99	x										Chief executive officer	x	x
22	Medium-sized enterprise	50–99	50–99,99					x						Manager for primary production Adviser for primary production	x	

(*continued on next page*)

Table 1 (*continued*)

	Company size			Positioning of companies in food value chain										Interviewees	Use of secondary material	
				Primary production				Processing	Trade & Retail			Food services				
#	Company type	Total staff employed	Turnover (M€)	Agricultural inputs	Plants	Fish	Meat	Processing	Wholesalers	Retail	Alternative	Food services	Restaurants	Interviewee's role	Company website	Additional information gained
23	Medium-sized enterprise	50–99	10–19,99					x						CEO, main owner Vice- Chief executive officer	x	
24	Medium-sized enterprise	100–249	1–4,99			x								Chief executive officer	x	
25	Medium-sized enterprise	100–249	10–19,99										x	Development manager Sustainable development expert	x	
26	Large enterprise	250–500	100–999,99					x						Chief executive officer Manager of Communications & Sustainability	x	x
27	Large enterprise	250–500	1000+					x						Sustainability Program Manager	x	x
28	Large enterprise	250–500	20–49,99									x		Director	x	
29	Large enterprise	250–500	50–99,99									x		Global Head of Sustainability	x	
30	Large enterprise	1000–2500	100–999,99					x						Director of Sustainability	x	
31	Large enterprise	1000–2500	100–999,99										x	Senior Manager of Sustainability	x	
32	Large enterprise	1000–2500	1000+					x						Director of Corporate Social Responsibility	x	x
33	Large enterprise	2500+	1000+					x						Development Manager	x	x
34	Large enterprise	2500+	1000+					x						Director of Sustainability Sustainability Manager	x	
35	Large enterprise	2500+	100–999,99										x	Director of Development Sustainability Manager	x	x
36	Large enterprise	2500+	1000+							x				Director of Sustainability	x	x
37	Large enterprise	2500+	1000+							x				Director of Sustainability	x	x
TOTAL companies per food company type				2	8	2	1	12	2	3		4	3		36	9
	TOTAL companies per value chain actor type			= 13				= 12	= 5			= 7				

Legend: x refers to the company's core business, while (x) refers to additional business.

Table 2
Analytical framework presenting the qualitative findings.

Data structure's analytical categories			Number of companies (total *n* 37) per action			
Aggregate dimension *(Title numbering)*	Second-order themes *(Sub-title numbering)*	First-order concepts *(Enumerated bd actions)*	Primary production	Processing	Retail	Food Services
4.2. Biodiversity actions geared at land use						
4.2.1. Biodiversity actions aiming at sharing land with nature						
		1. Organic and regenerative farming	4	5	4	2
		2. Agroforestry	1	2	1	
		3. Management of traditional rural biotopes and seminatural grasslands	2	1		
		4. Grazing	2	4	1	1
4.2.2. Biodiversity actions improving soil and growing conditions						
		5. Improving soil health	6	4		
		6. Decreasing chemical use	5	2	1	
4.2.3. Biodiversity actions aiming at sparing nature						
		7. Reducing deforestation		3	3	1
		8. Developing plant-based proteins	1	3	1	
		9. Food without agriculture		1		
4.3. Biodiversity actions undertaken in organizational functions						
4.3.1. Biodiversity actions in supply chain management						
		10. Procurement criteria	2	7	4	4
		11. Contract producer agreements	1	8	3	1
		12. Pilot activities and sharing best practices	1	4	2	1
		13. Favoring local producers	1	2		4
4.3.2. Biodiversity actions in sales and marketing						
		14. Increasing the biodiversity-friendly product offering	3	4	2	2
		15. Making the biodiversity-friendly choice easier				2
		16. Educating customers on making biodiversity-friendly choices	1	2	1	2
4.3.3. Corporate-level biodiversity actions						
		17. Strategy	3	6	3	3
		18. Biodiversity reporting	1	4	3	1
		19. Biodiversity measurement		4	2	2
		20. Education and training		1	1	2

Legend: actions marked in grey indicate direct biodiversity actions, all other actions consist in indirect biodiversity actions.

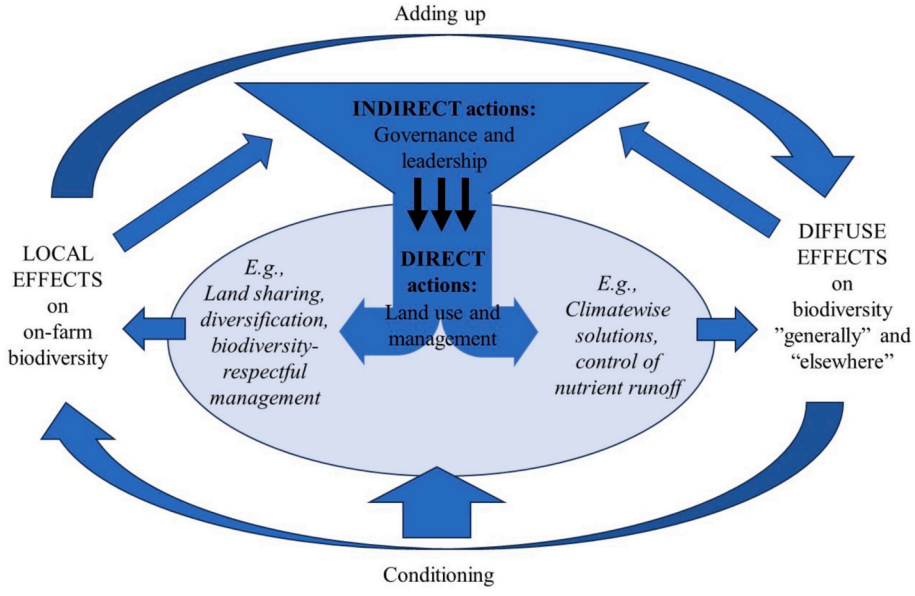

Fig. 1. Conceptual framework: direct and indirect biodiversity actions and dynamics.

sharing, land sparing as well as an inductively identified, data-driven category related to soil and growing conditions that cuts across both approaches. As regards organizational functions (2), the identified biodiversity action types resonated with Porter's classical value chain framework, which distinguishes between the organizational functions of supply chain management, sales and marketing and corporate functions (Porter, 1985).

Next, for each category of biodiversity actions, we identified whether it bears direct or indirect impacts on biodiversity. To this end, we developed a conceptual framework indicating the relationship between actions taking place on farms vs. the value chain actions adopted to drive on-farm actions (see section 4.1), while considering the impacts of these actions on biodiversity (Fig. 1). Essentially, direct actions affect non-human nature, whereas indirect actions affect humans, who may act differently due to being influenced by these actions and thus engage in actions with concrete biodiversity impacts.

Finally, we cross-tabulated the biodiversity actions with the companies' value chain position. This enabled us to identify, contrast and compare the actions undertaken by actors operating in different parts of the food value chain. While companies operating beyond primary production (i.e. in food processing, trade, and food services) shared many biodiversity actions, they also shared others with primary producers. The results of the analysis are presented in the next sections (4.2–4.3), and the resulting categorization of the findings is presented in Table 2. Some of the actions identified were mentioned in more than one category, as indirectly influencing land use takes place in the organizational function of the company.

4. Results

In this section, we first present our abductively derived conceptual framework on companies' direct vs. indirect biodiversity actions (section 4.1). Thereafter, we proceed to a detailed overview of the empirically identified actions companies adopt to address biodiversity decline (sections 4.2–4.3), divided into the two categories, i.e. actions (1) geared at land use, and (2) undertaken across organizational functions.

4.1. Conceptual framework of direct vs. indirect biodiversity actions

Within the value chains of food, the direct impacts on biodiversity take place via land use, whereas the nature of all the other actions within the food value chains is indirect. Nevertheless, indirect actions can bear consequences on biodiversity, if they prompt direct actions, i.e. specific land-use decisions and farming practices. The dynamics prevailing between direct and indirect biodiversity actions are illustrated in Fig. 1.

Taking a closer look, we identify two kinds of direct biodiversity actions: actions that have an effect on biodiversity at a very local level (e.g. at the level of a farm), and actions whose effects are diffuse and mostly felt beyond the location where they are carried out. Both types of direct actions can be carried out anywhere where primary production of food takes place. When carried out in many places over time, the direct biodiversity actions with local (on-farm level) effects add up in space and time, therefore also contributing to broader changes in biodiversity. Furthermore, the effects of direct actions that are felt diffusely beyond the local level may over time contribute to conditioning future direct actions carried out on farms. We categorized these actions as geared at land use.

Indirect biodiversity actions, in turn, seek to prompt direct actions. Such indirect actions are, for example, practices of governance or leadership that elicit people to carry out the above-described direct actions on farms or elsewhere in primary production. In sum, as we see them, indirect actions prompt human action, whereas direct actions influence non-human nature. Therefore, an effective indirect action unleashes a chain reaction that ultimately leads to individuals or collectives carrying out direct actions (elsewhere) at a given moment in time. Unless this happens, there is no contribution to biodiversity.

Combined, all biodiversity actions, whether direct or indirect, and their effects on people and non-human nature influence back on how new actions are designed and implemented, Fig. 1. We identified and categorized such actions as taking place in all companies across the food value chain, and moreover, across their organizational functions.

In our interviews, we identified a total of 161 biodiversity actions, of which the majority (88%) were indirect, as direct biodiversity actions (12%) occur only in primary production. Via our iterative data analysis process, we distilled the total number of biodiversity actions identified to a final set of 20 biodiversity actions, as presented and enumerated in Table 2 and used as the basis of reporting our findings (in sections 4.2.-4.3). The direct biodiversity actions that took place at the farm level consisted of practices that aim at sharing land with nature (section 4.2.1) and actions improving soil and growing conditions (section 4.2.2). In addition to these, a number of actions taking place in primary production but aiming at land sparing (section 4.2.3) were categorized as indirect, as the biodiversity impact of these actions requires other kinds of actions to take place – such as implementation of conservation programs. All actions taking place within organizational functions were labelled as indirect (section 4.3).

Beyond the two broad categories of biodiversity actions, Table 2 highlights how these actions are undertaken differently by actors along the food value chain (i.e. primary producer, food processing, food trade, food services). Taking a closer look, the uptake for biodiversity actions varies among companies, as each company reported between 0 and 12 actions, with the average number of actions being 3.7. Moreover, out of studied 37 companies, seven did not report or identify any biodiversity actions, while six had actions in only one of the identified categories; combined, these represent over a third of the studied companies. Most of the reported biodiversity actions occurred in primary production and supply chain management. These were also the only parts of the value chain with more companies conducting actions than not. Over the next sections, we move onto presenting our findings, following the data structure (Table 2).

4.2. Biodiversity actions geared at land use

Biodiversity actions involving land use are conducted directly in touch with nature. Actions related to land use are undertaken by companies operating in primary production, yet they are supported by indirect actions conducted by companies operating in processing, trade and food services. From the land use related actions, two types of actions have a direct biodiversity impact: 1) those aimed at sharing land with other lifeforms within production areas, 2) those aimed at improving soil and growing conditions of the fields. The third category of land use related actions we identified is based on land sparing; those actions are indirect, as for any biodiversity impacts to take place, further measures are required (i.e. assigning land to restoration or conservation purposes). Quotes referred to in the text feature in Table 3, tabulated based on the enumerated 20 biodiversity actions in Table 2.

4.2.1. Biodiversity actions aiming at sharing land with nature

We identified actions aimed at increasing biodiversity in production areas by sharing land with non-human nature, i.e. implementing production approaches that tolerate more biodiversity. These actions include 1) organic and regenerative farming, 2) agroforestry, 3) management of traditional rural biotopes and seminatural grasslands, and 4) grazing, as detailed below. These direct biodiversity actions occur in primary production, yet they are encouraged through indirect actions undertaken by companies in other parts of the value chain (see Table 2).

4.2.1.1. Organic and regenerative farming. Organic farming relies on ecosystem management instead of using synthetic inputs such as synthetic fertilizers or pesticides (Food and Agriculture Organization of the United Nations (FAO) (s.a.), 2020). In Finland, the standards for organic

farming are regulated by the rules and regulations of both the European Union (EU) and national legislation (European Union regulation 2018/848; Finnish law 1330/2021).

Four of the interviewed primary producers engaged in organic farming, considering it offering a means to have a direct positive effect on nature. To this end, a producer considered organic farming as more sustainable (see Table 3, quote 1–1). Another producer had noticed the direct biodiversity benefits of organic farming, as compared to mainstream methods (quote 1–2).

In parallel, for companies outside of primary production, organic production was indirectly promoted by favoring or including organic products in procurement. This was the case with five food processing, four retail and two food services companies in the studied sample. Taking a closer look, a company operating in retail had increased the share of organic products to more than 90% of their product portfolio (quote 1–3). A company operating in food services, in turn, stated that they take part in a program that aims at increasing the use of organic products (quote 1–4). A food processing company supports organic farming through contract producer agreements as well as through actions in their own pilot farm (quote 1–5). Another representative from a food processing company considered organic products as the most impactful way to support biodiversity (quote 1–6).

Regenerative farming is another way to directly increase biodiversity in production areas. Thus far, regenerative farming does not have a widely agreed definition, nor is it regulated by strict process-oriented standards, as is the case with organic farming. The goals of regenerative farming are to improve soil health, increase carbon sequestration, and to increase biodiversity in the fields with continuous crop cover, reduced tilling and reduced use of fertilizers (Newton et al., 2020). In our sample, one of the producers considered a commitment to the principles of regenerative farming as more ambitious than those of organic farming (quote 1–7). A representative of a company operating both in primary production and processing reported that they have targets for regeneratively produced ingredients (quote 1–8). Even though climate issues were the main motive for a company operating in retail to support regenerative farming, they also consider it as important for biodiversity protection (quote 1–9). Interestingly, a company operating in primary production and retail promotes regenerative farming, but without recognizing its connection with biodiversity (quote 1–10).

4.2.1.2. Agroforestry. Agroforestry is based on integrated management of multifunctional agroecosystems that host both trees and crops (and sometimes also farmed animals). Agroforestry provides benefits in terms of creating habitats for wildlife, protects soil, improves water resource management, mitigates climate variation and improves landscape quality (EIP Agri Focus Group Agroforestry, 2017). Taking a closer look, though, studied companies rarely engaged in agroforestry ($n = 4$). One primary producer had created a pilot site for modeling a forest system that is suitable for production. Their goal was to create a diverse ecosystem which would also benefit humans (quote 2–1). Methods of agroforestry can also be introduced via grazing cattle in wooded pastures, as mentioned by an interviewee operating in retail. They were cooperating with a cattle farm that provides them meat from cattle grazing in wooded pastures (quote 2–2). Finally, agroforestry was also mentioned by two food processing companies.

4.2.1.3. Management of traditional rural biotopes and seminatural grasslands. Even though maintaining traditional rural biotopes and seminatural grasslands are among the most important direct actions that farmers and food value chain actors can engage with to promote biodiversity (cf. section 2), as biodiversity actions, they were rarely mentioned. Traditional rural biotopes were mentioned by three companies, two of which were primary producers and the third a food processing company. Taking a closer look, a producer managing traditional rural biotopes cooperates with researchers to map biodiversity in their biotopes (quote 3–1). Besides traditional rural biotopes, the interviewed producer also manages a wetland and provides nesting places for loons and ducks (quote 3–2). One processing company promotes traditional rural biotopes by paying extra for them (quote 3–3). For the processing company, this is an indirect biodiversity action, as the company is not directly engaged with the biotope.

4.2.1.4. Grazing. While traditional rural biotopes are typically managed by grazing, cattle can also graze on cultivated grass. Even though the resulting biodiversity benefits are not as high as in seminatural grasslands, in the Finnish context they are generally positive in comparison with the rapidly spreading confined housing of cattle (Rytteri et al., 2024). In total eight companies mentioned grazing, this including two of the interviewed primary producers. Grazing was specifically identified as a biodiversity-friendly action by one of the interviewed farmers (quote 4–1). Notwithstanding, farmers managing traditional rural biotopes were also grazing cattle.

Beyond these two primary producers, grazing was mentioned as an indirect biodiversity action by six companies operating outside of primary production, be it in food processing, trade or food services. Indeed, four food processing companies use it. As an example, one of them has been paying premiums to promote grazing (quote 4–2). For a company operating in food services, grazing is a theme discussed with their suppliers (quote 4–3).

4.2.2. Biodiversity actions improving soil and growing conditions

Actions aimed at improving the soil and generally the growing conditions on the fields were a recurring theme across the interviews. Agricultural soils not only form the basis for yields, they can also host high levels of biodiversity, as soil biota is estimated to form 25% of biodiversity on Earth (Decaëns et al., 2006). Therefore, improving soil condition can have a direct, positive impact on biodiversity. Two biodiversity actions were identified: (1) improving soil health, and (2) decreasing chemicals use, as detailed next. In this sense, improved growing conditions bridge land sharing with soil biota and efficiency-oriented land sparing.

4.2.2.1. Improving soil health. With six engaged producers in our sample, improving soil health was among the most popular of the producers' biodiversity actions, also supported by four food processing companies. Improving soil health and its biodiversity can further boost productiveness of the soil (Finnish Food Authority, 2022). The economic benefits of soil actions might, in part, explain their popularity among the interviewed producers. Five types of direct actions targeting soil health actions were identified. First, avoiding unnecessary tilling boosts biodiversity and helps to avoid compressing the soil (Peltoniemi et al., 2020). As regards tilling, an interviewee emphasizes that it is important to do all the procedures in the fields by the book (quote 5–1). Second, with direct seeding, tilling can be avoided. The positive impacts of direct seeding on yield surprised one of the producers (quote 5–2). Third, if managed correctly, using manure for fertilizing can improve soil biodiversity when compared to synthetic fertilizers (Köninger et al., 2021). An interviewee using manure for fertilization has witnessed an increase in the humus content in their fields (quote 5–3). Fourth, when compared to repeated monocultures, crop rotation improves biodiversity in the fields. One producer noted that crop rotation has also improved productivity (quote 5–4). Another representative of a company operating both in primary production and food processing saw paying premiums for crop rotation as an easy way to make an impact (quote 5–5). Fifth, one of the companies operating in input processing (quote 5–6) manufactured recycled fertilizers from organic waste and by-products, which can be used to improve soil condition and thus biodiversity. Overall, the importance of soil actions can be described as improving the basis for both biodiversity and economic gains (quote 5–7).

Table 3
Quotes supporting the findings.

Biodiversity actions geared at land use		
Biodiversity actions geared at sharing land with nature		
Organic farming	By primary producers	*Quote 1-1. "Well, there has been a lot of talk about the decline of insects and such. We also know that we need to make everything sustainable, which is one of the reasons why we are engaged in organic farming. It's a more sustainable business model in the long run." - Owner, Farmer / Company 10* *Quote 1-2. "We have done organic farming for 40 years. Cultivating herbs is of course more diversity-friendly compared to crop monocultures. There are a lot of flowers, coneflowers, marigolds and others. So, the number of pollinators, hymenoptera and butterflies is high. This, altogether, creates biodiversity [...] organic farming by itself increases the diversity of soil and species. Further, what we cultivate directly affects this [diversity]." - Development Manager / Company 11*
	By companies outside of primary production	*Quote 1-3. "We have made a choice - that our store at the farm, as well as this store .. [by deciding to offer organic products] .. we have not, by any means, taken the easiest route. Presently, 90 percent of our product offering and purchasing is organic." - CEO / Company 5* *Quote 1-4. "In essence all of our restaurants are taking part in the "Steps to organic" -program. Most of them are likely on step 2 at the moment which means that they use at least two organic products. But then, for example, we have a restaurant with around 30 products in use. But I think the most important thing is that we have those organic products available in our offering." - Senior Manager of Sustainability / Company 31* *Quote 1-5. "We also have organic production as contract production as well as experimental organic production at our pilot farm .. well .. it is not just experimental, we are cultivating organic vegetables there." - CEO / Company 26* *Quote 1-6. "Of course, our organic product offering is the one that – – most supports biodiversity because there is grazing, and particularly the fact that we don't use pesticides, and crop rotations are diverse. Organic farming is a kind of regenerative farming by itself, and, like I said, [the animals] are all grazing."- Development Manager / Company 33*
Regenerative farming	By primary producers	*Quote 1-7. "Organic farming is in principle .. or many of its elements are about regenerative farming, but with regenerative farming, we want to achieve even more. A lot of things have to do with the soil, which is after all the basis for biodiversity, from which other things can grow. With the methods of regenerative farming, we store as much carbon in the soil as possible and feed the micro-organisms in the soil. Instead of destroying them, we improve the soil's condition, year by year." - Development Manager / Company 11* *Quote 1-8. "Our goal is that every kilogram of broad beans this company procures or produces has been produced regeneratively. We have not achieved that yet but we are currently well over 50 percent." - Owner, Farmer / Company 1* *Quote 1-9. "From a climate perspective, we have been aiming at supporting carbon farming or this kind of regenerative farming, which bears effects on biodiversity. This is something we support." - Director of Sustainability / Company 36* *Quote 1-10. "Regenerative farming is one of the things we are doing. But it does not directly speak for biodiversity either. So, let's say, if we have around 400 products currently in our offering, then maybe two of them promote biodiversity." - Owner / Company 3*
Agroforestry	By primary producers	*Quote 2-1. "We have created a small patch of a forest garden – – [where] we try to model the forest, i.e. it has trees, bushes, and undergrowth, in a way that most of them are such species that produce yield. In other words, we are creating a diverse ecosystem, which then also bears benefits to humans." - Development Manager / Company 11*
	By companies outside of primary production	*Quote 2-2. "On the side of our production, we have one pilot farm with which we cooperate. They exercise rotational grazing, which means that they are shifting pastures and grazing animals while trying to optimize the development of undergrowth so that the rotation improves biodiversity the best. In addition, forest pastures are an essential part of this approach." - Owner / Company 3*
Management of traditional rural biotopes and seminatural grasslands	By primary producers	*Quote 3-1.. "For many years already, bug researchers have visited us because our fields have been grazed for a long time. [They are interested in] what kind of living organisms are there, what kind of bugs, what kind of plants one can find …" - Owner, Farmer / Company 8* *Quote 3-2. "Regarding wetlands, at our farm, for birdlife we have built duck nests, loon nests, nesting sites. Moreover, we have grass areas around the wetland, which comply with the regional business centre requirements, which are mowed annually…" - Owner, Farmer / Company 8*
	By companies outside of primary production	*Quote 3-3. "If there is an environmental contract related to rural traditional biotopes or related to an area that is of high nature value … they get more bonus, our responsibility bonus." - Development Manager / Company 33*
Grazing	By primary producers	*Quote 4-1. "We don't have traditional rural biotopes at the moment. I have been trying to find them. The basic idea is to graze such biotopes so that the species living there, the buzzy bugs and plants would not go extinct. So similarly, on our fields, as the animals are grazing and we use forest pastures, forest areas and grasslands. The biodiversity work is at its greatest in those areas." - Owner, Farmer / Company 10*
	By companies outside of primary production	*Quote 4-2. "But we also want to support grazing, and actually, out of all the voluntary actions, we pay most responsibility premium for free-range, grazing dairy cows." - Development Manager / Company 33* *Quote 4-3. "Well, concretely speaking, we engage in strong supplier cooperation. We have large product suppliers particularly in our meat and dairy products, which naturally bear numerous impacts on animal welfare and of course nature and in this way biodiversity, for example regarding the cows' grazing. These are issues that we have identified." - Senior Manager of Sustainability / Company 31*
Biodiversity actions improving soil and growing conditions		
Improving soil health	By primary producers	*Quote 5-1. "Timing the actions correctly, cultivation by the book. We try to optimize the timings on the fields. Whether it is seedbed preparation, sowing, spreading manure. For example, if we go to the fields too early in the spring, we ruin the soil texture, we compress the soil when it is too wet, or work the field too late in the autumn. All these [actions] are ones that also ruin nature." - Owner, Farmer / Company 7* *Quote 5-2. "After we bought the direct seeding machine – – we have also had very good successes. This was actually a real surprise, because so far the message has been that you cannot get as good a yield without tilling." - Owner, Farmer / Company 4* *Quote 5-3. "The manure is not going to industry but as a fertilizer to the fields to improve the soil condition. And the humus content is also rising with using manure. Of course, when we are spreading organic fertilizer." - Owner, Farmer / Company 7* *Quote 5-4. "We keep changing the crops in our fields, because if we are growing for example only oats from one*

(continued on next page)

Table 3 (*continued*)

		year to the next, we are impoverishing the soil. – – There needs to be fallow years or deep-rooted crops because there is need to influence the structure of the field, i.e. the soil texture. – – When field structure, i.e. the soil texture, is good, the field produces us yield which is our source of income. In other words, the better care we take of our field, the better yields it can provide." - Owner, Farmer / Company 8 *Quote 5-5. "There is, luckily, quite a simple model, i.e. that when our producers grow broad bean, we pay them a little extra to keep their crops in rotation. After growing broad beans, there will be two years of biodiverse fallow." - Owner, Farmer / Company 1* *Quote 5-6. "The amount of microbial biomass and the carbon and nitrogen that has been bound in it will increase significantly after using [these products]. We are talking about 100+ percent growth at the best. Of course, this does not say much about biodiversity, but when we have assessed the species composition, it has become more diverse. For example, the rot fungus and different kinds of decomposing bacteria have become more abundant and diverse." - Director of Research and Development / Company 16* *Quote 5-7. "After all, the soil is the biodiversity and the basis of everything, from which all else grows." - Development Manager / Company 11*
Decreasing chemical use		*Quote 6-1. "We have to have and bring also variation to our [crop varieties], as for example drought, resistance to drought. We have to be able to cultivate these kinds of other sustainability characteristics [of the crops]. And improving these kinds of characteristics is very important as regards maintaining biodiversity so that we could decrease the use of pesticides." - CEO / Company 21* *Quote 6-2. "We are using as little pesticides as possible. There are some that we have to use, but surely it is also a financial question: it is not worth using more pesticides than necessary, as it is a matter of cost." - Owner, Farmer / Company 8*
Biodiversity actions aiming at sparing nature		
Reducing deforestation		*Quote 7-1. "We have set up collaborative cooperation schemes with their producers to have a direct effect on deforestation." Quote from sustainability report / Company X*
Developing plant-based foods		*Quote 8-1. "And the other point that is a bit harshly said but if my company focuses on plant-based proteins, [then increasing biodiversity] is kind of automatic. Meaning that when it's not animal production, this would occur. But it is not that simple. One can also cultivate erroneously from a plant cultivation viewpoint." - Owner, Farmer / Company 1* *Quote 8-2. "[Acknowledging biodiversity] is visible all the way even toward our product development. It's not just about how we limit our own impacts, but about the impact of the end-user. In a way we have the opportunity to make choices on behalf of the end-user." - Sustainability Manager / Company 26* *Quote 8-3. "At first, we had this product family centered around fish caught from lakes. Now we have taken up Baltic herring as well and I think the result of our work is amazing. When there is a resource that exists but is presently under-utilized, while furthermore its fishing has positive impacts ..." - - Sustainability Manager / Company 26* *Quote 8-4. "I have – – a producer – – making broad bean products. – – Unfortunately, it is a boring product. But then we started to think what else we could do with the ingredient [names a list of novel products]." Owner / Company 3*
Food without agriculture		*Quote 9-1. "We have set targets .. that the environmental impacts [of our products] should be 1/100 as compared to meat production and 1/10 as compared to plant-based products. And that is something that we can achieve." - CEO / Company 14*
<u>Biodiversity actions undertaken in organizational functions</u>		
Biodiversity actions in supply chain management		
Procurement criteria	Company own policies	*Quote 10-1. "Well, for us – – deforestation has been one such perspective. There are concrete objectives, for example, for these risky ingredients, that they have to come from certified sources, whether it be soy or cotton or cocoa, coffee, wood, these kinds of things, also meat. And then of course, regarding water bodies, we also have our fish policy." - Director of Sustainability / Company 36* *Quote 10-2. "We have a food strategy which includes domestic food, and then we have these [Finnish governmental organization's] responsibility criteria, according to which we procure; there we have sought to ensure that we would stay at least at a good level. [Those criteria] consider palm oil, how animals are raised and how crops are grown et cetera ... And then, with all of our partners, we go through their sustainability reports, and use them as our procurement criteria. Through these [actions], we have .. well .. done what can easily be done." - Director / Company 28*
	Use of externally validated certifications	*Quote 10-3. "Even though [XXX] is a commercial actor, well to me, every time we are checking our product offering listings with our procurement manager, one knows that we [from the perspective of a commercial actor] are advancing the sustainable use of fish. It's like, well, I'm doing good while reading an Excel sheet and checking whether the supplier has a certificate…" - Sustainability Expert / Company 20*
Contract producer agreements		*Quote 11-1. "We have a 'responsible cultivation methodology'-titled cultivation methodology which means that each contract food producer commits to following the instructions set by [..] this methodology. This includes plant species-specific instructions and then we have our own cultivation team that visits the fields if necessary to see when is there need to undertake some action. – – And then we have a cultivation register that the producer fills so that all the actions undertaken on the field are visible in our system .. and in that way we can then see what have been the successes and what practices could be further favoured. In this way, we are developing the cultivation method continuously." - Manager of Communications & Sustainability / Company 26* *Quote 11-2. "Well, we have instructions for production for dairy farm entrepreneurs to which they have committed and this includes the legal standard and there are our requirements. If there is an environmental contract as regards rural traditional biotopes or otherwise biodiversity-wise valuable areas, or – – a contract that is according to [Finnish governmental biodiversity restoration] program's criteria, that gets [the farmer] a higher bonus, our responsibility bonus. – – It is directly a part of the price for milk. We want to motivate the farms that way." - Development Manager / Company 33*
Pilot activities and best practices sharing		*Quote 12-1. "We are trying to develop the cultivation methods in our own pilot farm so that the [negative] biodiversity impact of the production would be as small as possible and that way, at a sustainable level. With pilot activities – – we are getting better yields which is also financial good for the company but there are other aspects as well. So, it can be considered an investment for the company." Manager of Communications & Sustainability / Company 26*

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Table 3 (*continued*)

Favouring local producers	*Quote 13-1. "We have domestic local fish products, wild Baltic herring, as an example .. eutrophication is reduced as we increase the use [of herring] for food." - Manager of Communications & Sustainability / Company 26* *Quote 13-2. "One of our clear policy guidelines is that we have a high share of domestic products in use. It is around 60-70 percent annually and of course, when we are talking about coffee, tea or rice, they are foreign products. Therefore, we have reached the ratio of domestic products in our product portfolio that is feasible, so that we are still able to supply food." - Senior Manager of Sustainability / Company 31* *Quote 13-3. "Regarding fresh salmon trout, 95 percent of it is bought from regional producers, so the fish comes from rather close by. As a result, we not only know, but we personally know these producers and their operating practices etc. That is why we have sought to use regional salmon trout." - Owner / Company 6*
Biodiversity actions in sales and marketing	
Increasing the biodiversity-friendly product offering	*Quote 14-1. "As our goal is to maintain business, that is why we cannot just directly start offering vegetarian food for customers. It is a dead-end. Instead, increasing the share of vegetarian options as well as consumer awareness about these choices, that has been our choice." - Director of Development / Company 35* *Quote 14-2. "At the start, when we set the goal as to how many vegetarian options we need to have in our offering, it seemed like a really difficult target to reach. We set our target for three years. During the first year, we had already reached it." - Director of Development / Company 35*
Making the biodiversity-friendly choice easier	*Quote 15-1. "Our lunch buffer is very vegetarian-oriented, our vegetarian foods are served first and if we have meat-based protein, it is served last. Given that our lunch plates are quite small, when you take food from the buffet, the plate is actually full of vegetables." - Manager of food products / Company 18* *Quote 15-2. "This summer, in our restaurant, we had a campaign by [a Finnish public figure] who created his own meal. We did not promote it specifically as a vegetarian meal, though the person is a vegetarian. We wanted someone who is a vegetarian and who tells that we offer good vegetarian options. He built the menu himself. That was our way of promoting the matter, we tried to boost it." - Director of Development / Company 35*
Educating customers on making biodiversity-friendly choices	*Quote 16-1. "… for example, on our product packaging, we inform the consumers about biodiversity." - Development Manager / Company 33* *Quote 16-2. "we … engage in food education work … we also provide environmental education, i.e. we do these 15-minute events for pupils, where we discuss food waste and why vegetarian food, why we have green lines [in the restaurant] and why we are serving vegetarian choices first." - Director / Company 28*
Biodiversity actions in corporate functions	
Strategy	*Quote 17-1. "We are now in the process of developing a roadmap, or plan/program. It has been scheduled for next year … So far, we have proceeded with an approach where we examine the impacts of our own activity and operations … And on the other hand, we examine how our value chain, well mostly suppliers upstream from us, i.e. scope 3, how product suppliers across several tiers in the supply chains, are involved." - Sustainability Director - Company 37* *Quote 17-2. "This year, we were involved in this … Science-Based Targets for Nature pilot working group where we began to examine … what it would mean to us, if we would want to set up these kinds of targets. So, in that work, we set out to familiarize ourselves with the process, and on the other hand, with the tools that we could use for mapping our own impacts on nature. That way we gained a kind of a first impression on what that work for us could be from now on. Next year, we will start to study these tools more closely and model our own value chain from that point of view." - Sustainability Program Manager / Company 27* *Quote 17-3. "Well, in our [responsibility] strategy …as we are a company involved in trade, we have this guiding principle, that our own impacts are of a certain size, but then the impacts toward the value chain are manifold [as compared to our own impacts]. Thus, if we wish to have some impact with this work, we need to influence the entire value chain. Naturally, we have to cover our own ground inhouse, but we also need to widen the scope. And our vision is to promote change in the entire value chain." - Sustainability Director - Company 37* *Quote 17-4. "We don't have written targets. But because this is (still) a one-man-show, our goal is that every kilogram of broad beans this company procures or produces has been cultivated regeneratively. We are not quite there yet, but we are currently well over 50 percent." - Owner, Farmer / Company 1* *Quote 17-5. "In practice, so we don't have any specific percentage that we are targeting. But we have noted in writing that we are trying to increase the share of organic ingredients and those that come from our own farm. And, for example, in our restaurant, this autumn we have pursued these aims very strongly." - Sustainable Development Expert / Company 25*
Biodiversity reporting	*Quote 18-1. "Well, we have aimed in our sustainability reporting to follow the structure of our sustainability program, i.e. we report accordingly … as regards biodiversity, in our latest report, for the first time we nudged for including biodiversity as well. We have started to draw a bigger picture as regards what it means to us, what our impacts are, what we are thinking about it and what kind of issues are linked to it. It was the first time we did this for the reporting for 2021." - Director of Sustainability / Company 36* *Quote 18-2. "… in last year's report, we dealt with this issue for the first time a bit more. We have previously had a bit of a looser description [of it in our report] but this time we have covered it via opportunities, impacts and risks. So broadly speaking, we have identified certain issues in our environmental impact that we can have an effect on and what kinds of impacts we have there. – – Of course, this remains at a rather high level of abstraction because measuring remains challenging." - Manager of Communications & Sustainability / Company 26*
Biodiversity measurement	*Quote 19-1. "We don't have metrics yet, but we have started the work, as we are trying to identify our impact areas and the kinds of metrics that could be set. We are currently involved in a project where we are determining biodiversity metrics suitable for companies operating n the food sector. In the project, we are also benchmarking against other countries and the present regulation." - Director of Corporate Social Responsibility / Company 32* *Quote 19-2. "And of course, we understand that we currently don't have an inhouse understanding of our negative impacts on nature. That is why we are cooperating with [partner] on measuring those impacts so that we can also numerically or in some way estimate it and consider our targets and then start to decrease those impacts. So that we potentially have some quantitative [evidence on those impacts] so that it is not just [guessing] what there is." - Director of Sustainability / Company 36* *Quote 19-3. "So, we are now manually [measuring] food waste but we are currently in the process of purchasing an electronic system for that. Then we follow percentages of what we are purchasing regarding for example local food and organic food. For these we have targets. Then we are following the share of vegetarian options in our menu…" - Director / Company 28*

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Table 3 (*continued*)

Education & training	*Quote 20-1. "We have this … mobile training which consists of micro trainings which takes maximum an hour, each. This includes short videos, questions, text, speech… [..] We have a separate training program for organic farming and also for environmental issues. [..] We are also connecting issues, for example, as there is certified palm oil in our products, this is not used for frying, and we explain why. In other words, we are engaged in connecting work … as we have been doing a lot of things for many years, now over the last year, we have sought to connect it all to the bigger picture where supporting biodiversity is one of the themes."- Senior Manager of Sustainability / Company 31* *Quote 20-2. "And then our restaurant partners .. we want that their employees also to come and become introduced to how fields work. And there .. it is explained that caring for soil is the first priority, meaning that we have to take care the soil, i.e. the biodiversity underground. In other words, we take good care of the soil so that we can grow seasonal ingredients, so that we get food." - Development Manager / Company 25*

4.2.2.2. Decreasing chemical use. Synthetic biocides increase productivity in agriculture, though they rank among the key contributors to biodiversity decline caused by food production (Geiger et al., 2010). Besides unwanted pests and weeds, biocides also unintendedly kill other creatures both on ground and soils, many of which are necessary for ecosystem services such as pollination and nutrient circulation. Five of the primary producers, as well as two of the food processing companies, and a retail company mentioned the decreased use of chemicals.

Synthetic biocides are not used in organic farming. Therefore, three primary producers were not using them at all. In addition, two primary producers were aiming at decreasing the use of chemicals. As an example, one of the interviewed companies in the field of input production and development aims at decreasing the use of chemicals in agriculture by breeding better crop varieties (quote 6–1). Besides biodiversity benefits, a primary producer observed that decreasing the use of chemicals enables saving money (quote 6–2).

4.2.3. Biodiversity actions aiming at sparing nature

Biodiversity actions aimed at sparing nature differ markedly from the sharing actions with a direct biodiversity impact presented in the previous section. The goal of sparing nature is to decrease the amount of area needed for agriculture via efficient production practices, thus freeing space for wild nature elsewhere. However, for efficient production to provide biodiversity benefits, it should be accompanied by concrete measures indicating land sparing. In our data, such examples were non-existing. Even though a number of primary producers quoted efficiency of production as their means of practicing biodiversity-friendly agriculture, as per our data coding principles described in Section 3.3, these actions were not coded as biodiversity actions.

Beyond intensifying production, extant research utilizing life cycle impact assessment methodologies indicates that reducing deforestation and land use conversion is a key to reducing the biodiversity footprint of food (e.g. Crenna et al., 2019; Kyttä et al., 2023). The biodiversity impact is indirect, as land sparing per se does not necessarily improve the state of biodiversity directly but removes some of the pressures on land use. From our data, we identified three biodiversity actions operating on the logic of land sparing: 1) reducing deforestation, 2) development of plant-based foods and 3) developing food without agriculture.

4.2.3.1. Reducing deforestation. Deforestation is globally one of the most pressing drivers of biodiversity loss especially in the biodiverse tropical areas, and a significant share of the biodiversity footprint of European consumption takes place in tropical areas due to deforestation (Cuypers et al., 2013). The seven companies that have taken action to reduce deforestation represented companies operating in food processing (3), retail (3) and food services (1). The actions that the studied companies had taken to decrease the effects of deforestation included recognizing risky ingredients such as coffee, soy, and palm oil and setting up either company-specific procurement criteria or purchasing ingredients only from certified sources. More concrete actions to halt deforestation are in the minority but one of the studied companies states in their sustainability report that they have set up collaborative cooperation schemes with their producers to have a direct effect on deforestation (quote 7–1).

4.2.3.2. Developing plant-based foods. Replacing meat with plant-based options or fish is one of the most often-cited measures in the literature to tackle food system driven biodiversity decline (Benton et al., 2021; Crenna et al., 2019). The land use requirement of animal-based foods is considerably larger than that of plant-based foods, and thus plant-based foods have a significantly smaller biodiversity footprint. The biodiversity impact of these actions is indirect, as land sparing as such does not automatically mean that the spared land would be assigned for conservation.

Five companies engaged in developing plant-based food, one operating in primary production, one in retail, and the remaining three in food processing. These companies are developing novel plant-based products, especially from broad beans. For example, a primary producer viewed that producing plant-based proteins is (almost automatically) better for biodiversity than meat (quote 8–1). A representative from a company operating in food processing considered developing plant-based products as a way to make biodiversity-friendly choices on behalf of the consumer (quote 8–2). Similarly, sustainably produced fish products can also be good for biodiversity by both decreasing meat consumption and improving underwater biodiversity (quote 8–3). Further, a representative of a food retail company described creating new, interesting products from seemingly boring ingredients as a way to increase consumption of vegetarian options (quote 8–4).

4.2.3.3. Food without agriculture. One of the studied companies operating in food processing was developing revolutionary new production methods based on cellular agriculture that would remove the link between land use and food production (Mazac et al., 2022). This is an example of an indirect biodiversity action, as it aims to influence people's consumption habits, which in turn would ultimately change land use patterns and spare agricultural land. If the company manages to mainstream the studied way of production, its representative believed that the effects of food production on nature could be massively decreased (quote 9–1).

4.3. Biodiversity actions undertaken in organizational functions

We now move on to presenting the biodiversity actions adopted across the studied companies' organizational functions, i.e. 1) supply chain management, 2) sales and marketing, and 3) the corporate level. All of these actions were indirect: for biodiversity impacts to take place as a result of these activities, they should prompt primary producers to take according action. Most of these actions were conducted by companies operating outside of primary production, i.e. by companies engaged in food processing, retail and services, but some actions related to, for example, strategy were adopted by primary producers as well.

4.3.1. Biodiversity actions in supply chain management

As the bulk of the environmental impacts of food production occurs through land use changes or in agricultural production (Deconinck and

Toyama, 2022), for companies not operating directly with land, acting via their supply chains is a central means for decreasing their negative impact on biodiversity. The studied companies addressed biodiversity decline in their supply chains via 1) procurement criteria, 2) contract-producer agreements, 3) pilot activities and sharing best practices, and 4) favoring local producers, as detailed next.

4.3.1.1. Procurement criteria. To begin with, procurement criteria are a central means of addressing biodiversity decline in supply chains, adopted by nearly half ($n = 17$) of the studied companies. In our sample, we observed that few primary producers ($n = 2$), yet a majority of companies located outside of primary production ($n = 15$), be it in food processing ($n = 7$), retail ($n = 4$) or food services (n = 4), have company policies or certifications related to decreasing their biodiversity impacts. These policies are targeted toward deforestation and over-exploitation of fish populations, as a representative of a company operating in retail explained (quote 10–1). A representative from a company operating in food services, in turn, revealed that as regards their procurement policies, they undergo specific details with their partners (quote 10–2). In parallel, many companies reported that they also use certificates for products identified as potentially risky for biodiversity, such as fish, palm oil, and coffee. As selecting certified products does not require specific expertise by the buyer, certificates are seen as a seemingly easy means of protecting biodiversity. This might explain their popularity among companies (quote 10–3).

4.3.1.2. Contract producer agreements. About a third ($n = 13$) of the companies operating across the food value chain, mostly in processing ($n = 8$) cooperate with producers to decrease their negative impacts on biodiversity by setting production standards in contract producer agreements. Such agreements can support production methods that are better for biodiversity and thus influence the land use decisions of primary producers (see Section 4.2). To this end, a food processing company has a cooperation program for its producers which enables guiding their contract-producers and following their actions (quote 11–1). Another way to support voluntary biodiversity actions is to reward producers with premiums for improving biodiversity, as illustrated by another food processor (quote 11–2).

4.3.1.3. Pilot activities and sharing best practices. Eight companies in our sample conduct pilot activities aimed at increasing biodiversity farmland. Mostly this occurred in food processing companies (n = 4) but it was also mentioned by one primary producer, two companies in food retail and a food services company. One food processor has its own pilot farm for testing novel cultivation methods. This allows developing and sharing best practices with their producers while being economically viable (quote 12–1). In parallel, another two food processing companies reported producing some of their ingredients themselves.

4.3.1.4. Favoring local production. Favoring local production was mentioned as a means of promoting biodiversity. If local food production systems are designed as diverse and multifunctional, they can indeed host more biodiversity than specialized, intensive monocropping systems (DeClerck et al., 2023; Estrada-Carmona et al., 2022); however, the potential impacts are difficult to verify. In our sample, six representatives of companies operating outside of primary production explicitly mentioned local production, two being food processing companies and four food services companies. As an example of the former, a company operating in processing favors local fish in their production, which helps to reduce eutrophication in the Baltic Sea (quote 13–1). Taking a closer look, though, the definition of local not only varied between companies, but the definition itself is amenable to critique. For a company operating in food services, local refers to any nationally produced items (quote 13–2), while for a food processing company, procuring fish from regional producers allows them to know their suppliers (quote 13–3).

4.3.2. Biodiversity actions in sales and marketing

Biodiversity actions in sales and marketing focus on guiding consumers toward making biodiversity-respectful choices. This means (1) increasing the biodiversity-friendly product offering, (2) making the biodiversity-friendly choice easier and (3) educating customers on making biodiversity-friendly choices, as detailed next.

4.3.2.1. Increasing the biodiversity-friendly product offering. Increasing the biodiversity-friendly product offering is a means of improving the odds of a customer making a more sustainable selection. With 11 companies engaging in this biodiversity action, this was the most favored out of the biodiversity actions in the sales and marketing function. Indeed, three primary producers, four food processing companies, two retail and two food services companies mentioned this action. For example, three of the studied food processing companies are trying to increase the share of their organic or plant-based products in their product portfolio. In turn, a company in retail is actively marketing organic products and a planetary diet largely built on plant-based proteins in their stores. Increasing the number of plant-based choices was the preferred modus operandi of a food services company (quote 14–1). Even though increasing the share of vegetarian options seemed a difficult goal for the company at first, the three-year objective was ultimately reached within a year (quote 14–2).

4.3.2.2. Making the biodiversity-friendly choice easier. Making the biodiversity-friendly choice easier is a biodiversity action adopted by food services companies ($n = 2$). To this end, the studied food services companies position the plant-based foods strategically in buffet servings in order to decrease the share of meat on the customer's plate (quote 15–1). All the while, labeling food as vegan or plant-based can also have counter-productive effects, such as halting sales (see also Sleboda et al., 2023). Promoting vegetarian meals can thus be done effectively also without underlining them as such, as an interviewee representing a food services company observed (quote 15–2).

4.3.2.3. Educating customers on making biodiversity-friendly choices. Individual companies, across the food value chain ($n = 6$), are educating their customers on making biodiversity-friendly choices. A representative of a food processing company observed that they use the packaging of their organic products to educate their customers on biodiversity (quote 16–1), while a food services company educates school children on making biodiversity-friendly choices (quote 16–2).

4.3.3. Corporate-level biodiversity actions

We identified corporate-level biodiversity actions that are shared by companies operating in all parts of the value chain from primary production to processing, trade and food services, though they were more typical for the larger companies. These actions related to strategy, reporting, measuring, and training. Occurring in corporate functions and distanced from operations, these are the most indirect type of biodiversity actions identified in our analysis.

4.3.3.1. Strategy. As regards strategy, nearly half of the studied companies have biodiversity-specific strategic aims ($n = 15$), including companies in primary production ($n = 3$), processing (n = 6), retail (n = 3) and food services (n = 3). These strategic actions take different forms, though. To begin with, three companies either have or are developing biodiversity road maps, as in the example of a food trade company (quote 17–1). Moreover, some companies in the food industry have begun their biodiversity efforts with the help of the Science-Based Targets Network (SBTN), while one company has participated in a pilot program led by a food industry interest group. Taking part in the SBTN work has helped to kickstart the food processing company's biodiversity

work (quote 17–2).

The focus of strategic biodiversity actions depends on the company's position in the food value chain. Major companies operating in the trade sector have started to pay strategic attention to the biodiversity actions across their value chain (quote 17–3). Similarly, one of the studied companies in primary production and food processing has set their own ambitious strategic targets for procuring the main ingredient in their production (quote 17–4). Targets are not a silver bullet though, as strategic action toward protecting biodiversity can be undertaken without them. Indeed, one of the interviewed food services representatives stated that even though they have not set measurable targets yet, they have been able to further their use of home-grown and organic products e.g. in their own restaurants (quote 17–5).

4.3.3.2. Biodiversity reporting. For the studied companies, biodiversity has been introduced to their sustainability report only recently ($n = 9$). Interest in biodiversity reporting is visible across the food value chain, yet is highest in food processing ($n = 4$) and retail companies (n = 3), with less emphasis in primary production (n = 1) or food services (n = 1). A representative from a company operating in retail stated that they are currently trying to understand what biodiversity actually means for them (quote 18–1). Another representative from a company operating in processing further stated that they are considering biodiversity through both risks and opportunities (quote 18–2).

4.3.3.3. Biodiversity measurement. As biodiversity is a relatively new issue, companies throughout the food value chain, with the exception of primary producers, are piloting biodiversity impact measuring schemes ($n = 8$; quote 19–1). To a representative of a company operating in retail, measuring is a way to gather information on biodiversity impacts. This way, it is also possible to set more concrete targets and follow-ups (quote 19–2). Many have participated in consulting-led pilot measurement programs focused on supply chains, in which the biodiversity impacts of procurement, construction, investments, and other activities are measured. Besides actual biodiversity impact measuring, a company in food services is measuring the use of sustainably-produced ingredients in their procurement (quote 19–3).

4.3.3.4. Education and training. Finally, as regards the human resources function, our findings attest to early evidence of some companies, outside of primary production, educating their internal or external stakeholders on biodiversity (n = 4). As an example, a food services company has developed a special mobile-based educational application. The educational purposes are directly linked to everyday contexts of the company to increase their impact (quote 20–1). Such educational actions can also extend to the employees of stakeholder companies. To this end, a company operating in both food services and education organizes educational visits for their restaurant partners as a means to showcase the importance of biodiversity (quote 20–2).

5. Discussion

5.1. Contributions

Our findings make three contributions to literature. First, we adopt a value chain perspective in studying the biodiversity actions of food system companies. Second, we identify the nature of these actions in relation to their effectiveness logic as to whether they bring about direct or indirect biodiversity impacts, as well as the organizational actor type enacting this action. Third, zooming within organizations, we highlight how biodiversity actions not only depend on the company's position in the value chain, but, further, on the within-organizational function in question. In so doing, we offer a relational appreciation of these actions as occurring in uneven power positions between the value chain actors. These contributions are detailed next, before moving onto the limitations of the study and concluding alongside recommendations for practice, policy and research.

Extant research has shown that companies across industries and countries are, to different degrees, starting to adopt strategies, commitments and targets to address the biodiversity crisis (Boiral et al., 2018; De Silva et al., 2019; Zu Ermgassen et al., 2022; McKinsey, 2022). The prior literature connecting biodiversity and business has largely studied individual companies' biodiversity commitments or reporting approaches (De Silva et al., 2019; Hassan et al., 2022; Zu Ermgassen et al., 2022; Lamont et al., 2023; Jouffray et al., 2025) in addition to an interest in biodiversity impact measurement approaches (Farnsworth et al., 2015; Kassar and Lasserre, 2004). In the context of food systems, research has largely focused on farmers (Klebl et al., 2024). In contrast, studies adopting a value chain perspective to companies' biodiversity work remain scant (Lähtinen et al., 2016; Quarshie et al., 2021; Wilting and van Oorschot, 2017), indicating lacking focus on indirect drivers of change (IPBES, 2024). Indeed, the literature on supply chain management is awakening to the biodiversity crisis (Salmi et al., 2023). While extant research has discussed the role of value chains in enhancing sustainability of food systems in general or climate change in particular, the role of value chain actions in conserving or enhancing agrobiodiversity is not well understood. Indeed, prior research has focused on individual actor types, instead of value chain analyses. Furthermore, prior research has born scant interest on biodiversity actions.

Against this setting, in response to the first research question, this paper's first contribution is in offering an empirically grounded appreciation of food system companies' biodiversity actions across a national food value chain. We identified altogether 20 biodiversity actions that were undertaken by actors in the food value chain to varying degrees (cf. Table 2). While some companies do a lot for biodiversity, others still consider making minor improvements or complying with legal requirements as progressive biodiversity actions. Also, many actions were conducted by only a few companies and it can be said that, generally, the more ambitious the action, the fewer companies conducting them. In other words, the contrast between forerunners and laggards is sharp. The actions were classified into two broad categories: (1) actions geared at land use, and (2) actions occurring in organizational functions (Fig. 2). We observed these two broad categories of biodiversity actions to bear directly and indirectly on biodiversity conservation, while they are differently enacted by actors across the value chain. With this, our findings enable extending the observations by Wagner (2022), who found that companies' direct actions to protect biodiversity and ecosystem services remain low compared to indirect actions. Our conceptualisation differs from the mitigation hierarchy approach, as well as from the approach adopted by Panwar et al. (2023), which recognises restoration, reparation, conservation and compensation. In both of these approaches, company responses toward biodiversity are framed around loss of biodiversity, which can be counteracted either before loss or after loss. In contrast, our conceptualisation of direct vs. indirect actions also considers the possibility of human action contributing positively to biodiversity within production areas.

In this vein, in response to the second and third research questions, our second contribution is in identifying which biodiversity actions are direct vs. indirect, as well as the organizational actor type enacting this action. We argue that it is this combination that defines the direct vs. indirect nature of a biodiversity action. While overall, we find that what is considered a direct vs. indirect biodiversity action depends largely on the firm's position in the value chain, for primary producers, it also depends on the action type, as per Fig. 2. Taking a closer look, actions that had a direct, positive impact on biodiversity occur in the front-end of the value chain, i.e. on farms/primary production, where actors work directly with land. In other words, the closer to land a company operates, the more direct their biodiversity actions are. Direct actions are actions that allow, tolerate or even require more nature within production systems. They were categorized as actions aimed at sharing land with nature via farming practices such as organic and regenerative

farming, agroforestry, management of seminatural grasslands and grazing; as well as actions improving soil conditions by decreasing the use of pesticides and fertilizers and improving soil health. While actions aiming at improving soil also share land with nature as in improving the conditions for soil biota to do their work, they can also improve the production conditions and thus efficiency of farming. Thus, the line between sharing land with nature or sparing it for nature via efficient land use becomes blurred.

All other identified biodiversity actions were indirect, i.e. their impact on biodiversity decline requires further actions by other parties. For one, this included biodiversity actions occurring in primary production, as in the example of actions aimed at land sparing (see section 4.2.3.). For another, this included all biodiversity actions undertaken at the back-end of the value chain, i.e. in companies that are not directly operating on land such as food producers, food traders (e.g. retailers) and food services providers (e.g. restaurants). The impact of their biodiversity actions is indirect. Such biodiversity actions related (1) to supply chain management, with an impact on what kind of food is processed and sold, (2) sales and marketing that can increase the abundance of biodiversity-friendly foods on consumers' plates, and (3) corporate actions that determine the organization's strategy toward biodiversity, how it measures and reports about biodiversity, as well as how it educates its employees and stakeholders on the matter.

In Table 4, we summarize the identified biodiversity actions, assess their uptake in the studied companies, while critically reviewing the prospective effectiveness of each biodiversity action based on earlier literature. The assessment of the actions' uptake in the studied companies indicates that companies have already engaged, to varying extents, with actions that have at least potential for bringing about biodiversity impact (see middle column, Table 4). At the same time, the analysis of the effectiveness potential of the actions based on earlier literature (see right-hand column, Table 4) indicates that actions aiming to contribute to biodiversity are not always unequivocally beneficial for biodiversity, as biodiversity is contextual, particularly in the context of food production. Moreover, none of the identified biodiversity actions, alone, would offer a silver bullet, i.e. is unequivocally beneficial for biodiversity. Instead, contributing to positive impacts on biodiversity requires careful implementation, knowledgeability and motivation from the value chain actors. Biodiversity work in companies is thus not a 'tick-in- the-box' type of activity, but requires motivation, continuous learning and development within the companies. Careful implementation and within-company motivation ensures that also those companies operating further down in the value chains can have concrete biodiversity impacts extending to their supply chains (see Table 4, effectiveness potential analysis). Some practices have high biodiversity potential across various organizational types and value chain positions and can thus be considered 'low-hanging fruits'. One such practice is educating employees, which, however, was only adopted by a minority of the companies in our sample, indicating that a lot remains to be done to improve the food value chain companies' capacities to address the biodiversity crisis.

Our analysis indicates that actions aimed at land sharing to improve biodiversity are discussed throughout the value chain, from primary production to trade and retail and in some cases to food services. At the same time, land sparing actions are present in the accounts of the value chain actors, while less so in primary production (cf. Tables 2 and 4). All the while, the sparing approach dominates the public discussion about the biodiversity impacts of food production (Loconto et al., 2020), and it is especially relevant to firms that supply globally and that need to consider e.g. questions related to deforestation. Such firms in our data operate both in processing industry and in retail. Within this discourse, biodiversity is largely framed in terms of footprints, which emphasizes the land use impacts of food production, without necessarily addressing the multifunctionality of agricultural landscapes, the impacts of varying land use intensities on biodiversity, or the potential for agricultural ecosystems to maintain biodiversity (Gabel et al., 2016; Quevedo-Cascante et al., 2023). The question of land use efficiency and biodiversity footprint measurements can be an effective strategy if they lead to avoiding leakage effects, i.e. outsourcing biodiversity impacts overseas, especially to biodiversity-rich tropical areas (cf. Sandström et al., 2017). However, the tools available for minimizing the impacts taking place in global supply chains, such as certifications and other procurement criteria, are not necessarily sufficient for over-turning the current rates of biodiversity loss in tropical regions, as the needed actions such as habitat improvement, are beyond the scope of the certification schemes (Kubo et al., 2021). When efficiency of production is discussed from biodiversity point of view as in safeguarding the availability of "spared land" for other than productive purposes, this discourse fails to address

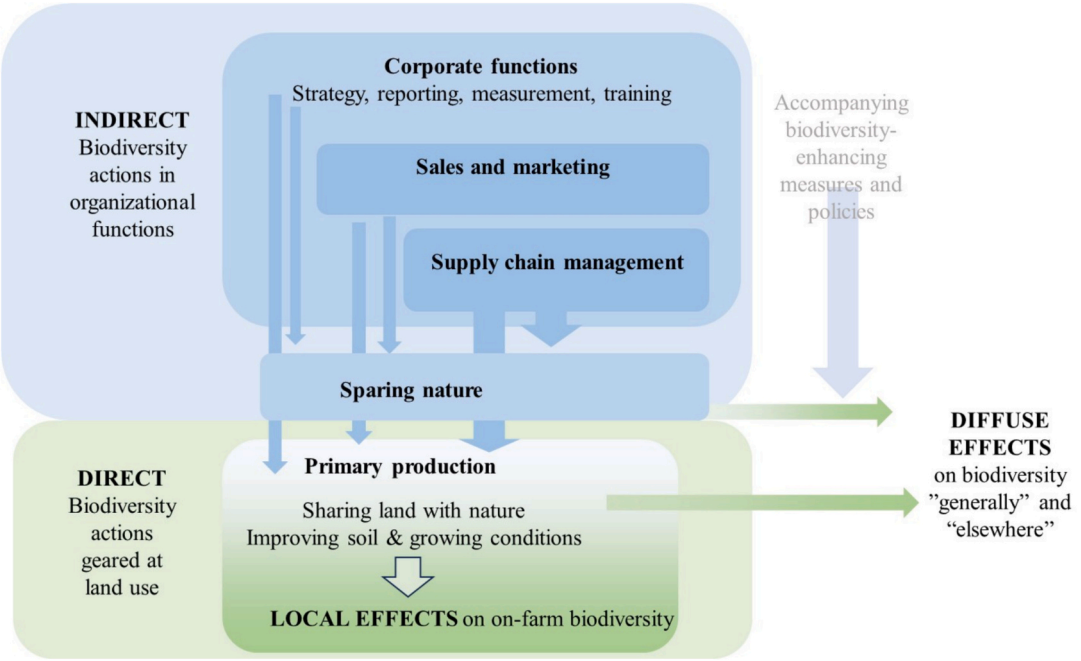

Fig. 2. Grounded framework classifying direct and indirect biodiversity actions in food value chains.

Table 4
Summary of the identified biodiversity actions, uptake in studied companies and their prospective effectiveness based on earlier literature.

Biodiversity action	Uptake in studied companies		Prospective effectiveness based on earlier literature
	n	%	
DIRECT ACTIONS			
Actions related to land use: land sharing			
Organic and regenerative farming	11	30%	Organic farming has been extensively studied and indicated to have positive biodiversity impacts (Santangeli et al., 2019; Tuck et al., 2014). However, controversy remains in relation to the positive impacts arising from the inefficiency of organic farming, which can lead to demand for more farmland (Gabriel et al., 2013; Tuomisto et al., 2012). Even though regenerative farming has not been studied as extensively as organic farming, the existing empirical evidence indicates that regenerative farming supports biodiversity (Hawes et al., 2025).
Agroforestry	2	5%	Agroforestry promotes biodiversity, when implemented as 'agroecoforestry', but not all solutions marketed as agroforestry are unequivocally beneficial for biodiversity (Mupepele et al., 2021; Ollinaho and Kröger, 2021).
Management of traditional rural biotopes and seminatural grasslands	3	8%	Traditional rural biotopes are seminatural grasslands, which are among the most biodiversity-rich habitats in boreal ecosystems. Due to changing management practices, they are under growing extinction threat (Herzon et al., 2022). Continued maintenance, management and restoration are crucial for their existence.
Grazing	7	19%	Generally, extensive grazing enhances diversity while intensive grazing decreases it (Plantureux et al., 2005). In the Finnish context, grazing is a central management practice that supports farmland biodiversity (Rytteri et al., 2024; Santangeli et al., 2019).
Actions related to land use: improving soil and growing conditions			
Improving soil health	8	22%	A rough estimate has been presented that 25% of species diversity resides in soils (Decaëns et al., 2006), which means that efforts to improve soil health in agriculture have direct, positive impacts on biodiversity. Soil health can be improved e.g. by appropriate manure application as well as by using organic fertilizers (Cozim-Melges et al., 2024; Köninger et al., 2021).
Decreasing chemical use	6	16%	Decreasing the use of pesticides and herbicides is a centrally important action for conserving farmland biodiversity (Geiger et al., 2010).
INDIRECT ACTIONS			
Actions related to land use: land sparing			
Reducing deforestation	7	19%	Land use change that drives biodiversity loss takes to a large extent the form of deforestation (Cuypers et al., 2013; Wiebe and Wilcove, 2025). In the case of Finland, land use change occurs for the most part beyond Finnish borders and is driven by international trade. Thus, efforts to reduce deforestation in supply chains can have substantial impacts on biodiversity.
Developing plant-based proteins	3	8%	Production and consumption of animal-based foods is a major cause of biodiversity decline especially through land use change in tropical areas, but also via impacts on eutrophication and climate change (Benton et al., 2021; Machovina et al., 2015). Therefore, developing plant-based counterparts for animal-based foods can promote biodiversity.
Food without agriculture	1	3%	Novel food production technologies have significantly lower land use impacts than their conventional counterparts (Mazac et al., 2022), although their biodiversity impacts remain poorly understood (Järviö, 2022).
Actions in organizational functions: supply chain management			
Procurement criteria	15	41%	Procurement criteria, standards etc. can have an impact on biodiversity, but require full implementation and motivation from the companies (Lambin et al., 2018). The effectiveness potential of certification schemes is limited and preventing biodiversity decline would require additional measures extending beyond the certification areas (Kubo et al., 2021).
Contract producer agreements	11	30%	Contracts made between value chain partners can be impactful and bring biodiversity benefits (Bredemeier et al., 2022).
Pilot activities and sharing best practices	6	16%	Pilot projects can be seen as partnerships (Manyise and Dentoni, 2021) and innovation activities that, for example in the framework of strategic niche management (Kemp et al., 1998), can be pivotal sources and catalysts for applying new, biodiversity-friendly farming practices (Hvitsand et al., 2024).
Favoring local producers	7	19%	Locally oriented food systems that encourage diversified production can lead to higher levels of agrobiodiversity due to increased landscape diversity, more diversified cropping systems and management of semi-natural landscapes (Björklund et al., 2019; DeClerck et al., 2023; Estrada-Carmona et al., 2022).
Actions in organizational functions: sales and marketing			
Increasing the biodiversity-friendly product offering	8	22%	Increasing the offering of biodiversity-friendly products is central to the efforts to promote biodiversity in the food context, and it translates to the effort of increasing sales of products that have either specific labels (such as organic products) or that aim at substituting animal-based foods with plant-based foods. Critical questions relate to consumers' willingness to pay premiums for biodiversity-friendly foods, consumers' (lacking) awareness of such foods as well as overcoming barriers related to consuming animal-based foods (Böhm and Schäfer, 2025; Uusitalo et al., 2026).
Making the biodiversity-friendly choice easier	2	5%	Making the biodiversity-friendly choices easier for consumers, in other words nudging, has been indicated to be effective in bringing about more sustainable practices in general (Ferrari et al., 2019), which is likely to apply to biodiversity-friendly practices too.
Educating customers on making biodiversity-friendly choices	5	14%	Building awareness and impacting food system sustainability through consumer choices is a popular strategy among trade and retail, and changing consumer preferences have had an impact on the selection available in food retail (Vaskelainen et al., 2022). At the same time, the transformative potential of building consumer awareness has been questioned on the basis of shifting responsibility to consumers from more powerful actors (Helander et al., 2024).
Actions in organizational functions: corporate-level biodiversity actions			
Strategy	14	38%	Incorporating biodiversity promotion to the strategic level in companies is crucial for combating biodiversity decline (Panwar et al., 2023). However, biodiversity protection goes beyond what is traditionally considered being within the domain of business strategy (Bansal et al., 2025). Thus, promoting biodiversity requires adoption of nature-based business models that extend the range of value creation beyond the conventional range of stakeholders (Bocken, 2023; de Lauwere et al., 2025).

(*continued on next page*)

Table 4 (*continued*)

Biodiversity action	Uptake in studied companies		Prospective effectiveness based on earlier literature
	n	%	
Biodiversity reporting	9	24%	Reporting is an important means for companies to retain their legitimacy in the face of stakeholders (Hassan et al., 2022), but reporting can, under some conditions, also reflect sustainability performance in general (Al-Shaer and Hussainey, 2022). However, companies' reporting practices on biodiversity are generally vague (Addison et al., 2019; Hassan et al., 2022).
Biodiversity measurement	8	22%	Business demand for tools to measure and evaluate biodiversity impacts has been increasing rapidly (Katic et al., 2023). However, even though measurements can have an impact in directing the actions of value chain partners, they typically do not involve additional premiums to producers but rather assume that measurement will help to remove inefficiencies and improve supply chain relations as a whole (Friedberg, 2017), the causal impacts of which to biodiversity are dubious.
Education and training	4	11%	Educating and involving employees in biodiversity protection is crucial for the adoption of biodiversity-friendly management practices in companies and is thus a central aspect of companies' biodiversity work (Boiral et al., 2018).

Legend: n = the number of companies that have mentioned the action in the dataset; % = share of companies adopting the action from the total of 37 companies.

the fact that thus far, efficient production methods have mainly contributed to a declining trend of biodiversity. It is thus unclear how continuing on the same trajectory of increasing efficiency is supposed to contribute to halting biodiversity decline in the future. Thus, for the supply chain actions to make a difference for biodiversity when operating on the logic of land sparing, their contribution to further actions to create direct and positive biodiversity impacts taking the forms of e.g. restoration and conservation would be necessary.

At the same time, supply chains should address the question of bringing more biodiversity within the biodiversity-depleted production systems. For example, managing semi-natural grasslands and rural biotopes can be seen as the single most effective action to improve biodiversity in agroecosystems in the Finnish context based on the abundance of endangered species in such habitats (Hyvärinen et al., 2019). However, this action was present in the accounts of only few actors (cf. Tables 2 and 4). More attention was, however, paid to actions that regenerate soils, as such actions include the aspect of valorising on ecosystem services (Voglhuber-Slavinsky et al., 2023). Increasing biodiversity via land sharing has potential to materialise through diversified local agroecosystems that operate on local resource bases and lead to diversified forms of production (Koppelmäki et al., 2021); thus, local food sourcing can be a key factor in the attempts to build more local and diversified food systems fostering agrobiodiversity (IPBES, 2016). However, our findings reveal a risk of co-opting the biodiversity agenda to support companies' business-as-usual, as some of the interviewees widened the scope of 'local food' to include any kind of food produced within the Finnish borders. Thus, favoring local production can have indirect but positive biodiversity impacts at best but, depending on how 'local' is framed, such action as a biodiversity policy can come close to greenwashing at worst.

Our analysis shows that biodiversity actions cannot be imposed via the supply chains blindly without being mindful about the embedded complex causalities and power relations between the value chain actors and actions. For example, labels and certificates may impose costs on farmers and can lead to restricted access to markets due to the resources required by certification (Freidberg, 2017; Vermunt et al., 2022). Similarly, while measurement and reporting are endorsed by the value chain actors as a means for promoting biodiversity, they can also be used as another way of driving down prices (Freidberg, 2017). In sum, biodiversity is at risk of becoming one of the many sustainability issues by means of which large companies use their purchasing power to pass the responsibility for dealing with sustainability questions on to farmers, along with the associated costs and financial risks (Glover and Touboulic, 2020).

Finally, zooming within organizations, we highlight how biodiversity actions not only depend on the company's position in the value chain, but, further, on the within-organizational function in question. In so doing, our third contribution is in offering a within-organizational perspective to companies' biodiversity work. In contrast, while prior research on biodiversity and business has tended to treat companies as monothetic entities, our findings posit the significance of attending to the role of different organizational functions vis-à-vis biodiversity protection. Such a within-firm approach builds on the value chain analysis developed by Porter (1985), a classic in management studies. Taking a closer look, biodiversity actions can be enacted in and across companies' functions, be it in corporate strategy departments, human resources management, sales and marketing, supply chain management, or product development. Moreover, our findings posit how the type of biodiversity action undertaken differs depending on the organizational function in question. Upon comparison, the biodiversity actions that increase the likelihood of biodiversity-friendly farming practices, such as procurement criteria or development of biodiversity-friendly products have a more direct effectiveness potential than those related to organizational functions, for example. These findings align with previous research that has identified product development along with supply chain management as central means for promoting biodiversity (Lambin et al., 2018; Vermunt et al., 2022).

5.2. Limitations

In terms of limitations, although we sought a representative sample of companies in the Finnish food system, it is possible that companies not included in the study or those who declined participation could have influenced upon the findings. Furthermore, the identified actions are not all-encompassing; instead, they offer an overview of the state of biodiversity actions in the studied companies across the Finnish food value chain. Moreover, they are based on the interviewees' subjective views of their company's biodiversity actions, cross-checked against reported actions, instead of an analysis of what they are actually doing on the ground. Indeed, identifying biodiversity actions was not a straightforward task for the interviewed managers, which suggests that promoting biodiversity requires more knowledge and understanding about the phenomenon. This echoes Freidberg 's (2017) argument that corporate sustainability managers "are working in uncharted terrain, often with limited expertise, authority, and resources." As our approach was inductive and data-driven, future research could adopt more structured approaches to data collection and develop pre-given categories of biodiversity actions, which could be explored via survey-based or theory-driven qualitative research designs. To this end, biodiversity actions could be mapped onto the stages of the mitigation hierarchy, while analyses of their effectiveness and scalability are also warranted. Finally, the temporal limitation of the findings deserves recognition, as our findings represent the state of biodiversity actions in the Finnish food sector in 2022–2024.

6. Conclusions

In this paper, we engaged in an in-depth qualitative interview-based study to appreciate the kinds of biodiversity actions undertaken by Finnish companies across the national food value chain. Our findings offer a multifaceted perspective to companies' biodiversity actions, as we (1) identify what companies' biodiversity actions are, (2) assess which actions bear direct vs. indirect impact on biodiversity, and further, how these actions depend on (3) a company's position in the value chain, and (4) the function within an organization. Put differently, the analysis of whether companies engage in direct or indirect biodiversity actions is not a clear-cut, black-and-white question, but rather a matter of different shades of grey.

In terms of implications for practice, the findings offer tangible ideas for actors operating in different parts of the food value chain as to the kind of biodiversity actions they can adopt. Our findings are a call for companies, across food value chains, to

- recognize that their business activity impacts on biodiversity
- move beyond strategic commitments, measurement and reporting toward identifying and implementing actions supportive of biodiversity
- appreciate that only biodiversity actions undertaken on land bear directly on biodiversity
- recognize that companies not working directly with land impact biodiversity, though indirectly
- identify the kinds of biodiversity actions that can be undertaken across a company's departments and functions

To begin with, companies can start by picking the low-hanging fruits, i.e. actions whose biodiversity potential is significant that remain nevertheless unacknowledged, as in the case of traditional rural biotopes. Yet, the scaling of biodiversity actions can be challenging. The studied companies complained that economic reasons, lacking human resources, lacking transparency in global supply chains, lacking measurement systems, as well as the complexity of the concept of biodiversity make increasing the scale of biodiversity actions difficult.

Going forward, in order to address global biodiversity decline, there is a need to raise the level of ambition. To this end, there is need to engage in a critical discussion on the role and effects of efficiency-based agricultural production vis-a-vis biodiversity protection. In this regard, there is a need to critically assess the mechanisms that ensure that reducing land use through intensive production, i.e. land sparing, actually will contribute to biodiversity conservation. Moreover, especially the question of plant-based foods in tackling biodiversity decline merits further research from the value chain perspective. While plant-based foods are given ample attention further down the value chains, they are hardly discussed in primary production as a means for protecting biodiversity. This raises the question – how can plant-based foods be turned into a business opportunity also in agriculture? How will plant-based foods increase the biodiversity, for example in the Finnish food system, where the decline of agrobiodiversity is essentially related to changing practices in animal husbandry?

This leads to policy implications, as there is a need to critically assess the power relations between the value chain actors and not only rely on top-down power in implementing measures aiming at biodiversity conservation. Overall, there is a need to raise the current minimum standards of environmental requirements. A lot can be done on fields to promote biodiversity, but these actions impose costs on farmers, many of whom are already financially vulnerable. A fair sharing of the financial burden is thus required within the value chain. Going forward, halting and reversing biodiversity decline requires a large-scale transformation of the society: companies' actions and the current minimum standards are not sufficient (Díaz et al., 2019; IPBES, 2024). In other words, value chain actions need to be accompanied by governmental policies aiming to halt biodiversity decline guided by shared targets and future visions.

As our study was conducted in the food sector, further research is needed to understand, across countries, sectors and supply chains, how businesses (a) are planning to address, (b) are addressing, (c) ought to address biodiversity, (d) via what kinds of in/direct biodiversity actions, while (e) assessing the effectiveness of these actions. Future studies are needed to connect companies' biodiversity conservation motivations with their biodiversity actions. Moreover, we call for research on how these actions could be further encouraged, scaled up and their effectiveness assessed and measured. Also, an analysis of the shared effects and potential tensions in companies' climate vs. biodiversity actions is needed. In light of the severity of biodiversity decline, research addressing companies' biodiversity work is direly needed.

CRediT authorship contribution statement

Otto Lappalainen: Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Irene Kuhmonen:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Satu Teerikangas:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Matti Salo:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Funding acquisition, Conceptualization. **Marja Turunen:** Methodology, Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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References

Adams, D., Donovan, J., Topple, C., 2021. Achieving sustainability in food manufacturing operations and their supply chains: key insights from a systematic literature review. Sustainable Prod. Consumption 28, 1491–1499. https://doi.org/10.1016/j.spc.2021.08.01.

Addison, P.F.E., Bull, J.W., Milner-Gulland, E.J., 2019. Using conservation science to advance corporate biodiversity accountability. Conserv. Biol. 33 (2), 307–318. https://doi.org/10.1111/cobi.13190.

Addison, P.F.E., Stephenson, P.J., Bull, J.W., Carbone, G., Burgman, M., Burgass, M.J., Gerber, L.R., Howard, P., McCormick, N., McRae, L., Reuter, K.E., Starkey, M., Milner-Gulland, E.J., 2020. Bringing sustainability to life: A framework to guide biodiversity indicator development for business performance management. Bus. Strateg. Environ. 29 (8), 3303–3313. https://doi.org/10.1002/bse.2573.

Ahnström, J., Höckert, J., Bergeå, H.L., Francis, C.A., Skelton, P., Hallgren, L., 2009. Farmers and nature conservation: what is known about attitudes, context factors and actions affecting conservation? Renewable Agriculture and Food Systems 24 (1), 38–47. https://doi.org/10.1017/S1742170508002391.

Al-Shaer, H., Hussainey, K., 2022. Sustainability reporting beyond the business case and its impact on sustainability performance: UK evidence. J. Environ. Manag. 311, 114883. https://doi.org/10.1016/j.jenvman.2022.114883.

Atupola, U., Gunarathne, N., 2023. Institutional pressures for corporate biodiversity management practices in the plantation sector: evidence from the tea industry in Sri Lanka. Bus. Strateg. Environ. 32 (5), 2615–2630. https://doi.org/10.1002/bse.3143.
Atupola, U., Vola, P., Gunarathne, N., Truant, E., Gelmini, L., 2023. Corporate biodiversity management and organisational change mechanisms: the case of a tea producer in Sri Lanka. Corp. Soc. Responsib. Environ. Manag. 30 (2), 791–801. https://doi.org/10.1002/csr.2388.
Balmford, A., 2021. Concentrating vs. spreading our footprint: how to meet humanity's needs at least cost to nature. J. Zool. 315 (2), 79–109. https://doi.org/10.1111/jzo.12920.
Bansal, P., Durand, R., Kreutzer, M., Kunisch, S., McGahan, A.M., 2025. Strategy can no longer ignore planetary boundaries: A call for tackling strategy's ecological fallacy. J. Manag. Stud. 62 (2), 965–985. https://doi.org/10.1111/joms.13088.
Beck-O'Brien, M., Bringezu, S., 2021. Biodiversity monitoring in long-distance food supply chains: tools, gaps and needs to meet business requirements and sustainability goals. Sustainability 13 (15), 8536. https://doi.org/10.3390/su13158536.
Benton, T., Bieg, C., Harwatt, H., Pudasaini, R., Wellesley, L., 2021. Food System Impacts on Biodiversity Loss – Three Levers for Food System Transformation in Support of Nature. Chatham House.
Björklund, J., Eksvärd, K., Schaffer, C., 2019. Exploring the potential of edible forest gardens: experiences from a participatory action research project in Sweden. Agrofor. Syst. 93, 1107–1118. https://doi.org/10.1007/s10457-018-0208-8.
Bocken, N., 2023. Business models for sustainability. Oxford Research Encyclopedia of Environmental Science. https://doi.org/10.1093/acrefore/9780199389414.013.842.
Böhm, U., Schäfer, M., 2025. Considering biodiversity in food purchases: consumer wishes and communication strategies. Front. Sustain. Food Syst. 9. https://doi.org/10.3389/fsufs.2025.1665754.
Boiral, O., Heras-Saizarbitoria, I., Broherton, M., 2018. Corporate biodiversity management through certifiable standards. Bus. Strateg. Environ. 27 (3), 389–402. https://doi.org/10.1002/bse.2005.
Booth, H., Milner-Gulland, E.J., McCormick, N., Starkey, M., 2024. Operationalizing transformative change for business in the context of Nature Positive. One Earth 7 (7), 1235–1249. https://doi.org/10.1016/j.oneear.2024.06.003.
Bowles, N., Alexander, S., Hadjikakou, M., 2019. The livestock sector and planetary boundaries: A 'limits to growth' perspective with dietary implications. Ecol. Econ. 160, 128–136. https://doi.org/10.1016/j.ecolecon.2019.01.033.
Bredemeier, B., Herrmann, S., Sattler, C., Prager, K., van Bussel, L.G.J., Rex, J., 2022. Insights into innovative contract design to improve the integration of biodiversity and ecosystem services in agricultural management. Ecosyst. Serv. 55, 101430. https://doi.org/10.1016/j.ecoser.2022.101430.
Carlson, K.M., Heilmayr, R., Gibbs, H.K., Noojipady, P., Morton, D.C., Walker, N.F., Paoli, G.D., Kremen, C., 2017. Effect of oil palm sustainability certification on deforestation and fire in Indonesia. PNAS 115 (1), 121–126. http://www.pnas.org/cgi/doi/10.1073/pnas.1704728114.
Carodenuto, S., Buluran, M., 2021. The effect of supply chain position on zero-deforestation commitments: evidence from the cocoa industry. J. Environ. Policy Plan. 23 (6), 716–731. https://doi.org/10.1080/1523908X.2021.1910020.
Chaudhary, A., Brooks, T.M., 2018. Land use intensity-specific global characterization factors to assess product biodiversity footprints. Environ. Sci. Technol. 52 (9), 5094–5104. https://doi.org/10.1021/acs.est.7b05570.
Chivian, E., Bernstein, A., 2008. Sustaining Life: How Human Health Depends on Biodiversity. Oxford University Press.
Clapp, J., 2025. Titans of Industrial Agriculture. How a Few Giant Corporations Came to Dominate the Farm Sector and why it Matters. MIT Press.
Collas, L., Crastes dit Sourd, R., Finch, T., Green, R., Hanley, N., Balmford, A., 2023. The costs of delivering environmental outcomes with land sharing and land sparing. People Nat. 5 (1), 228–240. https://doi.org/10.1002/pan3.10422.
Cozim-Melges, F., Ripoll-Bosch, R., Veen, G.F. (Ciska), Oggiano, P., Bianchi, F.J.J.A., van der Putten, W.H., van Zanten, H.H.E., 2024. Farming practices to enhance biodiversity across biomes: a systematic review. NPJ Biodivers. 3 (1), 1. https://doi.org/10.1038/s44185-023-00034-2.
Cramer, K.L., Kittinger, J.N., 2021. Reef conservation off the hook: can market interventions make coral reef fisheries more sustainable? Front. Mar. Sci. 8. https://doi.org/10.3389/fmars.2021.675274.
Crenna, E., Sinkko, T., Sala, S., 2019. Biodiversity impacts due to food consumption in Europe. J. Clean. Prod. 227, 378–391. https://doi.org/10.1016/j.jclepro.2019.04.054.
Crist, E., Mora, C., Engelman, R., 2017. The interaction of human population, food production, and biodiversity protection. Science 356 (6335), 260–264. https://doi.org/10.1126/science.aal2011.
Cuypers, D., Lust, A., Geerken, T., Gorissen, L., Peters, G., Karstensen, J., Prieler, S., Fisher, G., Hizsnyik, E., Van Velthuizen, H., 2013. European Commission. In: Vito, Cicero, IIASA (Eds.), The Impact of EU Consumption on Deforestation: Comprehensive Analysis of the Impact of EU Consumption on Deforestation: Final Report. European Union, Publications Office. https://doi.org/10.2779/82226.
Dasgupta, P., 2021. The Economics of Biodiversity: The Dasgupta Review. HM Treasury.
de Lauwere, C., Smits, M.-J., Dijkshoorn-Dekker, M., Brummelhuis, A.K., Polman, N., 2025. Understanding circular and nature-inclusive agricultural business models. Circ. Econ. Sustain. 5 (1), 161–192. https://doi.org/10.1007/s43615-024-00433-y.
de Silva, G.C., Regan, E.C., Pollard, E.H.B., Addison, P.F.E., 2019. The evolution of corporate no net loss and net positive impact biodiversity commitments: understanding appetite and addressing challenges. Bus. Strateg. Environ. 28 (7), 1481–1495. https://doi.org/10.1002/bse.2379.
Decaëns, T., Jiménez, J.J., Gioia, C., Measey, G.J., Lavelle, P., 2006. The values of soil animals for conservation biology. Eur. J. Soil Biol. 42, S23–S38. https://doi.org/10.1016/j.ejsobi.2006.07.001.
DeClerck, F.A.J., Koziell, I., Benton, T., Garibaldi, L.A., Kremen, C., Maron, M., Del Rio, C.R., Sidhu, A., Wirths, J., Clark, M., Dickens, C., Carmona, N.E., Fremier, A.K., Jones, S.K., Khoury, C.K., Lal, R., Obersteiner, M., Remans, R., Rusch, A., Schulte, L. A., Simmonds, J., Stringer, L.C., Weber, C., Winowiecki, L., 2023. A whole earth approach to nature-positive food: Biodiversity and agriculture. In: von Braun, J., Afsana, K., Fresco, L.O., Hassan, M.H.A. (Eds.), Science and Innovations for Food Systems Transformation. Springer International Publishing, pp. 469–496. https://doi.org/10.1007/978-3-031-15703-5_25.
Deconinck, K., Toyama, L., 2022. Environmental impacts along food supply chains: Methods, findings, and evidence gaps. In: OECD Food, Agriculture and Fisheries Paper 185. Directorate, OECD Trade and Agricultural.
Dengler, J., Biurrun, I., Boch, S., Dembicz, I., Török, P., 2020. Grasslands of the Palaearctic biogeographic realm: introduction and synthesis. In: Goldstein, M., DellaSala, D.A. (Eds.), Encyclopedia of the World's Biomes, 3. Elsevier. https://doi.org/10.1016/B978-0-12-409548-9.12432-7.
Desquilbet, M., Dorin, B., Couvet, D., 2017. Land sharing vs land sparing to conserve biodiversity: how agricultural markets make the difference. Environ. Model. Assess. 22 (3), 185–200. https://doi.org/10.1007/s10666-016-9531-5.
Díaz, S., Malhi, Y., 2022. Biodiversity: concepts, patterns, trends, and perspectives. Annu. Rev. Environ. Resour. 47 (1), 31–63. https://doi.org/10.1146/annurev-environ-120120-054300.
Díaz, S., Settele, J., Brondízio, E.S., Ngo, H.T., Agard, J., Arneth, A., Díaz, S., Settele, J., Brondízio, E.S., Ngo, H.T., Agard, J., Arneth, A., Balvanera, P., Brauman, K.A., Butchart, S.H., Chan, K.M., Garibaldi, L.A., Ichii, K., Liu, J., Subramanian, S.M., Midgley, G.F., Miloslavich, P., Molnár, Z., Obura, D., Pfaff, A., Polasky, S., Purvis, A., Razzaque, J., Reyers, B., Chowdhury, R.R., Shin, Y.-J., Visseren-Hamakers, I., Willis, K.J., Zayas, C.N., 2019. Pervasive human-driven decline of life on earth points to the need for transformative change. Science 366 (6471), eaax3100. https://doi.org/10.1126/science.aax3100.
Donal, P.F., Gree, R.E., Heath, M.F., 2001. Agricultural intensification and the collapse of Europe's farmland bird populations. Proc. Biol. Sci. 268 (1462), 25–29. https://doi.org/10.1098/rspb.2000.1325.
Dudley, N., Alexander, S., 2017. Agriculture and biodiversity: A review. Biodiversity 18 (2–3), 45–49. https://doi.org/10.1080/14888386.2017.1351892.
EIP-Agri, 2017. Agroforestry: Introducing Woody Vegetation into Specialized Crop and Livestock Systems. EIP-Agri Focus Group Agroforestry. https://ec.europa.eu/eip/agriculture/en/publications/eip-agri-focus-group-agroforestry-final-report.html.
Eisenhardt, K.M., 1989. Building theories from case study research. Acad. Manag. Rev. 14 (4), 532–550. https://doi.org/10.2307/258557.
Ekroos, J., Tiainen, J., Seimola, T., Herzon, I., 2019. Weak effects of farming practices corresponding to agricultural greening measures on farmland bird diversity in boreal landscapes. Landsc. Ecol. 34 (2), 389–402. https://doi.org/10.1007/s10980-019-00779-x.
Emmerson, M., Morales, M.B., Oñate, J.J., Batáry, P., Berendse, F., Liira, J., Aavik, T., Guerrero, I., Bommarco, R., Eggers, S., Pärt, T., Tscharntke, T., Weisser, W., Clement, L., Bengtsson, J., 2016. How agricultural intensification affects biodiversity and ecosystem services. In: Advances in Ecological Research, 55. Elsevier, pp. 43–97. https://doi.org/10.1016/bs.aecr.2016.08.005.
Estrada-Carmona, N., Sánchez, A.C., Remans, R., Jones, S.K., 2022. Complex agricultural landscapes host more biodiversity than simple ones: A global meta-analysis. Proc. Natl. Acad. Sci. 119 (38), e2203385119. https://doi.org/10.1073/pnas.2203385119.
Farnsworth, K.D., Adenuga, A.H., de Groot, R.S., 2015. The complexity of biodiversity: A biological perspective on economic valuation. Ecol. Econ. 120, 350–354.
Feola, G., Lerner, A.M., Jain, M., Montefrio, M.J.F., Nicholas, K.A., 2015. Researching farmer behaviour in climate change adaptation and sustainable agriculture: lessons learned from five case studies. J. Rural. Stud. 39, 74–84. https://doi.org/10.1016/j.jrurstud.2015.03.009.
Ferrari, L., Cavaliere, A., De Marchi, E., Banterle, A., 2019. Can nudging improve the environmental impact of food supply chain? A systematic review. Trends Food Sci. Technol. 91, 184–192. https://doi.org/10.1016/j.tifs.2019.07.004.
Finnish Food Authority, 2022. Kannattavuus. Ruokavirasto.fi. https://www.ruokavirasto.fi/tuet/maatalous/luonnon-monimuotoisuus-maatilalla/maatalousluonnon-monimuotoisuuden-oppaat/kannattavuus/kannattavuus/>. Accessed on 7.5.2024.
Fischer, J., Abson, D.J., Bergsten, A., Collier French, N., Dorresteijn, I., Hanspach, J., Hylander, K., Schultner, J., Senbeta, F., 2017. Reframing the food– biodiversity challenge. Trends Ecol. Evol. 32 (5), 325–345. https://doi.org/10.1016/j.tree.2017.02.009.
Food and Agriculture Organization of the United Nations (FAO), 2019. The State of the World's Biodiversity for Food and Agriculture. FAO Commission on genetic resources for food and agriculture assessments. http://www.fao.org/3/CA3129EN/CA3129EN.pdf.
Food and Agriculture Organization of the United Nations (FAO) (s.a.), 2020. What is organic agriculture? Fao.org. https://www.fao.org/organicag/oa-faq/oa-faq1/en/. Accessed on 11.4.2024.

Fraanje, W., 2018. What is the Land Sparing-Sharing Continuum? (Foodsource: Building Blocks). Food Climate Research Network, University of Oxford.
Freidberg, S., 2017. Big food and little data: the slow harvest of corporate food supply chain sustainability initiatives. Ann. Am. Assoc. Geogr. 107 (6), 1389–1406. https://doi.org/10.1080/24694452.2017.1309967.
Gabel, V.M., Meier, M.S., Köpke, U., Stolze, M., 2016. The challenges of including impacts on biodiversity in agricultural life cycle assessments. J. Environ. Manag. 181, 249–260. https://doi.org/10.1016/j.jenvman.2016.06.030.
Gabriel, D., Sait, S.M., Kunin, W.E., Benton, T.G., 2013. Food production vs. biodiversity: comparing organic and conventional agriculture. J. Appl. Ecol. 50 (2), 355–364. https://doi.org/10.1111/1365-2664.12035.
Garrett, R.D., Levy, S., Carlson, K.M., Gardner, T.A., Godar, J., Clapp, J., Dauvergne, P., Heilmayr, R., le Polain de Waroux, Y., Ayre, B., Barr, R., Døvre, B., Gibbs, H.K., Hall, S., Lake, S., Milder, J.C., Rausch, L.L., Rivero, R., Rueda, X., Villoria, N., 2019. Criteria for effective zero-deforestation commitments. Glob. Environ. Chang. 54, 135–147. https://doi.org/10.1016/j.gloenvcha.2018.11.003.
Geiger, F., Bengtsson, J., Berendse, F., Weisser, W.W., Emmerson, M., Morales, M.B., Ceryngier, P., Liira, J., Tscharntke, T., Winqvist, C., Eggers, S., Bommarco, R., Pärt, T., Bretagnolle, V., Plantegenest, M., Clement, L.W., Dennis, C., Palmer, C., Oñate, J.J., Guerrero, I., Inchausti, P., 2010. Persistent negative effects of pesticides on biodiversity and biological control potential on European farmland. Basic Appl. Ecol. 11 (2), 97–105. https://doi.org/10.1016/j.baae.2009.12.001.
Glaser, B.J., Strauss, A.L., 1967. The Discovery of Grounded Theory: Strategies for Qualitative Research. Aldine Publishing Company.
Glover, J., Touboulic, A., 2020. Tales from the countryside: unpacking "passing the environmental buck" as hypocritical practice in the food supply chain. J. Bus. Res. 121, 33–46. https://doi.org/10.1016/j.jbusres.2020.06.066.
Grass, I., Loos, J., Baensch, S., Batáry, P., Librán-Embid, F., Ficiciyan, A., Klaus, F., Riechers, M., Rosa, J., Tiede, J., Udy, K., Westphal, C., Wurz, A., Tscharntke, T., 2019. Land-sharing/−sparing connectivity landscapes for ecosystem services and biodiversity conservation. People Nat. pan3, 21. https://doi.org/10.1002/pan3.21.
Green, J.M.H., Croft, S.A., Durán, A.P., Balmford, A.P., Burgess, N.D., Fick, S., Gardner, T.A., Godar, J., Suavet, C., Virah-Sawmy, M., Young, L.E., West, C.D., 2019. Linking global drivers of agricultural trade to on-the-ground impacts on biodiversity. Proc. Natl. Acad. Sci. 116 (46), 23202–23208. https://doi.org/10.1073/pnas.1905618116.
Hallmann, C.A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H., Stenmans, W., Müller, A., Sumser, H., Hörren, T., Goulson, D., Kroon, H. de, 2017. More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLoS One 12 (10), e0185809. https://doi.org/10.1371/journal.pone.0185809.
Hassan, A.M., Roberts, L., Atkins, J., 2020. Exploring factors relating to extinction disclosures: what motivates companies to report on biodiversity and species protection? Bus. Strateg. Environ. 29 (3), 1419–1436. https://doi.org/10.1002/bse.2442.
Hassan, A.M., Roberts, L., Rodger, K., 2022. Corporate accountability for biodiversity and species extinction: evidence from organisations reporting on their impacts on nature. Bus. Strateg. Environ. 31 (1), 326–352. https://doi.org/10.1002/bse.2890.
Hawes, C., Christie, A., Banks, G., Boldrin, D., Brandt, J., Iannetta, P., Swyst, I., Turner, I., 2025. Long-term regenerative practices enhance in-field biodiversity and soil health for sustainable crop yields. Front. Sustain. Food Syst. 9. https://doi.org/10.3389/fsufs.2025.1651686.
Helander, H., Schnepf, S., Stetter, T., Ferrara, F., Leipold, S., 2024. Convenient solutions, inconvenient truths – why supermarkets will not drive food system transformation. Ecol. Econ. 218, 108096. https://doi.org/10.1016/j.ecolecon.2023.108096.
Herzberg, R., Schmidt, T., Keck, M., 2022. Market power and food loss at the producer-retailer interface of fruit and vegetable supply chains in Germany. Sustain. Sci. 17 (6), 2253–2267. https://doi.org/10.1007/s11625-021-01083-x.
Herzon, I., Rajala, T., Heinimaa, P., Birge, T., Kiviharju, E., Keskitalo, M., Kantanen, J., Helenius, J., 2014. FAO State of Biodiversity for Agriculture in Finland. Ministry of Agriculture and Forestry, Finland.
Herzon, I., Raatikainen, K.J., Helm, A., Rūsiņa, S., Wehn, S., Eriksson, O., 2022. Semi-natural habitats in the European boreal region: caught in the socio-ecological extinction vortex? Ambio 51 (8), 1753–1763. https://doi.org/10.1007/s13280-022-01705-3.
Hvitsand, C., Nicolaysen, A.M., Gjøtterud, S., Raanaas, R., 2024. Piloting a co-created local and alternative food network involving professional buyers in Norway: forces and tensions influencing viability. J. Rural. Stud. 110, 103362. https://doi.org/10.1016/j.jrurstud.2024.103362.
Hyvärinen, E., Juslén, A., Kemppainen, E., Uddström, A., Liukko, U.-M., 2019. The Red List of Finnish Species 2019. Ministry of the Environment & Finnish Environment Institute.
IPBES, 2016. The assessment report of the intergovernmental science-policy platform on biodiversity and ecosystem services on pollinators, pollination and food production. In: Potts, S.G., Imperatriz-Fonseca, V.L., Ngo, H.T. (Eds.), Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Bonn, Germany. (552 pages).
IPBES, 2019. Global assessment report of the intergovernmental science-policy platform on biodiversity and ecosystem services. In: Brondizio, E.S., Settele, J., Diaz, S., Ngo, H.T. (Eds.), IPBES Secretariat. https://doi.org/10.5281/zenodo.3831673.
IPBES, 2024. In: O'Brien, K., Garibaldi, L., Agrawal, A. (Eds.), Thematic assessment report on the underlying causes of biodiversity loss and the determinants of transformative change and options for achieving the 2050 vision for biodiversity of the intergovernmental science-policy platform on biodiversity and ecosystem services. IPBES secretariat, Bonn, Germany. https://doi.org/10.5281/zenodo.11382215.
Järviö, N., 2022. The Planet we Eat: Comparing Environmental Impacts of Protein-Rich Food and Feed Ingredients from Cellular Agriculture, Agriculture and Aquaculture. Publications 39. University of Helsinki, Ruralia Institute. https://helda.helsinki.fi/handle/10138/349522.
Jouffray, J.B., Virdin, J., Bebbington, J., Blasiak, R., Dunchus, A., Lo Presti, M., Vermeer, D., 2025. Identifying and closing gaps in corporate reporting of ocean impacts. Nat. Sustainability 1–10.
Kamgang, S.E., Boiral, O., Guillaumie, L., Brotherton, M.-C., 2023. Responsible sourcing in the food industry: a scoping review. Environ. Dev. Sustain. 26 (8), 19325–19349. https://doi.org/10.1007/s10668-023-03509-1.
Kangas, J., Majasalmi, T., Juva, K., Kotiaho, J.S., Ahlvik, L., 2023. *Suomen luonnon tila ja tulevaisuus – Skenaariotarkastelu luontokadon pysäyttämiseksi vaadittavista toimista.* Suomen luontopaneelin julkaisuja 4B/2023.
Kassar, I., Lasserre, P., 2004. Species preservation and biodiversity value: A real options approach. J. Environ. Econ. Manag. 48 (2), 857–879.
Katic, P.G., Cerretelli, S., Haggar, J., Santika, T., Walsh, C., 2023. Mainstreaming biodiversity in business decisions: taking stock of tools and gaps. Biol. Conserv. 277, 109831. https://doi.org/10.1016/j.biocon.2022.109831.
Kemp, R., Schot, J., Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. Tech. Anal. Strat. Manag. 10 (2), 175–198. https://doi.org/10.1080/09537329808524310.
Klebl, F., Feindt, P.H., Piorr, A., 2024. Farmers' behavioural determinants of on-farm biodiversity management in Europe: A systematic review. Agric. Hum. Values 41 (2), 831–861. https://doi.org/10.1007/s10460-023-10505-8.
Köninger, J., Lugato, E., Panagos, P., Kochupillai, M., Orgiazzi, A., Briones, M., 2021. Manure management and soil biodiversity: towards more sustainable food systems in the EU. Agric. Syst. 194. https://doi.org/10.1038/s41558-017-0061-1.
Koppelmäki, K., Helenius, J., Schulte, R.P.O., 2021. Nested circularity in food systems: A Nordic case study on connecting biomass, nutrient and energy flows from field scale to continent. Resour. Conserv. Recycl. 164, 105218. https://doi.org/10.1016/j.resconrec.2020.105218.
Kremen, C., 2015. Reframing the land-sparing/land-sharing debate for biodiversity conservation. Ann. N. Y. Acad. Sci. 1355, 52–76. https://doi.org/10.1111/nyas.12845.
Kubo, H., Darmawan, A., Hendarto, Mader, A.D., 2021. The effect of agricultural certification schemes on biodiversity loss in the tropics. Biol. Conserv. 261, 109243. https://doi.org/10.1016/j.biocon.2021.109243.
Kuhmonen, I., 2024. *Maatalousluonnon monimuotoisuuden hupenemisen taustalla vaikuttavat yhteiskunnalliset rakenteet* (fact box), 2024. In: Rytteri, S., Ekroos, J., Herzon, I., Kuussaari, M., Lehikoinen, A. (Eds.), Maatalousluonnon monimuotoisuutta edistävät ja heikentävät tekijät Suomessa, 2B/2024. Suomen luontopaneelin julkaisuja.
Kyttä, V., Hyvönen, T., Saarinen, M., 2023. Land-use-driven biodiversity impacts of diets—A comparison of two assessment methods in a Finnish case study. Int. J. Life Cycle Assess. 28 (9), 1104–1116. https://doi.org/10.1007/s11367-023-02201-w.
Lambin, E., Gibbs, H., Heilmayr, R., Carlson, K., Fleck, L., Garrett, R., Polain, Le, de Waroux, Y., McDermott, C., McLaughlin, D., Newton, P., Nolte, C., Pacheco, P., Rausch, L., Streck, C., Thorlakson, T., Walker, N., 2018. The role of supply-chain initiatives in reducing deforestation. Nat. Clim. Chang. 8, 109–116. https://doi.org/10.1038/s41558-017-0061-1.
Lamont, T.A., Barlow, J., Bebbington, J., Cuckston, T., Djohani, R., Garrett, R., Graham, N.A., 2023. Hold big business to task on ecosystem restoration. Science 381 (6662), 1053–1055.
Lanz, B., Dietz, S., Swanson, T., 2018. The expansion of modern agriculture and global biodiversity decline: an integrated assessment. Ecol. Econ. 144, 260–277. https://doi.org/10.1016/j.ecolecon.2017.07.018.
LaRue, E.A., Fahey, R.T., Alveshere, B.C., Atkins, J.W., Bhatt, P., Buma, B., Chen, A.P., Cousins, S., Elliott, J.M., Elmore, A.J., Hakkenberg, C.R., Hardiman, B., Johnson, J. S., Kashian, D.M., Koirala, A., Papes, M., St Hilaire, J.B., Surasinghe, T.D., Zambrano, J., Zhai, L., Fei, S., 2023. A theoretical framework for the ecological role of three-dimensional structural diversity. Front. Ecol. Environ. 21 (1), 4–13. https://doi.org/10.1002/fee.2587.
Lähtinen, K., Guan, Y., Li, N., Toppinen, A., 2016. Biodiversity and ecosystem services in the supply chain management of global forest sector. Ecosyst. Serv. 21, 130–140. https://doi.org/10.1016/j.ecoser.2016.07.006.
Li, D., Olden, J.D., Lockwood, J.L., Record, S., McKinney, M.L., Baiser, B., 2020. Changes in taxonomic and phylogenetic diversity in the Anthropocene. Proc. R. Soc. B 287, 1929. https://doi.org/10.1098/rspb.2020.0777.
Loconto, A., Desquilbet, M., Moreau, T., Couvet, D., Dorin, B., 2020. The land sparing – land sharing controversy: tracing the politics of knowledge. Land Use Policy 96, 103610. https://doi.org/10.1016/j.landusepol.2018.09.014.
Luonnontila, 2024. Farmland breeding birds. https://luonnontila.fi/en/indicators-by-major-environment-type/agricultural-environments/framland-breeding-birds/.
Luskin, M.S., Lee, J.S.H., Edwards, D.P., Gibson, L., Potts, M.D., 2018. Study context shapes recommendations of land-sparing and sharing; a quantitative review. Glob. Food Sec. 16, 29–35. https://doi.org/10.1016/j.gfs.2017.08.002.

Machovina, B., Feeley, K.J., Ripple, W.J., 2015. Biodiversity conservation: the key is reducing meat consumption. Sci. Total Environ. 536, 419–431. https://doi.org/10.1016/j.scitotenv.2015.07.022.

Malek, Ž., Douw, B., Van Vliet, J., Van Der Zanden, E.H., Verburg, P.H., 2019. Local land-use decision-making in a global context. Environ. Res. Lett. 14 (8), 083006. https://doi.org/10.1088/1748-9326/ab309e.

Mammola, S., Carmona, C.P., Guillerme, T., Cardoso, P., 2021. Concepts and applications in functional diversity. Funct. Ecol. 35 (9), 1869–1885. https://doi.org/10.1111/1365-2435.13882.

Manyise, T., Dentoni, D., 2021. Value chain partnerships and farmer entrepreneurship as balancing ecosystem services: Implications for agri-food systems resilience. Ecosyst. Serv. 49, 101279. https://doi.org/10.1016/j.ecoser.2021.101279.

Martínez-Ramón, V., Bromwich, T., Modernel, P., Poore, J., Bull, J.W., 2024. Alternative life cycle impact assessment methods for biodiversity Footprinting could motivate different strategic priorities: A case study for a Dutch dairy multinational. Bus. Strateg. Environ. 34 (2), 2128–2138. https://doi.org/10.1002/bse.4072.

Mazac, R., Meinilä, J., Korkalo, L., Järviö, N., Jalava, M., Tuomisto, H.L., 2022. Incorporation of novel foods in European diets can reduce global warming potential, water use and land use by over 80%. Nat. Food 3 (4), 286–293. https://doi.org/10.1038/s43016-022-00489-9.

McKinsey, 2022. Corporate commitments to nature have evolved since 2022. https://www.mckinsey.com/industries/agriculture/our-insights/corporate-commitments-to-nature-have-evolved-since-2022.

McKinsey, 2024. Corporate commitments to nature have evolved since 2022. December 10. https://www.mckinsey.com/industries/agriculture/our-insights/corporate-commitments-to-nature-have-evolved-since-2022.

Mupepele, A.-C., Keller, M., Dormann, C.F., 2021. European agroforestry has no unequivocal effect on biodiversity: A time-cumulative meta-analysis. BMC Ecology and Evolution 21 (1), 193. https://doi.org/10.1186/s12862-021-01911-9.

Natural Resources Institute Finland, 2023. Ratio between domestic production and consumption. https://www.luke.fi/en/statistics/indicators/cap-indicators/ratio-between-domestic-production-and-consumption. Accessed 21.9.2024.

Natural Resources Institute Finland, 2024. Utilised Agricultural Area 2023. https://www.luke.fi/en/statistics/utilised-agricultural-area/utilised-agricultural-area-2023. Accessed 15.2.2025.

Natural Resources Institute Finland, 2025. Proportion of high nature value farmland. https://www.luke.fi/en/statistics/indicators/cap-indicators/proportion-of-high-nature-value-farmland. Accessed 24.11.2025.

Newton, P., Civita, N., Frankel-Goldwater, L., Bartel, K., Johns, C., 2020. What is regenerative agriculture? A review of scholar and practitioner definitions based on processes and outcomes. Frontiers in Sustainable Food Systems 4, 2020. https://doi.org/10.3389/fsufs.2020.577723.

Ollinaho, O.I., Kröger, M., 2021. Agroforestry transitions: the good, the bad and the ugly. J. Rural. Stud. 82, 210–221. https://doi.org/10.1016/j.jrurstud.2021.01.016.

Palazzo, M., Vollero, A., 2022. A systematic literature review of food sustainable supply chain management (FSSCM): building blocks and research trends. TQM J. 34 (7), 54–72. https://doi.org/10.1108/TQM-10-2021-0300.

Panwar, R., 2023. Business and biodiversity: achieving the 2050 vision for biodiversity conservation through transformative business practices. Biodivers. Conserv. 32 (11), 3607–3613.

Panwar, R., Ober, H., Pinkse, J., 2023. The uncomfortable relationship between business and biodiversity: advancing research on business strategies for biodiversity protection. Bus. Strateg. Environ. 32 (5), 2554–2566.

Peltoniemi, K., Mattila, T., Nuutinen, V., Schrader, S., Waeyenberge, L., 2020. Tillage systems threaten or promote biodiversity. In: Book chapter in E-book about outcomes from systematic review, data mining and meta-analysis, SoildiverAgro project, pp. 38–49.

Peura, M., El Geneidy, S., Pokkinen, K., Vainio, V., Kotiaho, J.S., 2023. Väliraportti: S-ryhmän luontojalanjälki. JYU Reports 1–45. https://doi.org/10.17011/jyureports/2023/20.

Phalan, B., Onial, M., Balmford, A., Green, R.E., 2011. Reconciling food production and biodiversity conservation: land sharing and land sparing compared. Science 333 (6047), 1289–1291. https://doi.org/10.1126/science.1208742.

Plantureux, S., Peeters, A., McCracken, D., 2005. Biodiversity in intensive grasslands: effect of management, improvement and challenges. Agron. Res. 3 (2), 153–164.

Porter, M.E., 1985. Competitive Advantage. The Free Press, New York.

Quarshie, A., Salmi, A., Wu, Z., 2021. From equivocality to reflexivity in biodiversity protection. Organ. Environ. 34 (4), 530–558. https://doi.org/10.1177/10860266198371222.

Quevedo-Cascante, M., Mogensen, L., Kongsted, A.G., Knudsen, M.T., 2023. How does life cycle assessment capture the environmental impacts of agroforestry? A systematic review. Sci. Total Environ. 890, 164094. https://doi.org/10.1016/j.scitotenv.2023.164094.

Raatikainen, K., 2018. *Conservation of Traditional Rural Biotopes in Finland. A Social-Ecological Approach*. Jyväskylä Studies in Biological and Environmental Sciences 340. University of Jyväskylä.

Rigal, S., Dakos, V., Alonso, H., Devictor, V., 2023. Farmland practices are driving bird population decline across Europe. Ecology 120 (21), e2216573120. https://doi.org/10.1073/pnas.221657312.

Rudel, T.K., Schneider, L., Uriarte, M., Turner, B.L., DeFries, R., Lawrence, D., Geoghegan, J., Hecht, S., Ickowitz, A., Lambin, E.F., Birkenholtz, T., Baptista, S., Grau, R., 2009. Agricultural intensification and changes in cultivated areas, 1970–2005. Proc. Natl. Acad. Sci. 106 (49), 20675–20680. https://doi.org/10.1073/pnas.0812540106.

Rueda, X., Garrett, R.D., Lambin, E.F., 2017. Corporate investments in supply chain sustainability: selecting instruments in the agri-food industry. J. Clean. Prod. 142 (4), 2480–2492. https://doi.org/10.1016/j.jclepro.2016.11.026.

Rytteri, S., Ekroos, J., Herzon, I., Kuussaari, M., Lehikoinen, A., 2024. *Maatalousluonnon monimuotoisuutta edistävät ja heikentävät tekijät Suomessa.* Suomen luontopaneelin julkaisuja 2B/2024.

Saikkonen, L., Herzon, I., Ollikainen, M., Lankoski, J., 2014. Socially optimal drainage system and agricultural biodiversity: a case study for Finnish landscape. J. Environ. Manag. 146, 84–93. https://doi.org/10.1016/j.jenvman.2014.07.037.

Salmi, A., Quarshie, A., Scott-Kennel, J., Kähkönen, A., 2023. Biodiversity management: A supply chain practice view. Journal of Purchasing and Supply Chain Management 29, 4. https://doi.org/10.1016/j.pursup.2023.100865.

Sandström, V., Kauppi, P.E., Scherer, L., Kastner, T., 2017. Linking country level food supply to global land and water use and biodiversity impacts: the case of Finland. Sci. Total Environ. 575, 33–40. https://doi.org/10.1016/j.scitotenv.2016.10.002.

Santangeli, A., Lehikoinen, A., Lindholm, T., Herzon, I., 2019. Organic animal farms increase farmland bird abundance in the Boreal region. PLoS ONE 14 (5), e0216009. https://doi.org/10.1371/journal.pone.0216009.

Schadewitz, H., 2024. Natural capital and biodiversity accounting in the dairy industry: The case of Valio group. In: Atkins, J. (Ed.), Protecting Natural Capital and Biodiversity in the Agri-Food Sector. Burleigh Dodds Science Publishing, pp. 195–216. https://doi.org/10.19103/AS.2023.0128.08.

Sidemo-Holm, W., Ekroos, J., Smith, H.G., 2021. Land sharing versus land sparing—what outcomes are compared between which land uses? Conservation Science and Practice 3 (11), e530. https://doi.org/10.1111/csp2.530.

Sleboda, P., Bruine de Bruin, W., Gutsche, T., Arvai, J., 2023. Don't say "vegan" or "plant-based": food without meat and dairy is more likely to be chosen when labeled as "healthy" and "sustainable". J. Environ. Psychol. 93. https://doi.org/10.1016/j.jenvp.2023.102217.

Talbot, D., Boiral, O., 2021. Public organizations and biodiversity disclosure: saving face to meet a legal obligation? Bus. Strateg. Environ. 30 (5), 2571–2586. https://doi.org/10.1002/bse.2764.

Teerikangas, S., Unkila, M., Mäkelä, M., Möksy, J., Kervinen, V., Lappalainen, O., Turunen, M., 2023. *Biodiversity and business – A literature review and future research agenda.* Paper presented at the corporate responsibility research conference, Cambridge, September 7–8.

Testa, F., Tosi, D., Tessitore, S., Todaro, N.M., Iorio, Di, V., 2025. Untangling companies' engagement with biodiversity: a systematic literature review and research agenda. Bus. Strateg. Environ. 34 (6), 6773–6790. https://doi.org/10.1002/bse.4324.

Tobin, D., Bates, R., Brennan, M., Gill, T., 2018. Peru potato potential: biodiversity conservation and value chain development. Renewable Agriculture and Food Systems 33 (1), 19–32. https://doi.org/10.1017/S1742170516000284.

Toivonen, M., Huusela, E., Hyvönen, T., Marjamäki, P., Järvinen, A., Kuussaari, M., 2022. Effects of crop type and production method on arable biodiversity in boreal farmland. Agric. Ecosyst. Environ. 337, 108061. https://doi.org/10.1016/j.agee.2022.108061.

Tscharntke, T., Grass, I., Wanger, T.C., Westphal, C., Batáry, P., 2021. Beyond organic farming – harnessing biodiversity-friendly landscapes. Trends Ecol. Evol. 36 (10), 919–930. https://doi.org/10.1016/j.tree.2021.06.010.

Tuck, S.L., Winqvist, C., Mota, F., Ahnström, J., Turnbull, L.A., Bengtsson, J., 2014. Land-use intensity and the effects of organic farming on biodiversity: A hierarchical meta-analysis. J. Appl. Ecol. 51 (3), 746–755. https://doi.org/10.1111/1365-2664.12219.

Tuomisto, H.L., Hodge, I.D., Riordan, P., Macdonald, D.W., 2012. Does organic farming reduce environmental impacts? – A meta-analysis of European research. J. Environ. Manag. 112, 309–320. https://doi.org/10.1016/j.jenvman.2012.08.018.

Uusitalo, O., Rouhiainen, H., Salimi, M., 2026. Values, risk and biodiversity-friendly action: perceived consumer effectiveness matters. J. Consum. Mark. 43 (1), 108–121. https://doi.org/10.1108/JCM-01-2025-7548.

Vaskelainen, T., Siltaoja, M., Hoskonen, H., 2022. Hypes and the birth of new sustainable market categories – a socio-cultural perspective on the emergence of the meat substitute category in Finland. Tech. Anal. Strat. Manag. 1–13. https://doi.org/10.1080/09537325.2022.2070467.

Vermunt, D.A., Wojtynia, N., Hekkert, M.P., Van Dijk, J., Verburg, R., Verweij, P.A., Wassen, M., Runhaar, H., 2022. Five mechanisms blocking the transition towards 'nature-inclusive' agriculture: A systemic analysis of Dutch dairy farming. Agric. Syst. 195, 103280. https://doi.org/10.1016/j.agsy.2021.103280.

Voglhuber-Slavinsky, A., Lemke, N., MacPherson, J., Dönitz, E., Olbrisch, M., Schöbel, P., Moller, B., Bahrs, E., Helming, K., 2023. Valorization for biodiversity and ecosystem Services in the Agri-Food Value Chain. Environ. Manag. 72 (6), 1163–1188. https://doi.org/10.1007/s00267-023-01860-7.

Wagner, M., 2022. Business, biodiversity and ecosystem services: evidence from large-scale survey data. Bus. Strateg. Environ. 32 (5), 2583–2599. https://doi.org/10.1002/bse.3141.

Wiebe, R.A., Wilcove, D.S., 2025. Global biodiversity loss from outsourced deforestation. Nature 639 (8054), 389–394. https://doi.org/10.1038/s41586-024-08569-5.

Wilting, H.C., van Oorschot, M.M.P., 2017. Quantifying biodiversity footprints of Dutch economic sectors: A global supply-chain analysis. J. Clean. Prod. 156, 194–202. https://doi.org/10.1016/j.jclepro.2017.04.066.

Winn, M.I., Pogutz, S., 2013. Business, ecosystems, and biodiversity: new horizons for management research. Organ. Environ. 26 (2), 203–229. https://doi.org/10.1177/1086026613490173.

Wolff, A., Gondran, N., Brodhag, C., 2017. Detecting unsustainable pressures exerted on biodiversity by a company. Application to the food portfolio of a retailer. J. Clean. Prod. 166, 784–797. https://doi.org/10.1016/j.jclepro.2017.08.057.

World Economic Forum, 2024. The Global Risks Report 2024, *19th edition*. World Economic Forum.

Wright, D.R., Bekessy, S.A., Gordon, A., Bennett, R.E., Rodewald, A.D., Garrard, G.E., Lentini, P.E., Selinske, M.J., 2025. The critical role of retailers in leveraging sustainability of a global supply chain. Corp. Soc. Responsib. Environ. Manag. 32 (3), 3371–3382. https://doi.org/10.1002/csr.3136.

Zhang, Y., Pang, M., Dickens, B.L., Edwards, D.P., Carrasco, L.R., 2021. Global hotspots of conversion risk from multiple crop expansion. Biol. Conserv. 254, 108963. https://doi.org/10.1016/j.biocon.2021.108963.

Zu Ermgassen, S.O., Howard, M., Bennun, L., Addison, P.F., Bull, J.W., Loveridge, R., Starkey, M., 2022. Are corporate biodiversity commitments consistent with delivering 'nature-positive' outcomes? A review of 'nature-positive' definitions, company progress and challenges. J. Clean. Prod. 379, 134798. https://doi.org/10.1016/j.jclepro.2022.134798.