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Sustainability beyond the triple bottom line: evaluating transformative change in food systems

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The concept of 'sustainability' has developed into a rich discourse concerned with diverse human responsibilities in our economic life, and as such it is in constant danger of over-simplification. The conventional two-way analysis of sustainability, into (1) human needs as ends and (2) means to meet such needs, and the scheme of nine planetary boundaries, are taken as starting points for a more balanced proposal set out in this conceptual paper. Inspired by the framework of Doughnut Economics and drawing on a collection of recent articles in this journal, we identify a set of 12 aspects for evaluating transformative change and apply them to food systems: seven typically instrumental goods (means) and five typically final goods (ends). Recognising that such classifications are worldview-dependent, however, our 'home model' breaks down the 12 aspects into 37 criteria as the basis for a practical tool for evaluating particular business models and policy initiatives. The paper concludes by offering a philosophical account of transformative change and identifying institutional factors crucial for local progress towards sustainability transitions, in food systems and also more broadly.

KEYWORDS

environment, welfare, social, economic, harmony, justice, care, values

1 Introduction

Historically, growth in world population has mostly been exceeded by growth in global food production. The twentieth century saw particularly rapid increases in food production facilitated by developing sciences and technologies (Federico, 2005, p. 1), and in the present century, the prevalence of hunger in the world has largely continued to decrease (Food and Agriculture Organisation, 2023, p. 34). However, this has come at the expense of an increasing environmental footprint. Agriculture has been described as "the single largest contributor to the rising environmental risks of the Anthropocene" (Rockström et al., 2017), as 37% of our planet's land area has become agricultural (Food and Agriculture Organisation, via World Bank, 2024). The agricultural and food sectors have also driven huge increases in the demand for water, a steady rise in greenhouse-gas emissions, nitrogen and phosphorus loading, and other forms of pollution such as pesticides and plastics—each of which endangers the wellbeing of humans and other life-forms.

At the same time, there is increasing inequality of access to nutritious food. Since 2017, undernourishment has started rising in most regions (Food and Agriculture Organisation, 2023, p. 34), while all regions except Europe and North America reported increased food

insecurity in 2022 compared to 2015 (Food and Agriculture Organisation, 2023, p. 35). Some of this is due to changing climates (Myers et al., 2017, p. 262), but some arises more directly from socioeconomic factors. Obesity rates have been growing at 2–3% per year across all regions (Food and Agriculture Organisation, 2023, p. 37), and undernourishment at 6–10% per year globally (Food and Agriculture Organisation, 2024; our analysis). Suffering in domestic animals also rises steadily, with, for example, numbers of caged chickens growing at over 1% per year (Ritchie et al., 2023). It appears that some aspects of wellbeing are taking a downturn even before the worst impacts of global environmental change reach us.

The Brundtland Report (World Commission on Environment and Development, 1987) introduced the concept of sustainable development as a two-sided challenge: to meet present human needs without degrading our environment so as to frustrate the needs of future generations. Human needs, in this view, are final goods (ends), and environmental protections are means towards achieving them (so they are instrumentally good). At the global scale, sustainability has more recently been expressed in terms of various 'safe' environmental ceilings to humanity's footprint, while the 'development' motif has been linked to 'justly' providing for a range of human needs and aspirations (Raworth, 2017). In this 'doughnut model' framing (see Figure 1), the safe environmental ceilings are instrumental towards human ends such as survival and development (the 'just' floor). We take this two-sided model as the point of departure for a pluralistic analysis of the concept of sustainability.

Two notes on terminology are important at the outset. First, we will often refer to desirable 'means' and 'ends', respectively, as 'instrumental goods' and 'final goods'. Second, while the latter term commonly maps onto the concept of 'intrinsic goods', there can be exceptions. There can be, in at least some situations, final goods (ends) that are not conceived of as intrinsically good in the narrow sense of "good on account of their own nature" (Orsi, 2015, p. 31). Friendships, for example, may be ends (final goods) which people often seek, yet not good purely in themselves, but rather on account of the actual friends involved. Conversely, there can also be entities that a person recognises as having intrinsic value without their being seen as ends in the narrow sense of sought-after goals. Individual persons or animals, for example, may have value in the sense that they are 'considerable' without necessarily being 'desirable' (Deplazes-Zemp, 2023). In this article we focus on final goods, albeit with occasional reference to intrinsic goodness.

The UN's Sustainable Development Goals (SDGs: UN Sustainable Development Platform, 2015) implicitly span the Brundtland Report's combined vision, with three goals ("life on land," "life below water" and "climate action") primarily representing environmental concerns and the remaining 14 broadly concerned with human development (starting with "no poverty," "zero hunger" and "good health and wellbeing"). The division between means and ends is not so clear in this scheme, as all 17 SDGs have a similar framing. However, resolving the ultimate aim of sustainable development into a number of separate 'goals' and then numerous 'targets', many of which may be instrumentally rather than intrinsically good, is a promising way to facilitate positive change. The framing of the SDGs also moves us away from seeing sustainability (or sustainable development) as simply the conditions for a continuation of human life into the future. Rather, the architects of the SDGs sought

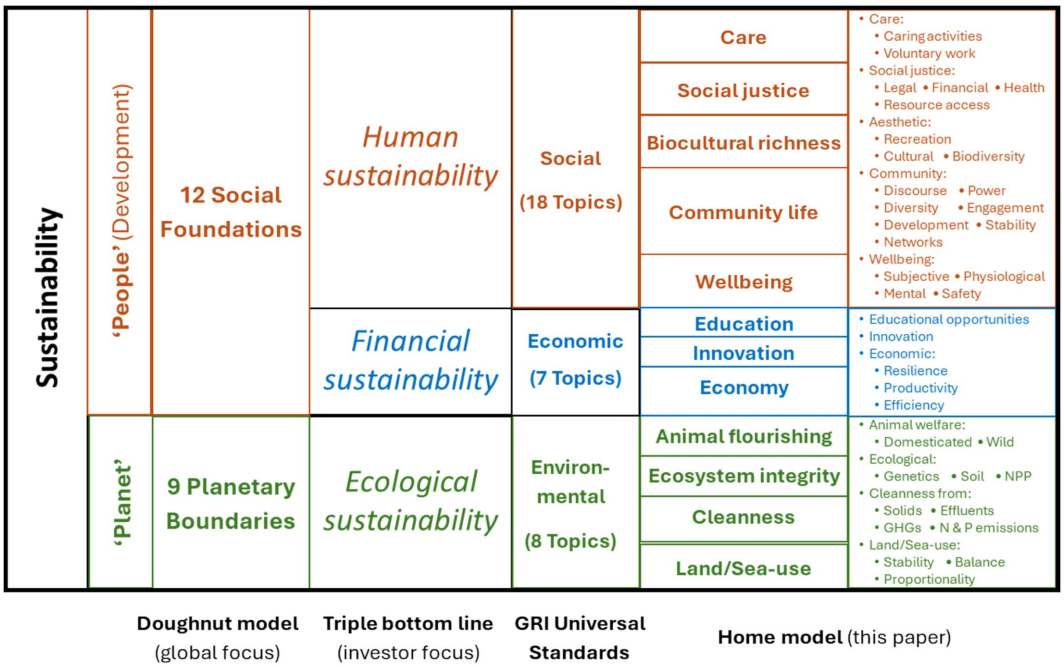

FIGURE 1
Conceptual analysis of sustainability into 21, 3, 33 and 37 criteria. The basic division into 'people' (human goods) and 'planet' (whether conceived as intrinsic goods or as means to achieve human goods) is echoed in the doughnut model, which draws together the planetary boundaries framework with the UN Sustainable Development Goals. Tripartite schemes add a third division (blue font) that takes on varying meanings: (i) financial sustainability in the triple bottom line model, (ii) 'governance' in ESG framings (not shown), (iii) issues of economic responsibility in the GRI Universal Standards and (iv) a social systems focus in the 'home' model (Figure 2). Moving from left to right, each scheme broadly includes the criteria of the previous one.

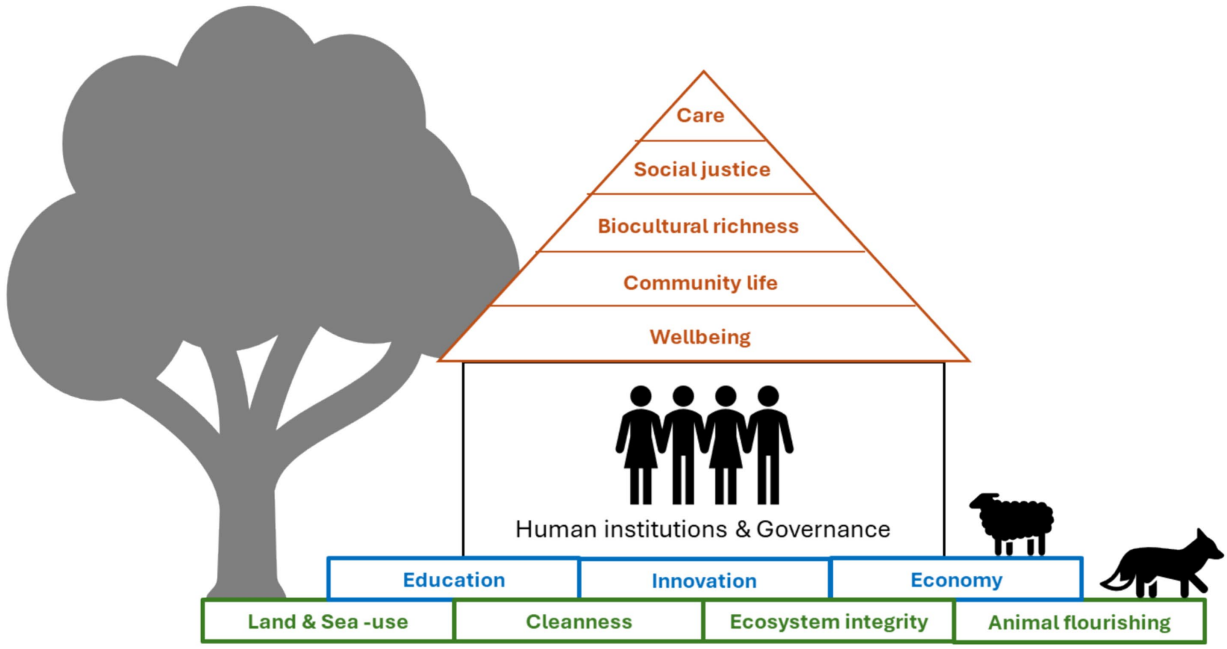

FIGURE 2
The home model of 12 aspects of sustainability: a pyramid of final goods founded on two layers of intermediate goods, leaving space for the diverse norms of institutional governance in the centre. The apex represents care as the highest civic good, and below it, intrinsic goods that are also to some extent instrumental towards the higher goods. The rectangles at the base of the diagram represent forms of goodness commonly considered as instrumental (but, in some worldviews, also as final): four at the bottom arising in non-human systems, and three at the second level arising in human systems. Poor functioning in these two layers has deleterious consequences for the goods above them, while dysfunction in institutional life and the pursuit of final goods can also destabilize the functioning of foundational systems (economic and ecological crises).

ways of living in the present that are consistent with the ongoing flourishing of human and other forms of life in a very broad sense.

Regardless of how sustainable development is framed, reports of current global trends indicate that it is not being satisfactorily realised. For example, recent assessments suggest that less than half of the targets within the SDGs are likely to be met by 2030, with poor progress on many of the environmental ones (United Nations, 2023). Averting a range of humanitarian and ecological crises will require not only international resolutions and global analyses, but also grassroots changes and pluralistic evaluation of social and business practices at local scales. To facilitate this, it has become common to distinguish three generic sustainability criteria for economic enterprise: social, environmental and financial concerns. Popularly referred to with the mnemonic "people, planet and profit," this view is framed in business terms as a triple bottom line (Elkington, 1994). That is, instead of considering the bottom line of a financial ledger as the ultimate metric of a business' success, three separate criteria must be considered simultaneously. If taken seriously, this fundamentally changes business accounting, since simple optimisation techniques only apply to a single objective (e.g., the conventional, financial bottom line). However, there is no consensus on how to define proper objectives in terms of the additional 'sustainability' considerations—let alone how to quantify them. Moreover, we do not believe that just three basic faces of sustainability, or the notions of 'transformative change' that sometimes accompany them (e.g., IPBES, 2019, p. 14; Pahl-Wostl, 2019; Klerkx and Begemann, 2020), are sufficient to build towards the kinds of 'sustainability transition' that people around the world increasingly call for.

This paper contributes to operationalising sustainable development by re-analysing the notions of sustainability and transformative change, to offer conceptual clarity without oversimplifying. It also provides editorial comment on a special article collection in this journal entitled "The many faces of sustainable food", We begin (Section 2) by looking at the structure of existing criteria and visions for sustainable food systems, and offering some critique (Section 2.1). Then, synthesizing certain insights from the articles in the collection (Section 2.2), we develop a proposal for a multi-modal assessment of sustainability that also leads to an account of transformative change. Section 3 presents this proposal along with a brief account of the philosophical paradigm in which it originates. We move on (Section 4) to discuss the value of multi-modal systems thinking and propose an account of transformative change before concluding (Section 5) by looking towards ways in which progress might be made towards a sustainably better nourished world. Since food systems are both foundational to and facilitative of human flourishing, our focus on food and eating can ground a general sustainability ethic without narrowing its scope. Indeed, as a primary human enterprise, food systems provide an ideal starting point for an account of what sustainability actually looks like.

2 Sustainability criteria for food systems

The basic imperative for a sustainable food system is to feed and nourish people, alleviating hunger and sustaining populations

and societies. The eradication of human hunger and the promotion of health and wellbeing, as envisioned, respectively, in the second and third SDGs, are therefore pertinent to any discussion of sustainable food systems (Bhagwat, 2022). Any enterprise that contributes to the perpetuation and flourishing of human life through delivering nutritious food thus contributes to sustainability in a biotic way even before it is assessed against other criteria (Vargas-Canales et al., 2024)—as reflected in the public subsidies provided to farming and the tax exemptions for foods in many industrialised economies. Nevertheless, food production can be more or less sustainable as regards its further impacts, beyond providing nutrition.

Some work on the concept of sustainable intensification has argued for a very broad assessment of the impacts of farming (Garnett and Godfray, 2012; Gunton et al., 2016), accounting for social and ethical context, while some limited attention has also been paid to fishing (Little et al., 2016). There is consensus that a successful response to our food crises entails system-wide transformations which prioritise not only the nutritional needs of the world's growing population but also environmental concerns, cultural traditions and governance (Béné, 2022). The fourfold pathway of "better production, better nutrition, better environment and better life" identified in the UN Food and Agriculture Organisation's (2021) Strategic Framework 2022–2031 expresses this breadth but begs the question of what counts as "better."

Following the model of the SDGs, there have been proposals to resolve local-scale sustainability goals into multiple criteria that can be monitored and managed. Environmental concerns are often broadly separated into mitigating (or adapting to) climate change, and preventing biodiversity loss. The 'social' pillar, meanwhile, may be broadly divided into individual health and wellbeing alongside concerns that are genuinely social or based on social interactions (Hubbard, 2009, p. 188; Lindell et al., 2022) such as work patterns, community life, security, justice and peace. Together, these are better termed 'cultural' aspects, and may be constitutive of wellbeing and/or also ends in themselves. We next look at the environmental and the cultural aspects in turn.

2.1 From environmental indices to physical and ecological conditions

As noted above, environmental dynamics are mostly conceived as instrumental towards human wellbeing. The two broad areas of climate change and loss of biodiversity (or of biosphere integrity) are supplemented in the popular framework of 'planetary boundaries' (Rockström et al., 2009; Richardson et al., 2023) by five additional processes concerned with forms of pollution: stratospheric ozone depletion, ocean acidification, nitrogen and phosphorus loading, atmospheric aerosol loading, and pollution by novel entities; and also two others: "freshwater change" (i.e., disruption of natural flows of freshwater; Richardson et al., 2023) and loss of forest cover. While this framework is not beyond critique (Montoya et al., 2018), and notwithstanding the epithet "planetary," these categories have been developed into a set of measurable criteria and indicators that can in many cases also be applied locally. But the selection of the nine processes has not itself been justified by scientific or philosophical reasoning (Rockström et al., 2009),[1] and some of them have changed identity over the last 15 years, begging questions about their coherence. Do these nine 'things' belong together?

Most of the "planetary" indicators are instrumental towards (or against) wellbeing in straightforward ways: they describe human interference with physical and ecological systems in ways likely to endanger the flourishing of humans (and non-humans). However, biodiversity loss is unique because while losing taxa can sometimes be shown to be instrumentally bad, biodiversity is also commonly attributed with intrinsic goodness, so that protecting it can be an end in itself. Loss of forest cover, meanwhile, can be attributed with positive as well as negative effects on human wellbeing (Bass, 2009), and is pertinent to the complicated land-sparing vs. land-sharing dilemma (Gunton, 2023). Is it better, on balance, to intensify agricultural production without taking additional land, so as to leave more space for greater biodiversity elsewhere? The answer is likely to be both context- and values-dependent (Garnett and Godfray, 2012).

Further questions are raised by ambiguity around the "planetary" epithet itself. If agriculture is "the single largest contributor to the rising environmental risks of the Anthropocene" (Rockström et al., 2017), one reason may be the peculiar way in which farms are part of their own environment. Indeed, the whole concept of 'environment' is problematic in the case of agriculture. Whereas 'environment' broadly denotes externalities in other areas of enterprise, Gunton (2023) argues that it is ambiguous and inadequate for assessing the sustainability of agricultural systems. Sometimes we want to refer to ecological considerations like biodiversity and agroecosystem functioning, which are part of any agricultural enterprise; other times we want to consider impacts external to and beyond the farm, such as pollution of watercourses or greenhouse gas dynamics. Below, we argue that the terms 'planetary' and 'environmental' in sustainability discourse should often be interpreted as 'physical' and 'ecological' respectively, and we separate instrumental criteria related to system dynamics from ultimate criteria related to how humans value ecological systems and their properties as intrinsically good. That is, properties like species richness, functional stability and carbon sequestration potential mostly seem good because they are instrumental towards other goods. We draw on the planetary boundaries concepts to provide criteria for the instrumental side of a sustainability assessment in Section 3.1.

2.2 Human-oriented goods as ends: the many faces of sustainable food

The articles in the collection that motivate this analysis mostly concern a range of intrinsic (and final) goods and norms for sustainable food systems. We begin with the argument of Bhagwat (2022) that diversification is needed, and at a range of levels: landscape ('macro'), species ('meso') and genetic ('micro') scales. At the landscape scale, Bhagwat evokes the intrinsic value of 'biocultural diversity' (Maffi, 2018), contributing to landscape beauty, and being recognised by the UNESCO World Heritage Convention. Beyond this, diversity (especially at the

1 See also https://www.stockholmresilience.org/research/planetary-boundaries.html

'meso' and 'micro' levels) is argued to have instrumental value towards agricultural productivity and its resilience, and other goods connected to human flourishing.

Gunton (2023), adopting the Normative Practices Framework, argues that a generic normative criterion for sustainability arises from looking at the opening up of farming to values beyond the economic concerns of productivity and efficiency. Models that explicitly promote goods such as fairness and justice, altruism and care, aesthetic appeal and harmony, or ideological and religious convictions can be considered "enlightened agriculture." While Gunton (2023) argues that promotion of biodiversity as an intrinsic good does not qualify in this way, we suggest in Section 3.2 below that the intrinsic goodness of biodiversity particularly belongs to the aesthetic mode of experience. Biodiversity-oriented models would, in that case, qualify as enlightened agriculture.

The social responsibility of enterprises is open to many interpretations. As mentioned above, the distinct themes of (individual) wellbeing and (social) justice run in parallel through much of what passes for the 'social' pillar of sustainability, and articles in our collection touched on each of these.

Del Prete and Samoggia (2023) investigate what aspects of fairness matter most to consumers making purchasing decisions. In their sample of Italian consumers, the concept of fairness extends beyond concerns for justice to both wellbeing and social issues. The "environmental" syndrome (factor) emerging from their exploratory factor analysis of consumer concerns includes some concerns that might be labelled "biotic," such as the perceived human health benefits of products, and others more purely "ecological," such as preference for organic cultivation, but it also encompasses concerns about justice or care, such as animal welfare. Another factor emerging was labelled "working condition," which represented a number of concerns for fair treatment of workers throughout agri-food chains. The remaining factors are mostly connected to economic concerns, labelled as "networking," "short chain" (localism) and "fair price."

Taking human and social considerations in a more philosophical direction, Nieuwland and Meijboom (2023) problematise the conventional dichotomy between our responsibilities to human vs. non-human animals by examining and interrogating the broader animal-focused ontology of philosopher Val Plumwood. Starting from Plumwood's non-dogmatic 'semi-vegetarian' ethic, Nieuwland & Meijboom engage in meta-ethical reflection on the validity of dualistic thinking for realising sustainable food futures. They urge the reader to consider the validity of such pervasive and powerful categories as 'meat', 'indigenous', 'human' and even 'self', suggesting that more fluid ontologies may help us create space for animal flourishing and sustainable living.

The concerns with diet considered in this last paper point to an integrating view of sustainability in terms of how consumers actually apply the range of values that they hold while navigating a complex web of choices. Salgado and Verkerk (2022) suggest that the everyday social practice of eating together naturally embodies certain visions of sustainability. They point out that sustainable home cooking requires sustainable practices throughout the food production chain, in particular sustainable farming and sustainable trade and marketing. Consumers' demands may further such practices, and Salgado & Verkerk posit a sequence of nine normative aspects by which to assess the sustainability of food systems, from farming through processing to cooking and eating. We return to these particular aspects (modes) in the next section.

A final pair of papers concerns the political aspect of sustainability—and especially the barriers preventing societies around the world from transitioning towards more sustainable food systems. Even et al. (2024) offer a framework of twelve barriers grouped into five domains, showing how even biophysical and technical obstacles are largely social in origin. Béné and Abdulai (2024), meanwhile, draw on the framework known as "multi-level perspectives of transition" and emphasise the importance of understanding political and social context. Crucially, they conclude that transformation must be normative, deliberate and goal-oriented—which is to say, directed towards good ends rather than merely propelled by means such as technological opportunities.

Elsewhere in the literature, there are sustainability schemes that add other fundamental considerations. A report seeking to classify the SDGs proposes "resource security" as a distinct concern within the environmental sector, referencing the 12th SDG and the literature on circular economics (CISL, 2015). While circular economy proposals are important, it is crucial to clarify their ultimate goals (Geissdoerfer et al., 2017); below we suggest that they typically belong with the instrumental criteria of the economic aspect of sustainability. Upadhyaya and Moore (2012) added 'technical' and 'institutional' concerns to the triple bottom line scheme. 'Technical' here broadly concerns the quantity and quality of the industry's focal product—e.g. the sense mentioned above in which food output must itself be a sustainability criterion for a food system. 'Institutional', meanwhile, is partly used in the sense of governance, as increasingly emphasised in environment, social and governance (ESG) corporate reporting (United Nations, 2004). 'Governance' can relate to sustainability in at least two ways. First, good corporate governance is seen as instrumental to realising environmental and social goods, beyond its role in facilitating financial performance. Second, good governance can focus on principles that open up business beyond its economic aspect: especially to concerns for fairness and wellbeing. In this second way, genuine governance considerations can qualify a business as 'enlightened' in the sense of Gunton (2023).

The ESG movement has its origins in investors' need to value companies realistically, as now embodied in the International Sustainability Standards Board, but it runs in parallel with a movement for reporting the outward-looking sustainability impacts of enterprises. The Universal Standards of the Global Reporting Initiative (GRI) (Global Sustainability Standards Board, 2024) span environment, people and economy. 'Economy' is meant in a systemic, macroeconomic sense, separate from the internal sense of finance referred to in 'triple bottom line' discourse. In this way, economics constitutes an additional instrumental concern. The latest GRI criteria also emphasise human rights as a special component of the 'people' concern (Global Sustainability Standards Board, 2024). A list of 'material topics' is then provided for enterprises to select from for their reporting, cutting across the environment, people and economy concerns. For the agriculture, aquaculture and fishing sectors, 26 topics are suggested (Global Sustainability Standards Board, 2024, pp. 301–393), spanning both instrumental and intrinsic goods. Figure 1 presents a conceptual analysis of the main sustainability frameworks discussed so far, along with the framework proposed below.

From this brief review, we find that (1) the primary output of any enterprise must be explicit in its sustainability assessment; (2) ecological and economic processes are important instrumental concerns for sustainability; (3) economic concerns occupy a special

place in sustainability analysis, and need resolving into internal and external perspectives; and (4) human wellbeing, various justice concerns, and non-human goods such as biodiversity and animal welfare are prominent forms of final goodness to monitor—to be integrated, if possible, into a normatively-explicit vision of transformative change.

3 Beyond the triple bottom line

The proposals that we have seen for extending sustainability criteria beyond the so-called triple bottom line do not, in most cases, explicitly build upon a philosophical rationale. We propose that a unifying framework could add coherence and force to such proposals, while also providing a clearer research agenda. Several philosophically-based frameworks might be drawn upon, of which two well-known ones are based in evolutionary psychology. Maslow's Hierarchy of Needs (Maslow, 1943) has broad appeal but appears too anthropocentric to do justice to the diversity of values espoused in contemporary sustainability discourse. Stephen Kellert's aspects of biophilia (Kellert and Wilson, 1993, chap. 2; Ross et al., 2018) offer a broader suite of concerns. Both options have strong consonances with the framework we outline below, which was originally inspired by jurisprudence and provides a philosophy of lawfulness.

Modal aspect theory draws on the philosophical work of Herman Dooyeweerd and Dirk Vollenhoven, and emphasises a balanced plurality of aspects of reality. A sequence of fifteen aspects is proposed as distinct ways (modes) in which things can exist and function and at the same time have meaning and value. This implies that each aspect has a distinct epistemology and science, with disciplines such as physics, psychology, sociology and law focusing on specific aspects (Basden, 2021). The aspects build on each other conceptually from the first (quantitative) to the last (pistic, or ultimate) (Basden, 2019), and all kinds of entities and processes are assumed to function in all aspects simultaneously. We suggest that even if one does not accept this theory as an ontology, it can be used fruitfully as a set of perspectives from which things and events can be evaluated to develop an integral view.

Modal aspect theory has been applied to research on sustainability by various authors in subtly different ways. From this work an approach has emerged known as multimodal systems thinking (Strijbos and Basden, 2006).

3.1 Complex interwoven systems and their sustainability criteria

In this section we discuss some key concepts in the sustainability discourse mentioned in Section 2 that refer to systems, and derive a corresponding set of sustainability criteria.

In Section 2.1 we questioned the utility of 'environment' as a concept for developing sustainable food systems. For example, the planetary boundaries framework, with its suggested mechanistic tipping points, evokes a Holocene "safe space," like a bubble which human development must not burst, and the notion of a bounded space also inspires the degrowth movement in economics (Brand et al., 2021; Engler et al., 2024). Instead, reframing environmental limits as ecological balances emphasises the interconnection of humanity, ecosystems and physical processes, enabling us to identify dysfunctional ecosystems as symptoms of distorted development (van der Stoep and Kee, 1997). While earth-system modelling may evoke 'tipping point' thresholds beyond which negative impacts on livelihoods would become far more severe (MacKay et al., 2022), apparently lending a certain normative force to scientific prediction (Russill, 2008; Hulme, 2009, p. 346), a more transparent diagnosis is that global systems can easily develop in ways that inhibit flourishing through interwoven ecological and economic dynamics that create scarcity and injustice (Jochemsen and Rademaker, 2019a).

An early version of multimodal systems thinking (MMST) presented a holistic approach to landscape planning that differentiates between a biotic and a human ecosystem, intertwined with each other (Hills, 1974). While biotic ecosystems combine physical and biotic features, human ecosystems also incorporate human communities. Agriculture, for example, depends on nutrient-rich soil, of which the humus is shaped by crops previously grown on it. The complex relationship between biotic and human ecosystems is problematized by the divergent perspectives of agroecologists, who emphasise embedding agriculture into the biotic ecosystem (Suarez and Ume, 2024; see Discussion), ecomodernists, who detach agriculture from the soil with technologies like hydroponics (Glas et al., 2024), and the organic movement, whose founders tended towards a holistic philosophy (Conford, 2001).

Considering plants and animals together as a 'biotic system' goes back to Leopold's (1949) 'land ethic', but particularly since the 1970s, there has been increasing scientific focus on animal behaviour (ethology) and experience (psychology). Like humans, animals are sensitive beings, evoking obligations that we do not have towards plants or other life-forms, especially concerning welfare. An ecosystem can thus be seen as a complex nexus of physical-topographical patterns, biotic relationships, animal interactions and human communities. This fits with the four structures that Dooyeweerd distinguished in his anthropology: a physical–chemical structure, a biotic structure, a sensory structure, and a human act structure (Troost, 2012, p. 191)—each with its own logic and efficacy. They are interrelated, such that dynamics in the 'higher' structures can shape dynamics in the 'lower' ones. Such an analysis allows us to distinguish systematically between our impacts on climate (physical–chemical structure), vegetation (biotic structure), animal behaviour (psychic structure) and human functioning (act structure). At the same time, this analysis offers space to think through the relationship between these four types of systems in search of win–win solutions.

Our first set of criteria for sustainability thus draws on structures thinking, together with the 'environmental' systems concerns of the planetary boundaries framework. The purpose of these criteria is to monitor how certain food system impacts may lead to harm or flourishing, beyond their virtue in supplying food. The first criterion is based on the spatial and kinetic modal aspects, while the following three relate to the first three structures, characterised by physical, biotic and sensory aspects. We return to human structures in the next section.

- *Land- and sea-use*. This criterion may include:
  - stability of land, sea and other water uses (e.g., penalising biodiversity offsetting manoeuvres).
  - proportionality of land and sea use to available biocapacity using ecological footprint analysis (Rees, 1992; Wackernagel et al., 2019).

- seeking an appropriate balance of land- and sea-uses among competing interests.

- *Cleanness*, monitored via pollution. This covers impacts on a number of the planetary boundaries, and can be broken down at source into:
  - Reactive N and P emissions.
  - Greenhouse gas emissions.
  - Other persistent effluents: gaseous, volatile, aerosol and soluble emissions (e.g., exhaust particles, ozone-degrading aerosols, polyfluoridated alkyl substances).
  - Persistent solids (e.g., plastics and metals).

- *Ecosystem integrity*. This can be broken down into impacts on at least:
  - Genetic richness (regional or global). This is the functional side of biodiversity, and could be assessed simply using species richness.
  - Soil creation.
  - Net primary productivity.

- *Animal flourishing*, e.g., via positive wellbeing metrics (Lawrence et al., 2019). This can be broken down into:
  - wild animal welfare, such as affected through habitat alterations and zoonoses.
  - domesticated animal welfare, such as affected by rearing and killing practices.

This scheme can accommodate diverse views on the pertinence of welfare concerns for different animal taxa.

3.2 Cultural systems and their sustainability criteria

Going beyond their animal life, humans create cultural systems. Our second set of criteria for sustainability looks at these, also building on the concepts of leverage points (Wigboldus and Jochemsen, 2021) and the pluralistic evaluation framework of Gunton et al. (2022). Like the foregoing criteria, these are relevant not only to food system enterprises, but also to the sustainability of enterprises and initiatives more generally.

Human cultural structures are invariably multi-layered, with active functioning in several aspects. A MMST analysis identifies systems of education and technology (formative aspect), of discourse (lingual aspect), of social relationships (social aspect), and of economics (economic aspect), as well as dynamics in aesthetics, justice, care, and ideology or religion (Gunton et al., 2022). Of these, formative and economic systems are engineered for broadly consensual goals (education, innovation and productivity), and have measurable criteria that can stand as indicators of sustainable development. We therefore consider these as additional systems whose functioning is at least partly instrumental towards overall flourishing. Thus, the next set of sustainability criteria is evoked by the conventional 'economic' pillar of sustainability discourse and covers the formative as well as economic aspects in MMST:

- *Education*, which is related to the concept of human capital and can be assessed through impacts on educational opportunities and achievement.
- *Innovation*, which can be assessed through impacts on technology and inventions realised.
- *Productivity*, which can be broken down into impacts on:
  - Economic resilience.
  - Economic productivity.
  - Efficiency and avoidance of waste (including circularity).

The criteria considered so far are instrumental to the flourishing of human and other animal life. Physical, biotic and sensory structures and systems commonly reduce the quality of life when they become perturbed from their natural states. Education, innovation and economic production are likewise widely seen as instrumental towards the common good (as well as being ends in themselves), and engineered changes in these systems can be transformative and conducive to global flourishing (Béné, 2022). Other human structures and systems, however, are often simply constitutive of good living and flourishing. We therefore leave space for a diverse set of norms concerning the functioning of human institutions, including their governance, before taking the remaining aspects of MMST as spheres of normativity, to identify final goods. These provide a set of generic, 'broad' values (Pascual et al., 2023) that can be adapted to the specific context of any part of a food system. The final batch of cultural criteria broadly corresponds to the so-called 'social' pillar of sustainability and covers the sensory, social, aesthetic, jural and ethical aspects of value:

- Wellbeing, which can be broken down into impacts on:
  - Safety from fatality;
  - Physiological health;
  - Mental health;
  - Subjective wellbeing.

- Community life, which can be broken down into impacts on:
  - Relationship networks (extent, connectivity, strength, etc.);
  - Stability and resilience of (agricultural or rural) communities;
  - Growth and development of communities;
  - Engagement of individuals in communities;
  - Diversity of communities;
  - Power of communities to innovate;
  - Quality of discourse in communities.

- Bio-cultural richness, which can be broken down into impacts on:
  - Biodiversity as a perceived richness and harmony of life-forms;
  - Cultural diversity and heritage;
  - Recreation (opportunities and participation).

- Social justice, including for distant populations and future generations, and broken down into impacts on:
  - Access to physical resources, such as freshwater and minerals;
  - Health and wellbeing parity;
  - Financial parity (e.g., assessed through Gini coefficients);
  - Legal rights, equality and assistance, and safety from criminal activities.

- Kindness and care, concerned with perceiving intrinsic value in other beings. This can be broken down into:
  - Voluntary work, as estimated, e.g., by charitable organisations.
  - Caring activities, whether paid or unpaid.

The hierarchical relationships among our proposed criteria are illustrated in Figure 2. The final aspect recognised by MMST, known as pistic or ultimate, is not used in the suite of criteria proposed here. Rather than attempting to integrate ideology, religion or spirituality into a model of sustainability, we invoke them in discussing the role of people's visions and values. Below, we argue that these realities determine the interpretation and application of all of the above criteria.

4 Discussion

A plurality of criteria for sustainability is necessary because the concept is not simple. We have traced the steps by which 'sustainability' has moved from a narrow focus on human survival needs to a multi-faceted agenda for the flourishing of life on Earth in a very broad sense. This culminated in our proposed 'home model', framing sustainability within 12 aspects promoting the delivery of both instrumental and intrinsic goods. Drawing on multimodal systems thinking, our model extends the leverage points approach (Wigboldus and Jochemsen, 2021) and the Pluralistic Evaluation Framework (Gunton et al., 2022) towards a practical tool.

This model is essentially evaluative, and does not in itself provide a guide towards the practical steps that could be taken in order to move actual food systems in the direction of improved sustainability. Whereas we hope that the 'home model' provides a widely-acceptable contribution to evaluating sustainability of policies and business operations, prescriptions for action will be more strongly characterized by normative visions, or worldviews. This is where religious, ideological and spiritual convictions come into play most clearly. The pistic aspect as recognized in MMST concerns people's ultimate convictions, which determine the weight they place on norms and obligations in the earlier aspects. For example, a final paper in our collection showcases the paradigm of agroecology as a grassroots movement for global reform. Suarez and Ume (2024) call for fairer, multi-aspectual integration of the economics of the Global South, where use-value is emphasized, with those of the Global North, where exchange value is emphasized, in order to move away from the prevailing global capitalist framework in which food systems are caught up. This ideological call implies a set of values, where justice is particularly prominent, without altogether disregarding other values. A multi-dimensional model for sustainability such as that articulated in Sections 3.1 and 3.2 will regularly require compromises, and when this happens there will be no uniquely objective formula for determining the best course of action. Thus, norms are always weighted by people's religious and ideological commitments.

That said, our evaluative framework does have its own normative emphases. Indeed, it leads to an account of transformative change grounded in MMST. In the context of sustainability transitions, transformative change means a suite of changes in systems at many levels, simultaneously guided by widely-appreciated norms in all aspects. Systemic change must run from governments and their international relations down to individual enterprises, communities and households, and hence also on to biotic and physical systems, while the norms guiding the change must run from ethical (love) down to sensory (health and wellbeing). This notion of transformative change is broadly yet explicitly normative, unlike conceptions that merely refer to change (e.g., IPBES, 2019, p. 14).

We now turn to look at how MMST can support such change by promoting interdisciplinary analysis, by providing new ways of approaching institutional diversity, by lending insight into the plurality of values, and by validating distributed forms of governance.

First, MMST undergirds an interdisciplinary approach calling for practical wisdom. Since no scholarly discipline is credited with an ultimate overview of how the world functions, genuine deliberation among diverse groups of citizens is called for. The many faces of sustainability can only be adequately handled through pluralistic dialogue informed by expert analyses from a wide range of academic disciplines. Citizens' assemblies can be an example of this open-ended approach to change.

Second, MMST offers a framework for assessing how the core entities and processes in food systems perform on all relevant scales and levels (Wigboldus and Jochemsen, 2021, p. 877). Such an approach may help to achieve better harmony in the way all parts of a food system function in diverse ways (e.g., the modal aspects of MMST). This involves considering the extent to which practices and processes contribute to promoting aspectual harmony globally. An important insight from MMST is that any practice or system has a particular qualifying aspect or core value that normatively characterizes it and should direct its goals. Enterprises and market organizations, for example, are economic in nature, seeking prosperity or wealth. Governments, courts, and political parties are qualified by juridical concerns, such as equality and public justice, while schools, universities and civil society organizations have cultural formative functions: e.g. education, research, innovation, citizenship formation. Respecting the proper character and functioning of such institutions is crucial for realizing any integrated vision of sustainability transformations in a way that does justice to diverse visions of the common good.

Third, MMST helps us recognise value hegemony (Gunton et al., 2022, p. 9). For example, the framing of sustainable food systems in terms of a dilemma between higher productivity and limits to growth betrays an economistic value orientation. Productivity and economic growth are not value-neutral concepts, and prioritizing them implicitly demotes other values such as wellbeing, justice and care. Sustainability in the broadest sense should mean that human life, and life in general, is able to flourish. Instrumental goods are important because there is broad consensus that they contribute to final goods, yet the conception and relative importance of final goods still depends on people's values. Therefore, discussion about final and intrinsic goodness is crucial: just how bad are different kinds of land degradation, pollution, animal suffering, etc., and how important are different kinds of biodiversity, wellbeing, justice, etc.? Such a renewed focus on normativity requires that we speak about sustainable development in terms of a dialogue about values as realized in the diversity of practices in society (Jochemsen and Rademaker, 2019b). In this vein, we welcome the burgeoning discussion of "values of nature" and worldviews in sustainability discourse (IPBES, 2022; Himes et al., 2023), although we believe this literature needs disciplined attention to clear definitions.

Fourth, we come to questions of governance. Normative applications of MMST advocate for a structural pluralism of institutions (a diversity of non-governmental organisations) alongside

the confessional pluralism (e.g., freedom of religion) that characterizes contemporary societies. Together, these principles call for distributed governance of land, resource bases and institutions—made all the more important in view of the geographical diversity of landscapes and ecosystems. Work on localist frameworks for resource management (Christie et al., 2019) indicates the potential for sustainability transitions to be most effective when higher levels of government foster and permit this. Hence our rallying call is for sustainability to be pursued beyond the triple bottom line by educational institutions, local businesses, community projects and charitable organizations as well as government bodies.

The home model that we propose here can only highlight certain important features of reality, leaving others out. Like any model, it represents concepts and their relationships while, as a normative model, also suggesting generic ways to improve system functioning. Recognising that reality is always more complex and richer than any model can grasp, we offer this integrating, value-pluralistic model as a helpful framework for understanding and progressing towards sustainability.

5 Conclusion

As we have seen, human life and life in general are interrelated in complex ways (Section 3.1). It is for this reason that we include plant and animal life in our proposed sustainability framework. Recognizing the intrinsic worth of non-human nature is an important incentive to bring agriculture and food production into harmony with biotic ecosystems, animal life and sustainable use of resources. Just as climate change, biodiversity loss and animal welfare issues make us increasingly aware of interdependencies between various forms of life, so rethinking these interdependencies can bring about transformations of thinking, speaking and acting that help us transition to a sustainable future.

To this end, we have proposed an analysis of the concept of sustainability into 12 broad aspects, along with specific criteria under each aspect. These criteria are offered as a starting point for developing a systematic evaluation protocol for business activities and those of other organisations. By distinguishing instrumental goods (means) from intrinsic goods (ends), we also seek to clarify the relative nature and importance of the different aspects and criteria. Different organisations and initiatives will naturally place different weights on each.

Kate Raworth opined that "the Doughnut might act as a 21st century compass, but the greater task is to create an effective map of the terrain ahead" (Raworth, 2017). She pointed to ongoing socioecological systems research to assist in this. We have argued that there is also a need for clearer conceptual framing of sustainable development. While there is no prospect of universal global agreement about the identity and relative importance of the goods considered in sustainability frameworks, we believe that conceptual mapping and clarity has enormous power to shape education and debates, and help us reach more satisfactory ways forward. In the face of current global crises, we hope that the 'home model' serves in some way as a means to this end, and that criticism will enable it to be refined.

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RG: Writing – original draft, Visualization, Writing – review & editing. JS: Writing – review & editing. YA: Writing – review & editing. HJ: Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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