



“More than bees and flowers”: understanding public perceptions of biodiversity in the context of food production and consumption

Julia Q. Shen¹ · Jonas House^{2,3} · Jasper R. de Vries⁴ · P. Marijn Poortvliet⁵

Accepted: 31 July 2025
© The Author(s) 2025

Abstract

Biodiversity, crucial for resilient agri-food systems, is declining at an unprecedented rate, largely driven by agricultural practices. In response, scientists and policymakers have called for a transition towards biodiversity-enhancing food systems, emphasizing the need for a systemic change that includes the consumer. However, as the term biodiversity is relatively new and complex, there have been worries whether broader publics understand and value biodiversity enough to support conservation practices or alter their consumption. By using associations as a means to access broader mental representations, the study explores how people make sense of the term biodiversity. Participants of a survey ($N=1971$) on biodiverse food production and consumption in the Netherlands were asked to list 5–7 associations they had with biodiversity. Thematic content analysis was performed on the associations elicited, and themes were further validated with focus group discussions ($N=24$) on biodiversity. The associations elicited revealed that participants mostly associate biodiversity with species diversity, with a focus on animals and plants. Many viewed biodiversity as valuable for ensuring a quality of nature and life, but some expressed scepticism or negative connotations, considering biodiversity a “hype” or questioning biodiversity loss. Lastly, associations showed that the relation between agricultural practices and biodiversity was understood both in terms of the negative consequences agriculture could have on biodiversity, as well as how it could contribute to enhancing biodiversity. Next to providing more deliberative and diverse perspectives on biodiversity and conservation, such insights could be essential for identifying how the public could be more engaged in the transition towards biodiversity-enhancing food systems.

Keywords Biodiverse food systems · Consumer research · Public understanding · Word association · The Netherlands

Introduction

Biodiversity – generally defined as the diversity of all life – is declining faster now than at any time in human history (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES] 2019; Richardson et al. 2023). Human activity and especially the global food system is one of the primary drivers of this loss, for example through altered land and water use, crop intensification through monocultures, and extensive use of agrochemicals (Benton et al. 2021; IPBES 2019). Simultaneously, global food security stands to be at threat in the face of biodiversity loss: biodiversity is indispensable in ensuring that agri-food systems are more resilient to stressors and shocks such as pests, diseases and changes in climate. Biodiversity not only ensures the availability of a diversity of the foods and materials on which humans are dependent, but also provides the interdependencies between different species and abiotic

✉ Julia Q. Shen
Julia.shen@wur.nl

¹ Strategic Communication Group, Wageningen University & Research, Hollandseweg 1, Wageningen, KN 6706, Netherlands

² Department of Industrial Economics and Management, KTH Royal Institute of Technology, Lindstedtsvägen 30, Stockholm SE-100 44, Sweden

³ KTH FOOD, KTH Royal Institute of Technology, Lindstedtsvägen 30, SE-100 44 Stockholm, Sweden

⁴ Landscape Architecture & Spatial Planning Group, Wageningen University & Research, Droevendaalsesteeg 3, Wageningen 6708 PB, The Netherlands

⁵ Cultural Geography Group, Wageningen University & Research, Droevendaalsesteeg 3, Wageningen 6708 PB, The Netherlands

elements that are necessary for food production. In order to ensure future food security, it is therefore essential to transition towards agri-food systems that enhance biodiversity, instead of harming it (IPBES 2019; Mommer et al., 2022; Food and Agriculture Organisation of the United Nations [FAO], 2019).

The need for a transition towards a more biodiversity-enhancing food system has been widely recognized and embraced by scientists, policy-makers and actors within the food production value chain (e.g. FAO, 2019; IPBES 2019; WWF 2024; Deltaplan Biodiversiteitsherstel 2019). It has been incorporated within the wider call for a transition towards a more sustainable food production system that operates within ecological limits (e.g. European Commission 2020; IPBES 2019; Mommer et al., 2022). Within this call, a systemic change is stressed: it is not only the farmers who need to adopt more biodiversity-enhancing agricultural practices, but it is the entire value chain, including the consumer and general public, who need to change and support change as well (Duru et al. 2015; Meier and Oehen 2019; Convention on Biological Diversity [CBD], 2000).

However, despite this call for a systemic approach, most of the research and policy efforts on the transition towards more biodiversity-enhancing food systems so far have focused on the production side (WWF 2024). While there have been multiple studies exploring farm level implementations and implications (e.g. Morel et al. 2020; Klebl et al. 2024; Leader et al. 2024), the consumer perspective remains underrepresented. Meanwhile these studies further underline that consumers are seen as important actors for change. For example, Morel et al. (2020) have shown that although farmers are willing to adopt biodiversity-enhancing farming practices, their worries about costs and lack of consumer interest are preventing them from doing so. They believe that the general public lacks understanding of biodiversity, and therefore will not see the need to adjust their consumption practices, especially if these will cost more. This further underlines the need for more research from a consumer perspective, beginning with an exploration on how biodiversity is generally understood and valued.

Previous research on public understanding of biodiversity has mostly focused on familiarity with the term. For example, in the mid-1990s (only a decade after the term first appeared in academic publications), only 36.7% of U.S. biology undergraduates recognized the term (Turner-Erfort 1997). The Special Eurobarometer on Biodiversity (European Commission 2019) shows gradual improvement: in 2015, 39% of EU respondents had never heard of biodiversity; by 2018, this had dropped to 29%. In both years, 30% of the respondents reported having heard of the term without understanding its meaning. Whilst the number of respondents who claimed to understand the terms increased

from 31% in 2015 to 41% in 2018, the survey did not include a qualitative assessment of *how* participants conceptualized biodiversity or how they valued it.

Several studies have attempted this, mostly through qualitative focus group discussions (e.g. Buijs et al. 2008; Fischer and Young 2007) or questionnaires (e.g. Runhaar et al. 2019). These studies demonstrate that people are able to give broad conceptualizations of biodiversity, sometimes anchored in their own personal experiences (Buijs et al. 2008; Fischer and Young 2007). Moreover, these studies show that participants appreciate biodiversity, both for its value to nature and for society (Buijs et al. 2008; Fischer and Young 2007; Runhaar et al. 2019). Yet these studies often rely on limited or specific populations—such as nature reserve visitors or students—restricting broader generalization about public perceptions of biodiversity.

The study reported on in this paper will contribute to a further understanding of how the general public views and values biodiversity, by exploring what perceptions people have of biodiversity as a concept in general and in the context of food production and consumption. As part of a mixed-method research project on biodiverse food systems in the Netherlands – consisting of a survey ($N=1971$) and four focus groups ($N=24$) – participants were asked to share their associations with the term “biodiversity”. This approach provides insight into the range and variation of perceptions that exist within the Dutch public. Uncovering these associations is crucial for advancing an understanding of how biodiversity (and its loss) is interpreted by the public, which in turn is a necessary foundation for more deliberative and inclusive strategies aimed at engaging consumers in the transition toward biodiversity-enhancing food systems (Pascual et al. 2021; IPBES 2022; Mommer et al., 2022).

The paper is structured as follows. As biodiversity is a multi-faceted and complex concept, the paper will proceed in Sect. “[The conception and conceptualization of biodiversity](#)” with a brief overview of the history of biodiversity as a scientific term, touching upon (some of) the scientific debates around different conceptualizations and valuations. Section “[Methods](#)” will discuss the research design and methods of collecting different representations of concepts such as biodiversity. Section “[Results](#)” will present an analysis of the associations collected, after which insights of the analysis will be critically discussed (Sect. “[Discussion](#)”) and synthesised (Sect. “[Conclusion](#)”).

The conception and conceptualization of biodiversity

The term 'biodiversity' is a relatively new term, as it was first coined in the 1980s. In response to the anthropogenically induced mass extinction of species and general degradation of natural ecosystems, scientists argued for the need to have a scientific basis and approach to nature conservation (Swingland 2013). In 1992 the Convention of Biological Diversity (CBD) – a treaty between currently 196 parties – was established, and remains the most authoritative document on biodiversity to date (CBD, 2011; Jetzkowitz et al., 2018). The CBD defines biodiversity as being "*the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems*" (CBD, 2011, Article 2). These three broad levels refer to genetic variability (within populations and species), diversity between species (and kingdoms), and variation in ecosystems, landscapes and biomes (including the abiotic components of nature that embed biodiversity). In order for ecosystems to continue to function, all three levels of biodiversity ought to be considered. Using the example of food production, diversity of species is necessary to provide diverse diets and maintain the existence of existing interdependencies (so-called food cycles). Similarly, genetic variability within species and populations is necessary for building resiliency against shocks and pests, whereas ecosystem diversity provides a diversity of habitats and abiotic components necessary for food production (e.g. soil composition and water provision) (FAO, 2019).

As this example already illustrates, the justification for biodiversity conservation is often shaped by its practical purpose and thus also reveals a normative connotation to how biodiversity is interpreted and applied. This is also visible in the CBD, which states as its first objective that biodiversity needs to be conserved and protected (CBD, 2011, Article 1), while the second objective provides the reason why: to ensure sustainable use of natural resources for the production of food, medicine, fiber, fuels, and other societal necessities (CBD, 2011, Article 1). Although the scientific term thus refers to a natural phenomenon, the type of nature that ought to be conserved has often been determined by its potential service to society (Pascual et al. 2021; Brunet et al. 2020; Jetzkowitz et al., 2018).

This focus on the instrumental value of biodiversity has opened the way for debates about the conceptualization, operationalization and application of biodiversity in practice (Swingland 2013; Lanzerath and Friele 2014). For example, the CBD focuses predominantly on measuring and safeguarding genetic diversity, whereas urban and

rural planners generally interpret and measure biodiversity as species richness, and ecologists operate from a broader interpretation that includes abiotic components as well (Brunet et al. 2020; Ferrier and Larson 2012; Jetzkowitz et al., 2018; DeLong 1996). Additionally, some scientists and policy-makers characterize biodiversity as limited to native biodiversity, arguing that "wild" or "untouched" biodiversity should be the primary focus of conservation efforts, whereas others argue that artificial biodiversity (as result of agricultural efforts and urbanization) is an important component of biological diversity as well (Brunet et al. 2020; Ferrier and Larson 2012; Swingland 2013).

Whilst this might have led to a diverse conceptualization and application of biodiversity and conservation, critics have also argued that it has led to a narrow notion of biodiversity conservation, often only representing dominant (i.e. often Western-centric) perspectives of nature and limited perspectives of what is valuable (i.e. often economic values) (Jetzkowitz et al., 2018; Pascual et al. 2021). In response to this, scientists and policy-makers have called for a broader perspective on biodiversity conservation that consider more pluralistic perspectives on nature, biodiversity and their valuation (Pascual et al. 2021; Jacobs et al., 2020; Jetzkowitz et al., 2018; IPBES 2022; Oostvogels et al. 2024). For example, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) adopted a more comprehensive values typology, in which a distinction is made between instrumental values (i.e. nature for society), intrinsic values (i.e. nature for nature's sake), and relational values (i.e. the meaningfulness of human-nature relations) related to biodiversity and biodiversity conservation (IPBES 2022). Taking into account such plural valuations, thereby making visible the diverse values people hold in relation to nature, is seen as necessary for coming to more just and effective biodiversity conservation (Pascual et al. 2021; IPBES 2022).

Methods

Accessing mental representations through associations

In response to the need for more pluralistic perspectives on biodiversity, this study sought to uncover the range of perceptions that people have with biodiversity that go beyond mere definitions. Especially in the context of the various debates about the conceptualization and valuation of biodiversity, it is important to acknowledge that while people may not be familiar with specific scientific terminology, they can form rich mental representations of concepts that include definitions, values, images, experiences or other

associations (Fischer and Young 2007; Weber and Stern 2011). In order to fully explore how people make sense of biodiversity, it is therefore necessary to tap into these mental representations, rather than try to objectively measure and qualify people's representation of a concept according to the yardstick of more established scientific definitions (if those exist).

To this end, interpretative elicitation techniques have proven insightful in uncovering broad mental representations that go beyond a mere definition (see also Barone et al. 2020; Doherty and Nelson 2010). One elicitation technique that is effective in revealing differences in interpretation of concepts in large samples is the word association technique, in which participants are asked to list all associations they have with a particular word (Doherty and Nelson 2010). Asking for associations with a concept can be an effective way of accessing broader mental representations of the concept in larger sample sizes, that extend beyond mere definitions to values, feelings, motivations, attitudes, and related concepts. This technique offers a low effort and simple method for freely exploring people's thoughts, beliefs, and perceptions surrounding a concept (Barone et al. 2020), without interfering too much through structured prompts or questions (Doherty and Nelson 2010).

Study design and setting

For this study, associations were collected as part of a larger survey on biodiverse food consumption ($N=1971$). Participants were asked to list a minimum of five and a maximum of seven associations they had with the term "biodiversity". Double associations per participant were removed after inspection. In total, 9412 associations with biodiversity were elicited and formed the corpus for analysis.

This association task was first tested in a smaller setting, as part of focus group discussions on biodiverse food consumption ($N=24$). Since these focus group discussions allowed for more detailed insights into why certain associations were elicited, we have included these focus group discussions in the research design. The focus groups were conducted by one independent moderator, a note taker, and one of the authors, with the same team present at each focus group to ensure consistence. During the focus groups, we strived for an open and conducive atmosphere in which participants felt free to state their opinions or ask for clarification when necessary. All recordings were transcribed (with the exception of the first focus group in which technical difficulties prevented a successful recording) and anonymized and the minutes of the focus groups were checked by the research team. After transcription, all video and audio data was deleted in accordance with privacy regulations.

Both they survey and focus groups were part of a broader consumer research project on biodiverse food production and consumption in the Netherlands, meaning that the associations tasks were conducted in this context. However, in order to get broader perceptions beyond this context, we explicitly asked for associations with biodiversity in general. Furthermore, the association tasks were placed in the first parts of both the survey and the focus groups, to minimize potential priming. Nonetheless, we cannot exclude that participants were not influenced by the context of the study when listing their associations. This is accounted for in further data analysis and interpretation of the associations.

The Netherlands provides a relevant study setting, as it has experienced a substantially larger decline in biodiversity than elsewhere in Europe (European Environment Agency, 2015), in part because of its intensive focus on agricultural production (over 50% of ground surface is designated for agriculture, Statistics Netherlands 2025). In response, the Dutch government has explored pathways to more 'nature-inclusive' farming, in which agricultural practices that work with natural processes are implemented to minimize negative ecological impacts (Runhaar 2017).

Study sample

Survey

A sample of 2,000 Dutch participants was recruited using market research agency MSi to fill in an online survey, for which they received a small monetary compensation. Twenty-nine participants were excluded because they met one or more of the following exclusion criteria: non-native speaker, low answer variability, unserious associations and/or short duration time, leading to a final sample of 1,971 participants, with an average age of 47.40 years old ($SD=16.14$, ages ranging from 18 to 75). In terms of gender, participants were evenly spread (48.8% identified as male, 51.2% identified as female). Of the respondents, 12.5% had a 'lower' educational attainment, 41.2% had a 'middle' educational attainment, and 46.0% had a 'higher' educational attainment (delineations as used by Statistics Netherlands 2024). When compared to the average Dutch educational attainment levels (25.7% 'low', 36.7% 'middle', and 37.0% 'high'), our sample is relatively higher educated (Statistics Netherlands 2024). In terms of regionality, our sample was evenly spread (23.4% lived in a village not bordering a city, 15.5% lived in a village bordering a city, 12.6% lived in a small city with maximum 30,000 inhabitants, 25.8% lived in a medium sized city with 30,000-100,000 inhabitants, and 22.6% lived in a big city with over 100,000 inhabitants). Lastly, we measured whether participants were motivated to consume more environmentally-friendly, using a validated six-item

measure (Haws et al. 2014), with 16.3% of respondents having little motivation, 53.1% average motivation, and 30.5% high motivation to consume more environment-friendly.

Focus groups

For the focus group discussions, participants were recruited via research agency Ipsos I&O and participants received a small compensation for their participation. Sampling was purposive, as participants had applied to take part in a two hour focus group discussion about biodiversity and food consumption, however, efforts were made to form heterogeneous focus groups in terms of age, gender, and regionality. Four focus groups were held, of which two took place in a city (larger than 100.000 inhabitants) and two in a rural region. The total sample ($N=24$, six per focus group) had an average age of 44.08 ($SD=15.63$, ages ranging from 21 to 70). In terms of gender, participants were evenly spread (50.0% identified as male, 50.0% identified as female). In terms of education, 4.2% had a 'lower' educational attainment, 16.7% had a 'middle' educational attainment, and 79.6% had a 'higher' educational attainment (again showing a higher than Dutch average educational attainment). When asked whether environmental concern influenced their consumption habits, almost all participants (with the exclusion of one) stated it did, signaling that the focus group sample

deviates from the survey sample in terms of level of environmental concern.

Codebook development and data analysis

Due to the nature of the data, coding and interpretation of the associations elicited during the survey involved an extensive five-stage, iterative process. Themes and sub-themes were identified according to the principles of triangulation in order to ensure a measure of validity and reliability (Flick et al. 2004): first, the survey associations were sorted into groups based on similarity and inductive coding groups. Second, potential themes were deductively identified in the survey associations based on the literature review conducted for this study and the three-leveled definition of biodiversity as phrased by the CBD (2011). Third, these themes were further validated and situated using the focus group discussions. Based on this, a coding tree was developed (for full coding tree with explanations and examples, see Appendix). Fourth, the coding tree was checked with a subset of the survey associations to determine whether the coding tree covered the breadth of the associations. Finally, all associations were manually coded for the presence of each theme and sub-theme per participant to check for the depth of each theme (i.e. % of the participant that mentioned the (sub-)theme). It is important to note that the survey associations were always coded based on the full set of associations a participant submitted, to facilitate interpretation. For example, when "health" was mentioned, whether this was interpreted in relation to health of nature, or healthy food, was dependent on the other associations mentioned by the participant. At each step of the process, the coding tree was discussed among the author team, and themes or sub-themes were merged or added inductively if necessary.

Results

Several themes were identified in the survey associations, as presented in Table 1 (for a full overview of each themes and sub-themes with examples and percentages, see the coding tree in the Appendix). For each theme and sub-theme, we indicate whether the theme was prevalent in the focus group discussions, as well as the percentage of survey participants that mentioned said theme at least once. It is important to note, however, that whilst such percentages indicate the prevalence of a theme, the aim of this paper is to uncover the diversity in mental representations of biodiversity rather than the pervasiveness of such representations.

In this section, each theme will be discussed in detail, combining both the insights from the survey and the focus group discussions

Table 1 Prevalence of (sub-)themes identified in survey associations corpus and focus group discussions

Theme	Subtheme	Mentioned in focus groups	% of survey participants
No associations with biodiversity	-	No	11.4%
Diversity	-	Yes	30.4%
Life and Nature	<i>Ecosystem level</i>	Yes	43.0%
	<i>Species level</i>	Yes	46.0%
	<i>Genetic level</i>	Yes	1.6%
Decline of Nature and Life	<i>Environmental degradation</i>	Yes	4.3%
	<i>Biodiversity loss</i>	Yes	3.7%
Value of Biodiversity	<i>Biodiversity is not important/exaggerated/hoax</i>	No	5.1%
	<i>Biodiversity is important (explicit mention)</i>	Yes	9.6%
	<i>Biodiversity being good for nature</i>	Yes	24.2%
	<i>Need for conservation</i>	Yes	12.8%
	<i>Sustainability in general</i>	Yes	13.7%
Food Production and Consumption	-	Yes	36.9%

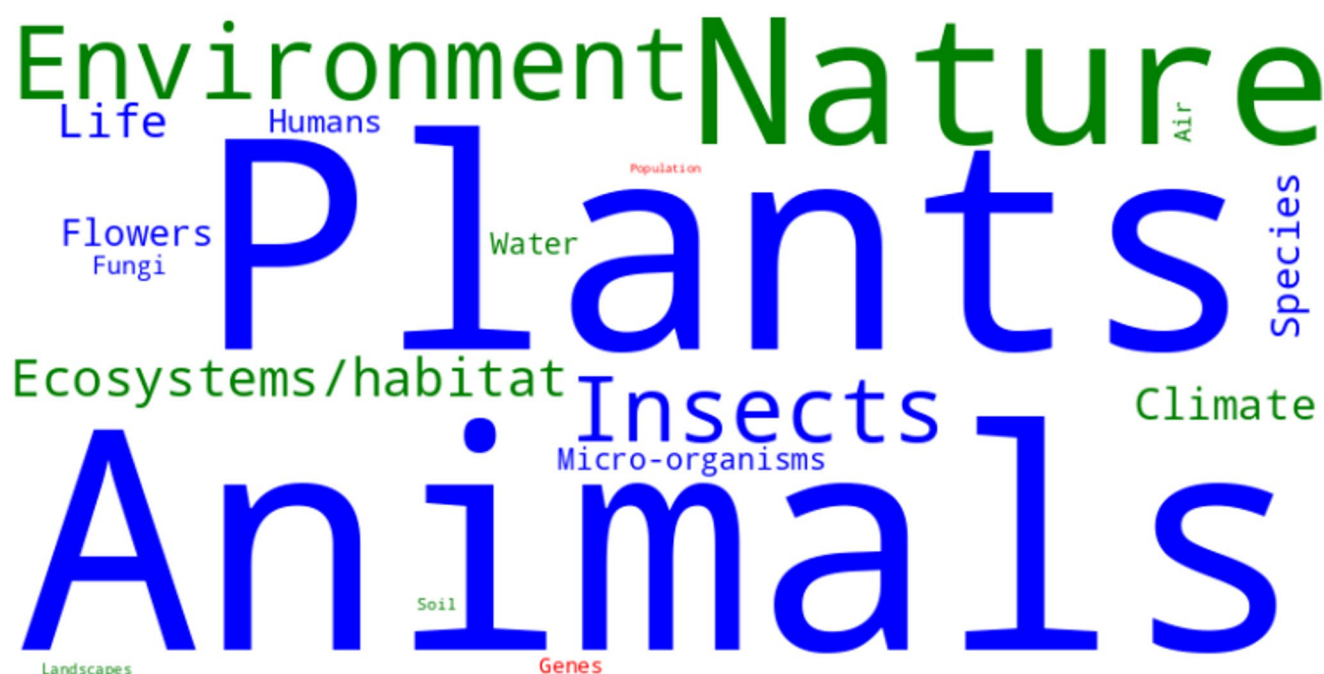


Fig. 1 Word Cloud based on prevalence of each sub-theme, colour-coded by level of biodiversity (green for ecosystems diversity, blue for species diversity and red for genetic diversity). This Word Cloud was

created using matplotlib (Hunter 2007) and word cloud library (Muel-ler 2020) within Google Colaboratory

No associations or too little knowledge

One of the aims of this study was to explore whether people were familiar with the concept of biodiversity. As the focus group participants had applied to participate in a two hour discussion on biodiversity, none of the participants stated that they were unfamiliar with the concept or that they had no associations or opinions on biodiversity, despite a few stating that it is a “vague” or “broad” term. However, 11.4% of the survey respondents stated that they had no associations with biodiversity, were not familiar with the term, or had too little knowledge to submit associations. This excludes participants who stated they had no associations, yet still submitted at least three other associations.

Diversity in relation to life and nature

The study additionally aimed to explore how people make sense of biodiversity as a scientific concept concerning the diversity of life and nature. The ‘diversity’ part of the concept was referred to by 30.4% of the survey participants, including mentions of differences, variation, richness, and/or quantity of life and nature. Regarding the ‘bio’ aspect of the definition, there was a broad spread of associations concerning life and nature. The various associations of life and nature were sorted in the three levels of biodiversity as determined by the CBD (2011): (I) diversity within and between ecosystems, including the abiotic components of

nature such as soil and climate, (II) diversity between species (and kingdoms), (III) genetic diversity within populations and species. For visual illustration of the relative prevalence of each sub-theme in the theme Life and Nature, we have created a Word Cloud (Fig. 1), with colours indicating the various levels of biodiversity (green for ecosystem diversity; blue for species diversity; red for genetic diversity).

It becomes clear that there is a prevalence of associations with biodiversity in relation to nature and environment (ecosystems level, mentioned by 43.0% of the participants) and flora and fauna (species level, mentioned by 46.0% of the participants), whereas associations regarding genetic diversity were only mentioned by a fraction of the participants (1.6%).

This was also a common theme during the focus group discussions, in which the full definition of biodiversity that includes the three levels raised questions amongst all four discussions.

FG3 participant: “[After hearing the definition of biodiversity] If I would have to come up with a description, I don’t think I would have thought of differences in ecosystems for example”.

Especially the inclusion of genetic diversity raised confusion, as participants were unfamiliar with the concept or even doubted whether it should be specified in the definition.

FG1 participant: "Well, I hadn't thought of the issue of genetic variation. If I read the first line of the definition [stating that it concerns diversity of all kinds of life], I still wouldn't think of that. I'm wondering, to what extent does this add something?"

FG3 participant: "Genetic variation, why did you include that in the definition?"

FG4 participant: "I am just wondering, genetic variation, is that within animal species, or? The rest [of the definition] is quite clear, only this point raises questions with me."

Concerning the species level, the associations referring to the animal and plant kingdoms were the most dominant amongst the survey associations, compared to fungi or micro-organisms. This was also the case in the focus groups, where most discussants talked about diversity of flora and fauna.

FG2 participant: "[I would define biodiversity as] the coexistence of a lot of different species of animals and plants that are all connected with each other, that are in some way dependent on each other. [After hearing the CBD definition of biodiversity] We didn't really mention micro-organisms [in our definition], but that is important as well of course."

FG4 participant: "[In response to someone mentioning fungi] That is exactly something I wouldn't have thought of."

FG1 participant: "[On the inclusion of fungi in the definition] You easily associate [biodiversity] with a panda that is facing extinction, and not necessarily with the rest".

This also highlights that even within the associations regarding flora and fauna, there are specific mentions of specific classes, species, or parts of organisms (e.g. flowers) that seem to characterize or symbolize biodiversity. For example, there is a prevalence of insects (especially bees) and humans, which might be explained by the role these are understood to play in impacting biodiversity (either positively or negatively).

Decline of nature and life

Of the survey participants, only 3.6% explicitly mentioned loss of nature and life (including deforestation and species extinction), in addition to 4.3% mentioning

general environmental degradation such as climate change or pollution.

This co-occurrence of biodiversity loss and environmental degradation was mentioned by focus group participants as well.

FG2 participant: "All these issues are in some way connected: because of climate change biodiversity declines. Because of it, animals and plants go extinct."

However, although the focus group discussants acknowledged biodiversity loss was a problem, it was regarded as less top-of-mind compared to issues such as climate change. Participants linked this to media coverage of both topics: whereas climate change was perceived as a 'hot topic' in the public debate, biodiversity loss was perceived to be covered less or merely mentioned as relevant in relation to climate change.

FG1 participant: "At the same time [biodiversity loss] is not a topic that keeps me up at night, although I am someone who tries to live environmentally conscious. [...] It's also the amount of media attention that sustainability and climate get compared to biodiversity: climate gets much more attention than biodiversity."

The value of biodiversity

The issue of decline and loss links to another aim of the study, namely to explore what values people attach to biodiversity. Next to the associations that pertained more to the definition of biodiversity and the decline of biodiversity, a wide spread of associations mentioned the importance and value of biodiversity.

As the focus groups were self-selected, none of the participants raised doubts about the existence of biodiversity loss or expressed other negative opinions about biodiversity. Within the survey sample, in contrast, 5.1% of participants expressed a negative opinion of biodiversity, including those who expressed they were uninterested, raised doubts whether loss of biodiversity is happening, thought it was an exaggerated or "hype" concept, or associated it with groups that were perceived as trying to use biodiversity loss for their own agenda (often pointing at "woke" or "left wing" politicians or groups in society).

In contrast, 9.6% of the survey participants explicitly stated that biodiversity is positive, important, necessary, and/or good. Furthermore, many of the associations contained implicit evaluations of the importance of biodiversity by referring to the role of biodiversity in creating a certain quality in nature and life (stated by 24.2% of survey participants). Biodiversity seems to be associated with a certain

balance in nature, as well as a natural resilience necessary for planetary health. Additionally, many associated biodiversity with the health and quality of nature and life, with associations stretching from “fresh air”, “clean nature”, “the wellbeing of anything and everything”, and biodiversity being “good for nature and animals”. Furthermore, the value of biodiversity was also implicitly mentioned by those stating that biodiversity, life and nature ought to be protected: 12.8% of the survey sample listed at least one association calling for biodiversity conservation, including pleas for no further harm, paying more attention to nature, leaving nature alone, protecting nature, and increasing the amount of biodiversity. In addition to this, the topic of sustainability in general was a frequently mentioned topic (13.7% of survey participants), both in relation to quality of nature (e.g. sustainability of the planet) or in relation to actions to prevent further environmental decline (e.g. sustainable behaviour).

The interdependency of nature and life and its importance was acknowledged and stressed by focus group discussants as well.

FG2 participant: “[For me, biodiversity means] the co-existence of a lot of different species of animals and plants that are all interwoven, in some way dependent on each other or something.”

FG2 participant: “It should have been preserved. Because biodiversity is generally important to maintain the food chains on earth. And without those food chains, there’s going to be a lot of problems in nature, which we’re also going to be affected by. For example, if one animal dies, all the other animals in the food chain above might die as well. And certain plants might proliferate, after which others might go extinct.”

Biodiversity and food production and consumption

Data collection was undertaken in the context of a study on biodiverse food production and consumption, therefore many associations were related to food (mentioned at least once by 36.9% of the survey sample). Agriculture and farming practices were often mentioned, in relation to both the negative consequences of farming (such as use of pesticides and monocultures), as well as farming practices that could protect or enhance biodiversity (such as nature-based or organic farming).

The relation between agriculture and farming was mentioned by the focus group discussants as well. Monocultures and deforestation for arable land were mentioned as causes of biodiversity loss, however, farmers were also seen as

those caring and harbouring biodiversity for the provision of food.

FG4 participant: “[Agriculture] can have both positive and negative impacts. For example, there are some farmers who are doing very well-or at least, for biodiversity - and others less well. [...] Those are farmers who are organic, which increases the [biodiversity]. There are some farmers who deliberately set their mowing routes and deal with the birds. Thereby protecting meadow birds. And there are farmers who just, what you said earlier [referring to monocultures], have miles and miles of the same plants and big machines and they just go on.”

FG3 participant: “I think, [farmers] naturally, traditionally have an important role in providing food from nature, from a natural origin, nature which also feeds us literally and figuratively as humans. And now farming on itself is under pressure. The whole chain of food supply from the farmer to the consumer is very different from, say, 50 years ago. I think this also has a great effect on biodiversity and how we relate, or do not relate, to it.”

Additionally, within this theme, many survey participants referred to various food qualities that they associated with biodiversity in general, such as healthy or sustainably produced food. Notably, many of these associations focus on principles of organic food production, such as the lack of pesticides or artificial fertilizers, better care for nature and animals, and a fair compensation for the farmer (for an extensive overview of sub-themes relating to food qualities, see the Coding Tree in Appendix).

Within the focus group discussions, organic food production was often mentioned as well when talking about biodiverse food production, some even going as far as to see the two as synonyms (note: in Dutch the word for organic is ‘biologisch’, similar to ‘biodiversiteit’, the Dutch word for biodiversity).

FG1 participant: “I would just label [biodiverse food] as organic. It’s already often associated with organic food. No pesticides, good for nature, ties in nicely with that.”

In the same line, focus group participants mentioned that their way of contributing to biodiversity would be through purchase of organic food and they mention the various ways that organic or nature-inclusive farming could enhance biodiversity.

FG3 participant: "I think in the case of organic or bio-dynamic, these are ways of food production that are concerning themselves with this: that don't use pesticides and things like that. In that sense, that has a positive impact. I think, if people would buy those more, then that will have a great influence."

Other aspects, such as food security, accessibility and nutritional values, were also mentioned by the focus group participants, as they argued that biodiversity was the source of all food and was crucial for a healthy, nutritious diet.

FG2 participant: "Everything is becoming more and more uniform. And biodiversity does make sure that you have everything for health, different kinds of dishes, I don't know, minerals, everything."

FG4: "All our food comes from the earth, and everything connected to that is related to biodiversity."

Discussion

Reflections on mental representations of biodiversity

In recent years, policy-makers and scientists have argued that in order to engage the public more in conservation efforts, including biodiverse agricultural practices, effective communication should understand and match the language, expertise, and frame of reference of their audience (IPBES, 2024; Geschke et al. 2023). Using associations derived through a word association technique and elaborate focus group discussions, the current study explored how Dutch people make sense of a novel and complex scientific term such as biodiversity. Arabatzis (2019) argued that scientific concepts are public representations of objects, rather than hidden psychological entities, and that they cannot be divorced from the practices of their employment. Sense-making therefore happens in the context of daily life and is socially influenced. At the same time, the way people conceptualize the world influences their behaviour, in turn shaping society.

The current study highlights this, as it indicates that people make sense of concepts by relating them to their everyday world. This might explain why the associations centred around the most recognizable and tangible level of diversity, species diversity, and less on higher levels such as ecosystems, or on lower levels such as genetic variability. At the species level, it is also much more focused on diversity between flora and fauna, and less on other kingdoms such

as fungi and micro-organisms. Moreover, certain groups of animals, such as insects, or parts of organisms, such as flowers, were even more frequently associated with biodiversity than entire kingdoms.

Brunet et al. (2020) already argued that the various conceptualizations and operationalizations of biodiversity within conservation discourse might have societal implications as well, as they could impact what type of nature was valued and worthy of conservation. The prevalence of species diversity as shown in the current study might therefore be explained by the fact that species diversity has been a well-established aspect of biodiversity, compared to, for example, ecosystems diversity (Ferrier and Larson 2012). Heink and Jax (2014) already hypothesized that species diversity would mainly dominate mental representations of biodiversity, as this has often been the main unit of analysis for research and policy on biodiversity and conservation. Heink and Kowarik (2010) found that the majority of papers that make use of biodiversity indicators use species richness as a measure for biodiversity. Moreover, the focus on animals and plants might be explained by the common use of the 'flagship species' approach in biodiversity and conservation communication (Jepson and Barua 2015), in which conservationists have tried to appeal to broader publics by communicating about charismatic or well-known (parts of) species such as pandas, bees or flowers (Swingland 2013).

Furthermore, the focus group discussions point out that genetic diversity was a particularly difficult concept to grasp, and doubts were even raised whether this should be included in the definition of biodiversity at all. This is in line with previous research on public understanding of genomics, which has shown that people tend to associate the term with genetic modification technologies (Boersma et al. 2019). Given that genetic diversity is seen as an important marker of biodiversity in both scientific discourse (Jetzkowitz et al., 2018; Richardson et al. 2023) and conservation discourse (e.g. CBD, 2011) the results of the current study signal that this emphasis in science and policy debates on genetic diversity might not be interpreted by some as relating to biodiversity. Further efforts should therefore explore how this aspect of biodiversity could be better integrated in biodiversity conservation communication.

Reflections on valuations of biodiversity

In order to come to more inclusive policies for biodiversity conservation, it is also important to acknowledge the pluralistic valuation of nature that exists in society (Pascual et al. 2021; IPBES 2022). In line with Fischer and Young (2007), Buijs et al. (2008) and Runhaar et al. (2019), the current study shows that perceptions of biodiversity among Dutch people include appreciation of biodiversity as well,

both in terms of its value to nature as well as to society. Whilst it is difficult to pigeonhole the different values people have around biodiversity based upon the associations alone, the findings show that people appreciate biodiversity for its intrinsic value (e.g. biodiversity being important for nature's wellbeing) and instrumental value (e.g. biodiversity being important for food production), whilst relational values around human-nature connections were also mentioned (e.g. whether or not people should interfere with nature to protect it).

Next to these positive valuations, however, our study showed that negative valuations around biodiversity exist as well, with people stating biodiversity was exaggerated or pushed too much by certain actors (5.1%). This biodiversity scepticism seems to point towards what Oostvogels et al. (2024) would call negative relational values with biodiversity: conflicting views between humans is shaping how people view and value nature. The scepticism might stem from societal debates about science and science-based policy making, with certain groups displaying low levels of trust in science (Cologna et al. 2025). It suggests that biodiversity discourse that is exclusively framed through scientific conceptualizations and valuations may inadvertently alienate certain publics. This might have implications for biodiversity efforts as well: if people experience it as being too pushed or top-down, it will be more difficult to engage them in conservation efforts. Similar to how the debate around climate change has been influenced by climate sceptics and the contestation of scientific knowledge (potentially steering the debate away from coming to effective climate policy) (Bekkers et al. 2018; Dunlap and McCright 2008; Koninklijke Nederlandse Akademie and van Wetenschappen 2011), the issue of biodiversity might also be at risk of becoming a polarized, politicized issue. Further research is therefore necessary to explore the extent of biodiversity scepticism, its sources, and its consequences for conservation efforts.

Furthermore, whilst familiarity with biodiversity was not as low as shown in other studies (Turner-Erfort 1997; European Commission 2019), 11.4% of survey participants expressed to have no associations or no knowledge of biodiversity, with focus group participants acknowledging that the topic was not very salient for them either, compared to other issues such as climate change. This difference in familiarity and awareness might be explained by the degree of media attention paid to biodiversity loss compared to other issues such as climate change (Geschke et al. 2023). Legagneux et al. (2018), for example, demonstrated that biodiversity loss attracted up to eight times less media coverage than climate change between 1992 and 2016. They hypothesize that this might be the reason why the issue is not reaching broader publics effectively, potentially impeding on support

for more biodiversity conservation or enhancement efforts. As the media plays an important role in providing people with information and setting public agendas (McCombs 2005; McCombs & Shaw, 1972), further research on how the media frames biodiversity and how this influences people's perception of biodiversity loss as a societal challenge is warranted.

Reflections on biodiversity in the context of food production and consumption

Seeing as sensemaking happens in the context of daily life and familiar practices, it might also explain why organic production and consumption was often associated with biodiversity. This is one of the biodiverse practices that is currently (somewhat) readily available to Dutch consumers, whereas other practices such as agroforestry are still limited in availability and accessibility. Some focus group participants even treated biodiverse food production and consumption as equal to organic food production and consumption, viewing it as the best and easiest way to contribute to biodiversity as an individual. This association with organic shows how people envision a 'biodiverse' food system, but also presents challenges: organic production and consumption patterns in the Netherlands have lagged behind that of the EU average (e.g. in 2017, organic crop cultivation accounted for 7.0% of the total agricultural area in the European Union, compared to 3.1% in the Netherlands, Statistics Netherlands 2019). In addition, conflating biodiverse food production with organic food production might limit perspectives on biodiversity-enhancing efforts, as agricultural conservation practices extend beyond organic agriculture and farmers who engage in such practices already feel their efforts are not recognized sufficiently (Runhaar 2017). It is therefore important that the distinction between the two concepts is maintained sufficiently, whilst preserving the understanding of the two-way connection between agricultural practices and biodiversity.

Methodological limitations

This study introduces an interpretative approach to explore public mental representations based on associations, which brings with it several limitations that ought to be reflected on. First of all, associations are one way to access mental representations, however, it does not give a complete mental representation and is based on one moment of elicitation. For example, if participants would have been given the chance to give unlimited associations (which we did not opt for due to the survey sample size), genetic variation might have been mentioned eventually. Nevertheless, we assume that those associations that were listed give an impression of

the most dominant elements of mental representations, with the focus group discussions allowing for more elaboration and comparison of broad themes.

Second, we aimed to explore the diversity of perceptions that existed within Dutch society, in response to concerns about low 'public' understanding. However, next to the ontological debate around the notion of 'public' (which assumes that there this is a singular entity, thereby overlooking the heterogeneity of both individuals that constitute it and the communities that exist within society), we need to acknowledge that the panel samples of both the survey and the focus groups are not representative of the Dutch population, with especially the level of education being higher than average and potentially also more environmentally inclined (as both samples volunteered to take part in a study on biodiversity). However, compared to previous studies (e.g. Buijs et al. 2008; Fischer and Young 2007), this study made use of a larger and more heterogeneous sample and therefore was already able to show an increased diversity of perceptions (e.g. the negative relational values around biodiversity).

Lastly, data was collected as part of a larger project on biodiversity and food production, which might explain the prevalence of food-oriented associations. Although efforts were taken to ensure that participants were not steered too much in the direction of food production and consumption, we cannot exclude that they had been prompted nonetheless. Future studies should explore whether food production and consumption is also associated with biodiversity when unprompted.

Conclusion

A transition to more sustainable, biodiverse and resilient food systems entails a societal transition as well. As Mommer et al. (2022) stated: "Broadening decision making to reflect the diverse ways people interact with and value food

and nature is critical to food systems transformations". The current study has contributed to this objective by exploring the diversity of mental representations around biodiversity that exists among Dutch people. Based on associations around biodiversity collected as part of a survey and focus group discussions, the findings show that, contrary to previous concerns, there is a general understanding that biodiversity refers to the diversity of life and nature. However, understanding might not always reflect the complexity and multifaceted nature of biodiversity as it is conceptualized in scientific or policy discourses (in part maybe also because these discourses themselves debate this complexity). It further demonstrates that the intrinsic and instrumental values of biodiversity are appreciated, whilst some associate biodiversity with negative relational values that exist within society. Lastly, associations referred to the relationship between biodiversity and food production (with biodiversity being seen necessary for healthy and sustainable food production, whilst food production being seen as a driver of biodiversity loss), with especially organic production principles being associated as one way for restoring this relationship.

The findings of this study have implications for policy-making and communication around biodiversity and conservation, also beyond the context of food production. The study shows that especially the tangible, observable and familiar aspects of biodiversity are most easily understood, whereas more abstract notions of biodiversity require additional explanation and attention. Furthermore, it underlines the need for communication and policy-making on biodiversity that acknowledges the expertise and frames of reference that exist beyond the academic and policy spheres: in particular, as not doing so might further increase negative relational values present within society. By incorporating the diversity of mental representations and valuations that exist in society, we may come to more effective and deliberative engagement for biodiversity conservation.

Appendix

Coding tree

No associations with biodiversity

Theme	Explanation	Sub-theme	Example	Mentioned by # of participants	Mentioned by % of participants
No knowledge or no associations	Participants that stated that they had no knowledge, to little knowledge, or no associations related to biodiversity. Does not include participants who stated they had no idea, but still submitted at least three associations.	/	"geen idee", "geen mening", "ik weet niet"	225	11.4%

Diversity of life and nature

Theme	Explanation	Sub-theme	Example	Mentioned by # of participants	Mentioned by % of participants
<i>Diversity</i>					
Diversity	The richness, variation, differences, and/or quantity of life and nature	/	“rijkdom”, “variatie”, “verschillen”, “hoeveelheid”, “aantal”	600	30.4%
<i>Life and nature (sorted by levels of biodiversity)</i>					
Ecosystem level	Biodiversity within and between ecosystems, habitats and communities. Includes the abiotic components that make up ecosystems	Ecosystems/habitat	“ecosysteem”, “habitat”, “leefomgeving”	181	9.2%
		Earth	“aarde”, “wereld”, “planeet”	86	4.4%
		Nature	“natuur”	460	23.3%
		Environment	“milieu”	265	13.4%
		Landscapes	“landschap”	11	0.6%
		Climate	“klimaat”, “weer”	123	6.2%
		Air	“lucht”, “zuurstof”	28	1.4%
		Water	“water”, “oceanen”	52	2.6%
		Soil	“bodem”, “grond”	14	0.7%
<i>Theme mentioned at least once by a participant</i>				848	43.0%
Species	Biodiversity of species and life on earth	Life	“leven”, “organismen” “levensvormen”	149	7.6%
		Species	“soorten”	109	5.5%
		Animals	“dieren”, “fauna”	620	31.5%
		- Humans	“mensen”	64	3.2%
		- Insects	“insecten”, “bijen”, “vlinders”	194	9.8%
		Plants	“planten”, “flora”	565	28.7%
		- Flowers	“bloemen”	90	4.6%
		Fungi	“schimmels” “paddestoelen”, “zwammen”	33	1.7%
		Micro-organisms	“micro-organismen”, “bacteriën”, “een-celligen”	55	2.8%
		Keystone species	“wild”, “inheems”, “exoten”	47	2.4%
<i>Theme mentioned at least once by a participant</i>				906	46.0%
Genetic	Variation within and between populations of organisms	Genes	“genen”, “rassen” “cultivars”	26	1.3%
		Population	“populatie”	6	0.3%
<i>Theme mentioned at least once by a participant</i>				31	1.6%

Decline of nature and life

Theme	Sub-theme	Explanation	Example	Mentioned by # of participants	Mentioned by % of participants
Biodiversity loss and environmental degradation	Biodiversity loss	Associations that refer to decline of diversity	“achteruitgang”, “afname”, “uitsterven”, “minder soorten”	72	3.7%
	Environmental degradation	Associations that refer to decline of nature or causes of decline of nature	“klimaatverandering”, “CO2-uitstoot”, “stikstof”, “milieuvervuiling”	84	4.3%
<i>Theme mentioned at least once by a participant</i>				142	7.2%

Negative opinion or denial of biodiversity loss

Theme	Sub-theme	Explanation	Example	Mentioned by # of participants	Mentioned by % of participants
Negative opinion or denial of biodiversity loss	Not interested or not important	Participants that state that the topic does not interest them or is not important	"geen interesse", "niet boeiend"	18	0.9%
	Denial/hype/exaggerated	Participants that state that biodiversity does not exist, is a hype, or that biodiversity loss is exaggerated	"onzin", "overdreven", "hype",	63	3.2%
	Biodiversity agenda	Associations that refer to biodiversity being used by certain groups	"commercieel begrip", "drammerig", "linkse agenda"	55	2.8%
<i>Theme mentioned at least once by a participant</i>				100	5.1%

Value of biodiversity

Theme	Sub-theme	Explanation	Example	Mentioned by # of participants	Mentioned by % of participants
Biodiversity is important	/	Participants that state that biodiversity is important or good	"belangrijk", "relevant", "goed", "mooi"	190	9.6%
Biodiversity is important for nature	Balance	Associations that refer biodiversity in relation to a balance in nature	"Balans", "natuurlijk evenwicht"	86	4.3%
	Resilience	Associations that refer to biodiversity in relation to resilience and the future of the planet	"voortbestaan", "de toekomst"	56	2.8%
	Quality of nature and life	Associations that refer to the wellbeing and quality of nature and life	"gezondheid van alles", "welzijn", "leefbaarheid", "frisse lucht", "schone natuur", "goed voor dieren", "goed voor de natuur"	399	20.2%
<i>Theme 'Function of biodiversity' mentioned at least once by a participant</i>				476	24.2%
Conservation	No further harm	Associations that refer to preventing further damage to nature and biodiversity	"minder uitstoot", "geen schade toebrengen", "geen vervuiling"	48	2.4%
	Leave nature alone	Associations that refer to not interfering with nature in order to protect it	"minder menselijk ingrijpen", "natuur zijn gang laten gaan", "natuur zonder bemoeienis van de mens"	28	1.4%
	Protecting biodiversity	Associations that refer to protection of nature and biodiversity	"beschermen", "behouden", "beheren"	79	4.0%
	Paying more attention/increased awareness	Associations that call for more attention or awareness of nature and biodiversity	"zorgen voor het milieu", "milieubewustzijn", "meer aandacht", "denken aan de natuur"	69	3.5%
	Increasing biodiversity	Associations that call for the improvement and enhancement of nature and biodiversity	"bevorderen", "meer bomen", "ontregelen", "meer variatie in natuur"	72	3.7%
<i>Theme 'Conservation' mentioned at least once by a participant</i>				252	12.8%
Sustainability	/	Any association that referred to sustainability or sustainable behaviour	"duurzaamheid", "duurzaam", "duurzame productie"	270	13.7%

Food production and consumption

Theme	Sub-theme	Explanation	Example	Mentioned by # of participants	Mentioned by % of participants
Food production and consumption	Sustainable food	Associations that refer to nature-inclusive or sustainable food (production)	“duurzaam”*, “milieubewust”*, “natuur-inclusief boeren”	193	9.8%
	Healthy food	Associations that refer to healthy food	“gezond”*, “goed voor de mens”*	196	9.9%
	Organic food	Associations that refer to organic food (production)	“biologisch”*, “biologisch geteeld”, “biologische producten	168	8.5%
	Animal-welfare and plant-based	Associations that refer to plant-based or animal friendly food (production)	“diervriendelijk”*, “dierenwelzijn”, “meer ruimte voor dieren”, “plantar dig”, “vegetarisch”	132	6.7%
	Natural food	Associations that refer to natural food	“natuurlijk”*, “natuurlijk geproduceerd”	119	6.0%
	Price	Associations that refer to the price of food*	“duur”, “goedkoop”, “betaalbaar”	116	5.9%
	Pesticide-free food	Associations that refer to pesticide or insecticidefree food (production)	“onbespoten”, “geen pesticiden”, “geen insecticiden”, “geen gewasbeschermingsmiddelen”, “vrij van gif”	113	5.7%
	Locally sourced food	Associations that refer to local food (production)	“Lokaal”, “streekgebonden”, “bekende herkomst”	87	4.4%
	Taste	Associations that refer to taste of food	“lekker”, “smaakvol”	86	4.4%
	Diversity in food production	Associations that refer to diversity in food (production)	“geen monocultuur”, “verschillende gewassen”, “pluktuinen”	75	3.8%
	Fair	Associations that refer to fair food (production)	“fairtrade”, “eerlijk”, “eerlijke prijs voor de boer”	70	3.6%
	Safe and trustworthy	Associations that refer to safe or trustworthy food (production)	“veilig”, “betrouwbaar”	37	1.9%
	Seasonal	Associations that refer to seasonal food (production)	“seizoensgebonden”, “met het seizoen eten”	27	1.4%
<i>Theme ‘Food production and consumption’ mentioned at least once by a participant</i>				728	36.9%

*if at least three of the associations also referred to food qualities

Acknowledgements This work was published in the context of the strategic investment theme ‘Biodiversity-positive Food Systems’ of Wageningen University and Research’. The Authors would like to thank Anke Janssen, Rene de Wijk, Liesje Mommer, Anne Loos and Denise J. Roth for their helpful suggestions and proofreading the article.

Author contributions J.S. designed the study, collected the data, coordinated the analysis and took the lead in writing the manuscript. J.H., J.V., and P.M.P. contributed to data analysis and interpretation of the results, and provided critical feedback on the research and manuscript.

Funding The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: funding was received from the strategic investment theme ‘Biodiversity-positive Food Systems’ of Wageningen University and Research’.

Data availability Data will be made available upon request.

Declarations

Ethical approval Informed consent was obtained from all individual participants included in the study. WUR Research Ethics Committee for review of non-medical studies (WUR-REC) reviewed the studies reported on in this paper and deemed the studies to be at minimal risk to participants.

Conflicting interests The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Arabatzi, T. 2019. What are scientific concepts? In *What is scientific knowledge?*, Routledge.
- Barone, B., H. Rodrigues, R. M. Nogueira, K. R. L. S. L. de Guimarães Q., and J. H. Behrens. 2020. What about sustainability? Understanding consumers’ conceptual representations through

- free word association. *International Journal of Consumer Studies* 44(1):44–52. <https://doi.org/10.1111/ijcs.12543>
- Bekkers, V., A. V. Buuren, A. Edwards, and M. Fenger. 2018. *Contested knowledge in Dutch climate change policy*. <https://doi.org/10.1332/174426417X14996732347757>
- Benton, T. G., C. Bieg, H. Harwatt, R. Pudasaini, and L. Wellesley. 2021. *Food system impacts on biodiversity loss*. https://www.chathamhouse.org/sites/default/files/2021-02-03-food-system-biodiversity-loss-benton-et-al_0.pdf
- Boersma, R., P. M. Poortvliet, and B. Gremmen. 2019. The elephant in the room: How a technology's name affects its interpretation. *Public Understanding of Science* 28(2):218–233. <https://doi.org/10.1177/0963662518812295>
- Brunet, N. D., D. Dagenais, S. Breux, and I. T. Handa. 2020. A characterization of media representation of biodiversity and implications for public perceptions and environmental policy: The case of québec, Canada. *Environment Development and Sustainability* 22(2):1655–1669. <https://doi.org/10.1007/s10668-018-0244-6>
- Buijs, A. E., Fischer, Anke, Rink, Dieter, and J. C. Young. 2008. Looking beyond superficial knowledge gaps: Understanding public representations of biodiversity. *International Journal of Biodiversity Science & Management*, 4(2), 65–80. <https://doi.org/10.3843/Biodiv.4.2.1>
- Cologna, V., N. G. Mede, S. Berger, J. Besley, C. Brick, M. Joubert, E. W. Maibach, S. Mihelj, N. Oreskes, M. S. Schäfer, S. van der Linden, Abdul Aziz, N. I. Abdulsalam, S. Shamsi, N. A. Acel, B. Adinugroho, I. Alabrese, E. Aldoh, A. Alfano, and M. Zwaan, R. A. 2025. Trust in scientists and their role in society across 68 countries. *Nature Human Behaviour* 9(4):713–730. <https://doi.org/10.1038/s41562-024-02090-5>
- Convention on Biological Diversity. 2011. <https://www.cbd.int/doc/legal/cbd-en.pdf>
- Convention on Biological Diversity (Red.). 2000. *Sustaining life on earth: How the convention on biological diversity promotes nature and human well-being*. Secretariat of the Convention on Biological Diversity.
- DeLong, D. C. 1996. Defining Biodiversity. *Wildlife Society Bulletin (1973–2006)*, 24(4), 738–749.
- Deltaplan Biodiversiteitsherstel. 2019. *Het Deltaplan Biodiversiteitsherstel samengevat*. <https://www.samenvoorbiodiversiteit.nl/pdf/Deltaplan-Biodiversiteitsherstel-samengevat.pdf>
- Doherty, S., and R. Nelson. 2010. Using projective techniques to tap into consumers' feelings, perceptions and attitudes. Getting an honest opinion. *International Journal of Consumer Studies* 34(4):400–404. <https://doi.org/10.1111/j.1470-6431.2010.00880.x>
- Dunlap, R. E., and A. M. McCright. 2008. A widening gap: Republican and Democratic views on climate change. *Environment: Science and Policy for Sustainable Development* 50(5):26–35. <https://doi.org/10.3200/ENVT.50.5.26-35>
- Duru, M., O. Therond, G. Martin, R. Martin-Clouaire, M.-A. Magne, E. Justes, E.-P. Journet, J.-N. Aubertot, S. Savary, J.-E. Bergez, and J. P. Sarthou. 2015. How to implement biodiversity-based agriculture to enhance ecosystem services: A review. *Agronomy for Sustainable Development* 35(4):1259–1281. <https://doi.org/10.1007/s13593-015-0306-1>
- European Commission. 2020. A Farm to Fork Strategy for a Fair, Healthy and Environmentally-Friendly Food System (2020). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0381>
- European Commission. 2019. *Attitudes of Europeans towards biodiversity*. Publications Office <https://data.europa.eu/doi/10.2779/456395>
- European Environment Agency, and Ecologic Institute. Muséum National d'Histoire Naturelle., BirdLife International., & Stichting BirdLife Europe. (2015). *State of nature in the EU: Results from reporting under the nature directives 2007–2012*. Publications Office. <https://doi.org/10.2800/603862>
- FAO. 2019. *The state of the world's biodiversity for food and agriculture*. FAO Commission on Genetic Resources for Food and Agriculture. <https://doi.org/10.4060/CA3129EN>
- Ferrier, E. A., and B. M. H. Larson. 2012. *Biodiversity and Conservation Framing in Canada*.
- Fischer, A., and J. C. Young. 2007. Understanding mental constructs of biodiversity: Implications for biodiversity management and conservation. *Biological Conservation* 136(2):271–282. <https://doi.org/10.1016/j.biocon.2006.11.024>
- Flick, U., E. von Kardoff, and I. Steinke. 2004. *A companion to qualitative research*. SAGE.
- Geschke, J., M. C. Rillig, K. Böhning-Gaese, T. Potthast, A. Arth, L. V. Dicks, F. Habekuss, D. Kleinschmit, H. Lesch, E. M. Spehn, S. Wenzel, M. Fischer, and A.-M. Klein. 2023. Science journalism and a multi-directional science-policy-society dialogue are needed to foster public awareness for biodiversity and its conservation. *PLOS Sustainability and Transformation* 2(10):e0000083. <https://doi.org/10.1371/journal.pstr.0000083>
- Haws, K. L., K. P. Winterich, and R. W. Naylor. 2014. Seeing the world through GREEN-tinted glasses: Green consumption values and responses to environmentally friendly products. *Journal of Consumer Psychology* 24(3):336–354. <https://doi.org/10.1016/j.jcps.2013.11.002>
- Heink, U., and K. Jax. 2014. Framing biodiversity: The case of 'invasive alien species'. In *Concepts and values in biodiversity*, ed. D. Lanzerath, and M. Friele. 73–98. Routledge.
- Heink, U., and I. Kowarik. 2010. What criteria should be used to select biodiversity indicators? *Biodiversity and Conservation* 19(13):3769–3797. <https://doi.org/10.1007/s10531-010-9926-6>
- Hunter, J. D. 2007. Matplotlib: A 2D graphics environment. *Computing in Science & Engineering* 9(3):90–95. <https://doi.org/10.1109/MCSE.2007.55>
- IPBES. 2022. *Summary for policymakers of the methodological assessment of the diverse values and valuation of nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)*. Zenodo. <https://doi.org/10.5281/zenodo.7410287>
- IPBES. 2019. *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Zenodo. <https://doi.org/10.5281/zenodo.6417333>
- IPBES, K. O'Brien, L. Garibaldi, A. Agrawal, E. Bennett, O. Biggs, R. Calderón Contreras, E. R. Carr, N. Frantzeskaki, H. Gosnell, J. Gurung, S. A. Lambertucci, J. Leventon, L. Chuan, Reyes García, V. Shannon, L. Villasante, S. Wickson, F. Zinngrebe, Y., and L. Périanin. 2024. *IPBES Transformative Change Assessment: Summary for Policymakers*. Zenodo. <https://doi.org/10.5281/zenodo.14513975>
- Jepson, P., and M. Barua. 2015. A theory of flagship species action. *Conservation and Society* 13(1):95. <https://doi.org/10.4103/0972-4923.161228>
- Jetzkowitz, J., C. S. A. Van Koppen (Kris), R. Lidskog, K. Ott, L. Voget-Kleschin, and C. M. L. Wong. eds. 2018. The significance of meaning. Why IPBES needs the social sciences and humanities. *Innovation: The European Journal of Social Science Research*, 31(sup1), S38–S60. <https://doi.org/10.1080/13511610.2017.1348933>
- Klebl, F., P. H. Feindt, and A. Pierr. 2024. Farmers' behavioural determinants of on-farm biodiversity management in europe: A systematic review. *Agriculture and Human Values* 41(2):831–861. <https://doi.org/10.1007/s10460-023-10505-8>
- Koninklijke Nederlandse Akademie, and G. van Wetenschappen. 2011. *Klimaatverandering, wetenschap en debat*.

- Lanzerath, D., and M. B. Friele (Eds.). eds. 2014. *Concepts and values in biodiversity*. Routledge/Taylor & Francis Group.
- Leader, A., J. Kinsella, and R. O'Brien. 2024. Making sense of farmland biodiversity management: An evaluation of a farmland biodiversity management communication strategy with farmers. *Agriculture and Human Values*. <https://doi.org/10.1007/s10460-024-10573-4>
- Legagneux, P., N. Casajus, K. Cazelles, C. Chevallier, M. Chevrin, L. Guéry, C. Jacquet, M. Jaffré, M.-J. Naud, F. Noisette, P. Ropars, S. Vissault, P. Archambault, J. Bêty, D. Berteaux, and D. Gravel. 2018. Our House Is Burning: Discrepancy in Climate Change vs. Biodiversity Coverage in the Media as Compared to Scientific Literature. *Frontiers in Ecology and Evolution*, 5. <https://doi.org/10.3389/fevo.2017.00175>
- McCombs, M. 2005. A look at Agenda-setting: Past, present and future. *Journalism Studies* 6(4):543–557. <https://doi.org/10.1080/14616700500250438>
- McCombs, M. E., and D. L. Shaw. 1972. The Agenda-Setting Function of Mass Media. *The Public Opinion Quarterly* 36(2):176–187. <https://doi.org/10.1086/267990>
- Meier, C., and B. Oehen. 2019. Consumers' valuation of farmers' varieties for food system diversity. *Sustainability* 11(24). Article 24. <https://doi.org/10.3390/su11247134>
- Mommer, L., PE&RC, Nature Conservation, and Plant Ecology. 2022. Programme team ESG, Farming Systems Ecology, KB Programme leaders, LEI Green Economy and Landuse, WASS, Environmental Economics and Natural Resources Group, Alterra - Biodiversity and policy, Public Administration and Policy, LR - Management, WIAS, Public Affairs, Environmental Policy, WIMEK, Alterra - Climate change and adaptive land and water management, LEI International Policy, Fresh, Food & Chains, CVC Impact for society, ... De Wit, M. *Nature-positive futures: Food systems as a catalyst for change*. Wageningen University & Research. <https://doi.org/10.18174/574286>
- Morel, K., E. Revoyron, M. S. Cristobal, and P. V. Baret. 2020. Innovating within or outside dominant food systems? Different challenges for contrasting crop diversification strategies in Europe. *PLOS ONE* 15(3):e0229910. <https://doi.org/10.1371/journal.pone.0229910>
- Mueller, Andreas. 2020. WordCloud for Python documentation—Wordcloud 1.8.1 documentation. Geraadpleegd 31 oktober 2024, van https://amueller.github.io/word_cloud/
- Oostvogels, V. J., B. Dumont, H. J. Nijland, I. J. M. de Boer, and R. Ripoll-Bosch. 2024. What about the negatives? An integrated framework for revealing diverse values of nature and its conservation. *People and Nature* 6(6):2633–2646. <https://doi.org/10.1002/pan3.10750>
- Pascual, U., W. M. Adams, S. Díaz, S. Lele, G. M. Mace, and E. Turnhout. 2021. Biodiversity and the challenge of pluralism. *Nature Sustainability* 4(7):567–572. <https://doi.org/10.1038/s41893-021-00694-7>
- Richardson, K., W. Steffen, W. Lucht, J. Bendtsen, S. E. Cornell, J. F. Donges, M. Drüke, I. Fetzer, G. Bala, W. von Bloh, G. Feulner, S. Fiedler, D. Gerten, T. Gleeson, M. Hofmann, W. Huiskamp, M. Kumm, C. Mohan, D. Nogués-Bravo, ..., and J. Rockström. 2023. Earth beyond six of nine planetary boundaries. *Science Advances* 9(37):eadh2458. <https://doi.org/10.1126/sciadv.adh2458>
- Runhaar, H. 2017. Governing the transformation towards 'nature-inclusive' agriculture: Insights from the Netherlands. *International Journal of Agricultural Sustainability* 15(4):340–349. <https://doi.org/10.1080/14735903.2017.1312096>
- Runhaar, H., A. Buijs, and P. Runhaar. 2019. What explains citizens' valuations of and attitudes towards agricultural biodiversity? Results of an exploratory survey of Dutch students. *NJAS - Wageningen Journal of Life Sciences* 89:100303. <https://doi.org/10.1016/j.njas.2019.100303>
- Statistics Netherlands. 2019. *The Netherlands on the European scale*. <https://longreads.cbs.nl/european-scale-2019/>
- Statistics Netherlands. 2025. *Landbouw; gewassen, dieren en grondgebruik naar regio* [Webpagina]. Centraal Bureau voor de Statistiek. <https://www.cbs.nl/nl-nl/cijfers/detail/80780ned>
- Statistics Netherlands. 2024. *StatLine: Bevolking; Hoogstbehaald Onderwijsniveau En Onderwijsrichting*. Den Haag / Heerlen: CBS.
- Swingland, I. 2013. Biodiversity, Definition of. In *Encyclopedia of Biodiversity: Second Edition* (pp. 399–410). <https://doi.org/10.1016/B978-0-12-384719-5.00009-5>
- Turner-Erfort, G. 1997. *Public Awareness and Perceptions of Biodiversity*.
- Weber, E. U., and P. C. Stern. 2011. Public Understanding of climate change in the united States. *American Psychologist* 66(4):315–328. <https://doi.org/10.1037/a0023253>
- WWF. 2024. Solving the great food puzzle: Place-based solutions to help scale national action (B. Loken & P. Loring, Eds.). WWF. <https://www.wwf.nl/globalassets/pdf/rapporten/solving-the-great-food-puzzle.pdf>

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.