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Introducing the Food Value Framework (FVF) to empower transdisciplinary research and unite stakeholders in their efforts of building a sustainable global food system

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Abstract
The global food system provides numerous benefits to humanity but also faces critical sustainability challenges with respective costs often burdened by society. As these costs are not sufficiently represented in market prices, increasing monetization efforts of externalities aim to reveal such hidden costs. However, monetary evaluation approaches have limitations such as conformity or including arguably unmonetizable impacts. Given that food production and consumption have been deeply embedded in human culture and behavior throughout millennia, systemic change is generally slow and precarious to enforce externally, especially given its existential role for daily survival. Rather than imposing relatively recent sustainability challenges, such as climate change, onto food systems, we hence suggest incorporating them into a core natural driver of human behavior: values. The objective of this research is to create a framework that can holistically address values associated with food in order to guide and unite stakeholders along the food value chain. Based on this human-centered bottom-up approach, empirical relevance of a respective framework to successfully translate into and guide sustainability efforts should be increased. We therefore combined established approaches of monetary accounting with a psychosocial perspective on basic human values and ethics to derive the Food Value Framework (FVF). We conclude that the FVF could address shortcomings of current evaluation methods and serve as a common foundation to empower transdisciplinary research, value-based policy-making, transparent production, and responsible consumption across the food value chain.

Keywords Food value assessment · Sustainable food systems · Transdisciplinary research · True cost accounting · Basic human values · Value-based framework

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1 Introduction

Our global food system has become a prime example for rising issues across the three pillars of sustainability (Purvis et al., 2019). Environmentally, food is responsible for one-third of global anthropogenic GHG emissions (Crippa et al., 2021), is the main threat to marine sustainability with around 85% of global fisheries fully exploited, overexploited, or depleted (Worm & Branch, 2012), and continues to be the main driver of deforestation and habitat loss (Williams et al., 2020). Regarding social sustainability, current food consumption patterns drastically affect human health with over 600 million people globally being classified as obese (BMI > 30). Obesity is now the cause of ~ 8% or a total of five million premature deaths worldwide, with an additional ~ 20 million deaths associated with food consumption such as coronary heart disease, cancer, or high blood pressure and sugar. On the other end of the spectrum, around nine million people still die from hunger and undernourishment every year (Ritchie & Roser, 2017). Furthermore, labor standards in the food and agriculture industry suffer significant implementation shortcomings with dominant issues including forced and child labor (UNICEF & ILO, 2021). Ethically, increasing public discourse is highlighting concerns about the estimated 65 billion land and 2.7 trillion marine animals killed every year for human consumption (Mood & Brooke, 2010; Ritchie et al., 2019). Even from an economic perspective, food production and consumption face several sustainability issues. Many national food systems are threatened due to, e.g., speculation and subsidy price destruction which increasingly puts affected countries into import dependence (von Braun & Tadesse, 2012). An increasing price pressure on farmers and food producers has been encouraging large-scale farming and monocropping in order to leverage economies of scale and generate profitable businesses (Salaheen & Biswas, 2019). The extent of generally unsustainable and highly vulnerable stand-alone business cases is furthermore indicated by several countries, such as Japan, spending more than 40% of the produced food value on subsidies (OECD, 2021). Moreover, most of those subsidies, estimated at around $540bn globally, are supporting harmful agricultural practices (FAO et al., 2021). With an increasing share of younger generations lacking the desire to earn their livelihood in agricultural services due to factors such as the low monetary and associated socio-economic benefits, innovation and economic survivability of the sector are further compromised (Heide-Ottosen, 2014).

What appears to be connecting these sustainability issues is a lack of adequate evaluation; be it the subsidy dependent and price vulnerable agricultural sector or the gap in representing the value of commons on the social and environmental side (Gemmill-Herren et al., 2021). Addressing those additional values has driven the rise of ecosystem service valuations over the last decades (Scholte et al., 2015) as agriculture and food production do not only rely on produced capital but also on natural, social, and human capital (Bandel et al., 2020). While respective research does often include food systems, the underlying theories and frameworks are not explicitly tailored to the complexities of the entire food value chain. As pointed out by publications of the Stockholm Research Center, it is of pivotal importance to address the unaccounted impacts of agriculture and food systems. This requires an effective and systematic way to comprehensively capture such impacts in order to respond to the global goals of operating within the planetary boundaries (Rockström et al., 2009).

The issue of adequate evaluation affects all stakeholders along the food value chain: policy makers, businesses and farmers, as well as consumers. The immense complexities behind food systems are prominently apparent in extensive legislations such as the EU

Common Agricultural Policy (CAP) that is consistently trying to unify regional legislations while being lenient about local circumstances and respective adjustments (Recanati et al., 2019). The arguably biggest challenge for such unification and simplification is an alignment on values that justifies respective legislation. For instance, parliaments in Sweden, Denmark, and Germany discussed a tax on meat to address the environmental impact of animal agriculture. However, justifying a universal taxation for meat solely based on a general environmental impact does raise the concern of ignoring the large difference in GHG emissions of livestock as well as socio-economic or health value elements of different meat types (Bonnet et al., 2020).

At the upper end of the value chain, farmers and food producers face the respective issues of complex legislation alongside the responsibility of providing basic food supply all year around. As food markets have become heavily supply driven, providers lack value incentives for sustainable production while suffering from a permanent pressure of ensuring food security. Innovation and changes in agricultural practices could be significantly accelerated but carry a high risk for producers while also requiring extensive knowledge exchange and locally tailored approaches (Herrero et al., 2020).

Lastly, the consolidated food system issues affect the consumer side as well. A lack of transparency hampers fair and aware consumption while expectations, responsibility, and blame appear to be increasingly put on consumers (Wunderlich & Smoller, 2019). Recent Eurobarometer studies highlight this maladjustment of our food system; while 94% of EU citizen say that protecting the environment is important to them, approximately 50% of European consumers experience difficulties in distinguishing between environmentally friendly and non-environmentally friendly products (European Commission, 2020). Consequently, a similar share of participants indicated to not trust manufacturers' claims about environmental performance.

All in all, our current global food system appears to be driven by misguided incentives, aims to maximize production volume at the cheapest possible price, and neglects its impacts on climate, health, workers' rights, or equitable distribution. These sustainability issues are further worsened by a global dietary shift toward higher consumption of animal products which heavily impacts planetary boundaries, human health, and animal welfare (Bonnet et al., 2020; Ritchie et al., 2019). Based on these circumstances, we suggest that a more transparent value proposition and impact awareness of food products is needed by all stakeholders in their efforts to work toward more sustainable production and consumption by guiding, e.g., subsidies, prices, and public awareness. In order to provide such a value proposition, we believe that a respective framework which aims to holistically encompass food *value dimensions* is required. These dimensions must be able to encapsulate more detailed *value elements*, e.g., micronutrition as part of a health-related value dimension. Understanding these value elements and their impact on human decision making is crucial as numerous studies highlight the human hypocrisy in everyday food choices. Concepts such as motivated inattention or moral licensing help to explain why we, despite an impact awareness and a sincere pro-environmental attitude, frequently choose less sustainable meals for reasons such as taste, convenience, or personal identity (Oliver et al., 2018). Creating transparency and unveiling those often subconscious values would contribute to the essential first steps of any change process: awareness and acceptance.

The global food system is incredibly complex and the way we produce and consume foodstuff has developed over millennia. These deep cultural roots alongside the obvious existential need of eating for survival, create behaviors and systems where change is slow as well as hard and precarious to enforce externally (Tansey & Worsley, 2014). Rather than imposing, often recent and hard to conceptualize, sustainability challenges onto the food

system, a value-based approach could highlight psychosocial shortcomings in current policy-making and business practices as well as support a more intuitive behavioral transition toward more sustainable food production and consumption. Our work is hence based on the following research question:

What dimensions should define a holistic value framework for food?

Be it in monetary terms or as the subjective importance to oneself, value is driving human behavior and should therefore be well understood when formulating agendas for sustainable development (Ghazali et al., 2019). Sustainability itself can be viewed as an umbrella term for several human values such as wanting to preserve a societal or personal status-quo achieved through individual efforts as well as conserving an environment that allows future generations to make similar experiences as the ones, we cherish (Kassel, 2012). A large body of empirical evidence and associated theories, such as the *Value-Belief-Norm* theory, highlight that individuals start to act when they believe that a valued object or experience is threatened and their behavior can help to protect or restore them (Stern et al., 1999).

Conceptualizing and reasonably quantifying values where possible is also essential to grasp the trade-offs embedded in societal and individual decision making (de Groot et al., 2010). As food is directly or indirectly associated with all 17 Sustainable Development Goals (SDGs), this paper aims to bridge the gap between sustainability and the underlying values driving food consumption and production. We refer to the Food and Agriculture Organization (FAO) definition of sustainable food systems highlighting the maxim of food security across the globe which is not compromised for future generations by addressing all three pillars of sustainability (Nguyen, 2019).

1.1 Findings

To address the research question of defining holistic value dimensions, we followed a three-step approach guided by the two most common English dictionary definitions of value. While specific academic literature provides a vast array of value definitions, we believe that this linguistic view forms the most suitable foundation to build an empirically relevant framework for two reasons. Firstly, commonly used language generally reflects the thinking, concepts, and associations the majority of people share regarding given terms as it naturally derives from social discourse (Mercer, 2002). Secondly, English remains the most widely used and understood language around the world, increasing the potential for a broader applicability of our results (McKay, 2018). While being considered the global language, utilizing the English definition still puts an emphasizes on the Western world which should be addressed in future research.

Step 1 We looked at the monetary value perspective, defined as "the amount of money that can be received for something" (Cambridge Dictionary, 2022) and "how much something is worth in money […]" (Oxford Dictionaries, 2022).

Step 2 We addressed the broader and hard or impossible to monetize elements of values, defined as "beliefs about what is right and wrong and what is important in life" (Oxford Dictionaries, 2022) and "the importance or worth of something for someone" (Cambridge Dictionary, 2022).

Step 3 We created a structure around the derived value dimensions that reflects the ethical component and psychosociology behind values and actual behavior to increase the applicability of the framework as an empirical tool (Schwartz, 1994; Singer, 2011). Based on these three steps, we reviewed the prominent literature of food evaluation while

simultaneously following and applying respective findings to a graspable everyday food consumption example: a pound of US ground beef for a Sunday burger barbeque.

1.2 Step 1.1: Economic free market value

From a pure liberal and free-market economy perspective, the true value of food should be represented by the retail prices that consumers are willing to pay for food products. The underlying costs of products sold mark a base point for this price with every cent paid on top by the consumer resulting in gross profits and showcasing the value that has been generated (Sowell, 2007). While this macro-economic view can be extended by several complexities like implied selling, general and administrative expenses or political regulations, the core of this monetary assessment has become the societal default when prescribing value to products including food (Göpel, 2016).

However, one factor that heavily affects the straightforward "value equals market price" premise are governmental subsidies as these monetary gains are not directly reflected in revenues from product sales. According to a recent publication by the Agriculture Fairness Alliance (2021) based on data by the United States Department of Agriculture (USDA), the U.S. government spent around $53bn on farm subsidies and bailouts in 2020, $7.3bn of which went to cattle ranchers through direct payments and an additional $1.6bn to beef cattle feed producers. Notably, this total of around $8.9bn in subsidies for beef production does not include further indirect benefits through subsidies for, e.g., dairy production, given that dairy cattle also ultimately end up in meat production (Preston & Willis, 2013). Assuming an equal distribution of those $8.9bn to the total US beef production of 27.2bn pounds in 2020 (Statista, 2022b), at least $0.33 of taxpayer money are embedded in every pound of beef through governmental subsidies. Given the average retail price of $3.95 for a pound of US ground beef (Statista, 2021), one could argue that the true monetary value should be at least $4.28 (see Fig. 1). However, it should always be considered that subsidies are complex policy instruments that can arise from several motivations (Gawande & Hoekman, 2006). These underlying drivers include political lobbying or global market competitiveness and render a direct connection with associated societal values more or less futile.

While offering a comprehensible foundation, a pure free-market monetary value perspective starts becoming limited when considering the associated sustainability impacts that are caused by food production and consumption (Gemmill-Herren et al., 2021). All the aforementioned sustainability issues generate hidden costs, also known as negative

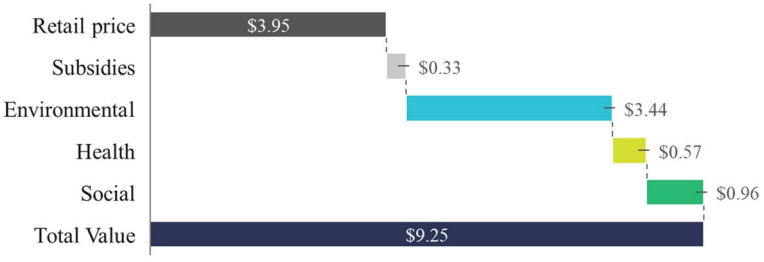

Fig. 1 *Monetary evaluation of US ground beef.* Exemplary TCA assessment of one pound of conventional ground beef produced in the US utilizing published secondary data. Rational of calculation highlighted throughout running text

externalities, which are currently not sufficiently reflected in global food prices or our burger patty example.

1.3 Step 1.2: True Cost Accounting (TCA)

From the 1960s, Environmental Economics emerged as a new field to address this lack of economic consideration for environmental externalities in pricing and evaluation with similar concepts probably reaching back as far as two centuries (Sandmo, 2015). As this approach was naturally only focused on environmental externalities, an increasing number of researchers also started to consider the aforementioned health and social costs embedded in consumer goods and services creating several further research strands such as ecosystem service evaluations. In a more recent effort to combine and monetize those different dimensions of externalities, the term of *True Cost Accounting* (*TCA*; sometimes also *Full Cost Accounting*) has been coined by several scientists as well as economic players to derive a holistic "true value" of systems and products. In their TCA inventory report, Bandel et al. (2020) define TCA as the "*evolving methodology to measure and value the positive and negative environmental, social, and health externalities in order to allow analyzing the costs and benefits […].*" This definition thereby highlights three main dimensions of value concern: environmental, social, and health. TCA acknowledges that food products carry a significant shadow price that is absent in the development of market prices and aims to expose as well as quantify such hidden costs. The last decade saw a drastic increase in TCA activities; 545 publications between 2011 and 2021 included the keyword "True Cost Accounting" compared to just 130 in the prior decade (based on Google Scholar analysis). Several impactful research initiatives joined the effort including *The Economics of Ecosystems and Biodiversity (TEEB)* which provides in-depth financial value analyses of ecosystem services (Helm & Hepburn, 2014).

A cumulation of the TCA developments in recent years can be found in the United Nations Food Systems Summit (UNFSS) 2021 publication "*The True Cost and True Price of Food*." The authors of this extensive study estimate that the annual negative externalities of the global food system total $19.8 trillion which more than doubles the $9 trillion of actual global food expenditures for consumption (Hendriks et al., 2021). The ratio for US food system value generation to health and climate externalities was found to carry an even higher disparity ratio of 1:3 (The Rockefeller Foundation, 2021). Additionally, several externalities like increases in antimicrobial resistance (AMR), transportation, or food processing have not been included in the UNFSS report mainly due to a lack of reliable data (Hendriks et al., 2021). Furthermore, these externalities do not account for the aforementioned governmental subsidies. Globally, a recent OECD report shows that governments invest a total of $700 billion in agricultural subsidies alone with some countries such as Japan, South Korea or Switzerland investing over 40% of actual gross farm revenue in agricultural support (OECD, 2021).

TCA can also be used to calculate externalities on a product-level (The Rockefeller Foundation, 2021). However, research and data on this level are still relatively scarce with externalities often arbitrarily chosen and focused on environmental costs. Utilizing the categories of environmental, health, and social externalities (Bandel et al., 2020), this study aims to combine several publications on externalities of food production and consumption to provide a product-level example of TCA. Given the scope of this research, our goal here is to create an illustrative "Pareto-esque" example for reference and discussion rather than trying to exhaustively include as many externalities as possible and create an extensive

accounting analysis. Referring back to the pound of ground beef, we calculated a potential total product value of $9.25 by including exemplary negative externalities which would equal a 134% value increase when added on top of the initial $3.95 retail price (see Fig. 1). The rational and scope behind those calculations as well as several limitations will be discussed in the following.

Estimations for the environmental costs are based on research by Pieper, Michalke, & Gaugler who assessed GHG emission externalities of food products in Germany (Pieper et al., 2020). The researchers used a life-cycle assessment analysis tool called GEMIS (Global Emission Modell of Integrated Systems) to derive CO_2 equivalents (CO_2eq) per product along the food value chain. This calculation hence also includes emissions from land use change (LUC), methane (CH4) and nitrous oxide (N2O), as well as indirect CO_2 emissions such as agricultural transportation or production of nitrogen fertilizers. Using cost estimations for environmental damage of 180€ per ton of CO_2eq, their results show that conventional meat produce of ruminants carries environmental externalities of 6.65€ per kilogram. It should be mentioned that this value is on the high-end of theoretical and empirical carbon pricing (World Bank, 2021). Given the similarities in agricultural practices and relatively consistent average GHG emissions of cattle in developed countries (Avery & Avery, 2008; Poore & Nemecek, 2018), we assume that this emission and cost profile for German beef can serve as a proxy for beef produced in the US. Hence, an average pound of ground beef would have a total of $3.44 environmental costs embedded in its emissions profile (see Fig. 1; avg. exchange rate EUR-USD of 1:1.142 in 2020). It should once again be noted that these environmental costs only refer to GHG emission and do not include other environmental considerations and costs such as loss of biodiversity or virtual water.

While the assessment of embedded CO_2eq alongside the extensive discourse on carbon pricing do provide a certain objectivity for one cost element of the environmental externalities, calculating health externalities on a product-level basis is a more divisive assessment. Human health is the result of countless intra-personal (e.g., immune system) and external factors (e.g., conventional pollutants) which all interact in incredibly complex and often unpredictable manners (Bleich et al., 2015). Even when just looking at diet, direct long-term health effects from consuming certain food groups have meaningful empirical evidence, yet often correlational by design with extensive longitudinal research being generally very difficult to conduct (Clark et al., 2019). Food-related health concerns are always the consequences of an individual's entire diet; consuming a single piece of candy likely has a negligible or occasionally even a positive health impact. However, that same piece of candy can also contribute to a diet high in refined sugar which can lead to several health issues (Edwards et al., 2016). Despite such complexities, several longitudinal studies and meta-analyses do provide solid evidence for the health implications of consuming certain food groups (Greger & Stone, 2016). In order to assess health externalities of the exemplary pound of ground beef, calculations for red and processed meat impact on health by Springmann et al. (2018) were utilized. The authors estimated health-related costs to society in the US by using a cost-of-illness approach which included direct costs (e.g., health care and medication expenditures) and indirect costs (e.g., productivity loss due to morbidity and mortality). Four major diet-related illnesses were analyzed: ischemic/coronary heart disease (CHD), stroke, cancers, and type-2 diabetes mellitus (T2DM). Leveraging risks assessment for those four diseases and their link to red and processes meat consumption, the yearly global health-related costs to society total $285 billion. More concretely, red meat consumption in the US was estimated to carry $20.8 billion of total health externalities. We used this total to break-down health externalities onto the pound of ground

beef example which is assumed to be non-processed and therefore considered red meat. With the average US red meat consumption (2020) per capita being 110.4 pounds (Statista, 2022a) and the total US population (2020) of 331,002,651 (UNDESA, 2022), health externalities for one pound of ground beef would amount to $0.57 (see Fig. 1). While serving as a reference value, this break-down to a product-level basis should again be taken with great considerations. Diet-related health consequences on an individual level cannot be attributed to single food servings and generally require a more holistic perspective due to the vast complexities of human health and nutrition. Assessments of such product-level health externalities could hence vary widely.

Lastly, socio-economic externalities arguably carry the biggest variety of germane elements that could be considered for TCA and cover a vast space of scientific discourse around concepts such as social life cycle assessment (Petti et al., 2018). Furthermore, these elements can also be highly subjective and hard to monetize (de Adelhart Toorop et al., 2021). One could look at, e.g., the underpayment of workers in the meat industry or the additional costs that would be associated with normative Fairtrade standards. Given the paradigmatic character of this paper's TCA example, an in-depth assessment of these manifold social cost elements was out of scope. Due to the increased consumer concerns for livestock farming conditions (Alonso et al., 2020) and recent political tractions in the US, such as the successful and since January 2022 legally binding bailout Proposition 12: *Prevention of Cruelty to Farm Animals Act* (Sumner et al., 2020), we decided to focus on animal welfare externalities in the following assessment. Thereby, another quantitative challenge arises as, unlike the environmental and health externalities, no direct costs to society can be used to monetize the value of animal welfare. Some authors did make an economic case for the loss in livestock productivity associated with low animal welfare (Grandin, 2014). However, these approaches generally address operational efficiency gains rather than social externalities. Therefore, our assessment will utilize Willingness to Pay (WTP) as a contingent valuation method of consumer research to assess what monetary value could be associated with animal welfare. Spain et al. (2018) have surveyed 1,000 US consumers of meat, eggs, and dairy on their attitude toward animal welfare and respective certifications. Their results show that consumers' WTP on top for a labeled pound of chicken breast is $0.96 which equates to a 48% price premium. We will use this price point of $0.96 as a conservative assumption for our ground beef example given that both are meat products, and the $1-mark likely being a meaningful value from a mental accounting perspective (Strulov-Shlain, 2019). However, this should be considered a conservative estimate as a 48% price premium in the ground beef example would equate to $1.90 and consumer empathy toward cattle could be higher than toward poultry (Adam & Joy, 2014).

1.4 Step 1: Limitations of monetary evaluation and TCA

"Nowadays people know the price of everything and the value of nothing"
Oscar Wilde - The Picture of Dorian Gray, 1890

Discussions and work around TCA have generated a highly valuable body of scientific research as well as political and economic suggestions for creating more sustainable and socially justifiable global food systems (Gemmill-Herren et al., 2021). As shown alongside the ground beef example, the concept can also be used on a product-level basis to disclose hidden costs. However, monetary evaluation approaches are subject to noticeable criticism, shortcomings, and limitations (Patel, 2021). In the following, we want to emphasize five of those limitations when trying to determine the true value of food.

Firstly, the vulnerability of and dependency on the financial system also applies to food value. As financial markets and currencies are in constant flux due to factors like inflation, exchange rates, sanctions, or embargos, local and global food commodities also suffer from price vulnerability and spikes (von Braun & Tadesse, 2012). Driven by deregulation, financial speculation has furthermore been severely impacting food prices, especially since the turn of the century, adding to the ever-increasing complexity of food commodity markets (Griffith-Jones & Gottschalk, 2016). Additionally, the inherent volatility of food value is likely to further worsen over the next years due to evermore weather and vermin-dependent harvest driven by the consequences of climate change or vulnerable supply chains as the world is currently experiencing due to the Russian–Ukrainian war (Behnassi & El Haiba, 2022). Such drastic changes and differences offer a relatively weak foundation for defining a monetary true value of food. As the externalities used in TCA (e.g., GHG emissions) can also suffer from the same financial market dependencies, value fluctuations can be even more extreme (World Bank, 2021). Going forward, alternative financial systems like cryptocurrencies would need to be considered further when determining how to execute TCA and derive a true value (Kamilaris et al., 2019). In summary: Can we really speak of a true value if it is that volatile and dependent on financial market dynamics?

Secondly, the assessment and respective political or economic implementation of a true value globally and across demographics carries major challenges. Linking externalities to financial markets and global food trade is further complicated by the different values of currencies which could create additional disadvantages for developing countries especially if local differences in valuation are not considered. Depending on the implementation, including externalities in food prices could make sufficient nutrition unaffordable for a large share of the population. Command and control as well as market-based (cap and trade) approaches could both yield significant justification challenges when burdening externalities on society (Mintz-Woo, 2022). This is likely further complicated as different populations and demographics vary in their value perception, making public acceptance an especially noteworthy hurdle to consider (Jeong & Lee, 2021).

Thirdly, a common framework, boundaries, and general consensus on what externalities to include are still missing**.** The TCA Inventory Report, a publication by the *TMG Think Tank for Sustainability* and *Soil & More Impacts* commissioned by the *Global Alliance for the Future of Food*, provides an extensive collection, analysis, and database of TCA approaches which is constantly being updated in an open-access online format (Bandel et al., 2020). In their analysis, the authors point out three major issues: lack of transparency and agreement on TCA frameworks, lack of globally and interdisciplinary agreed-upon terminologies, and lack of accessibility and acceptance for data bases. While their work clearly helps to address those issues, the authors explicitly state that no single blueprint for a TCA application can be derived from their inventory and further harmonization of definitions and methodologies alongside case studies is needed. Even the arguably most prominent framework provided by the TEEB, which does suggest more detailed impact factors alongside natural, produced, human, and social capital, is still depicting itself as an entry point focused on food system impacts rather than a holistic value assessment down to a product-level basis.

Fourthly, even if the coming years provide us with a widely accepted, standardized, and more detailed method to assess food externalities, the feasibility of measuring all relevant externalities remains questionable. This is mainly due to the tremendous effort required for being accurate along the aforementioned value elements and the vast scope of negative as well as positive externalities to possibly include. Even when looking at a single value element such as GHG emissions, carbon prices vary by a factor of over 100 and

require constant reconciliation and recalculation (World Bank, 2021). Additionally, potential double counting with certain externalities already partly included in retail prices or other externalities further exacerbates accounting complexities.

Lastly and perhaps most importantly, it will arguably remain impossible to holistically monetize human values for food utilizing TCA. Even if agreement and efficient accounting of externalities was to be achieved, human values go beyond monetary values (Sandel, 2013). The focus of value assessments most commonly relies on anthropocentric instrumental values but struggles to incorporate relational or intrinsic value elements (Pascual et al., 2017). Consequently, some of the major challenges are hedonistic values such as taste and stimulation, the physical and mental wellbeing of humans and animals alike, as well as cultural or religious values. Contingent valuation approaches such as the afore used WTP for assessing the social value of animal welfare can be utilized for these values but realistically require an unfathomable consumer awareness and balancing of all potential value elements. Decades of behavioral economics further indicate that such valuations are likely not going to translate into actual consumer behavior (Reisch & Zhao, 2017). When applying this to the ground beef example for a Sunday barbeque, one might hence question whether there could ever be a reasonable consensus for a price tag on the subjective enjoyment when taking the first bite of a freshly grilled burger or the live lost and suffering caused to the beef cattle needed to produce the patty.

Despite these limitations it should once more be highlighted how positively impactful TCA has been and will be for food system challenges. Referring to a quote often attributed to the economist John Maynard Keynes, *"It is better to be roughly right than precisely wrong,"* cost accounting does open the door for meaningful and important discussion. Furthermore, most publications highlight that the goal of TCA is to create transparency and a certain tangibility of externalities rather than a utopian universal agreement on an exact Dollar-value (Gemmill-Herren et al., 2021). By using monetization as a widely understood value definition, especially in the Western world, TCA manages to put attention on sustainability issues that clearly impact society. Nonetheless, the above-mentioned limitations pose a valid concern for how meaningful the truism implied by the word *True* Cost Accounting really is. We hence want to propose an extension of this scope when trying to define the value of food.

1.5 Step 2: Basic human values

As addressed in the prior chapter and pointed out by an extensive body of the literature, several anthropocentric value elements cannot be sufficiently covered by the TCA categorization of environmental, social, or health externalities. In order to systematically analyze and define such value elements, the *Theory of Basic Human Values* by social and cross-cultural psychologist Shalom H. Schwartz will be used as a foundational construct (Schwartz, 1994). In his research defining and uniting theory, Schwartz identified ten basic human values which are recognized across cultures and driven by four underlying motivations, namely openness to change, self-enhancement, conservation, and self-transcendence. An extensive body of research suggests that these value structures and human motivations are universal in nature but different groups and individuals around the world ascribe varying degrees of importance and hierarchy to them. The Theory of Basic Human Values was identified as most suitable for addressing our research question of deriving a holistic anthropocentric value framework due to its high scientific relevance as the most cited psychological model on values with transdisciplinary empirical evidence for its universal

applicability across more than 80 countries and hundreds of individual cultural backgrounds (Schwartz, 2012).

In Fig. 2, we propose a view on how the ten basic human values proposed by Schwartz could be mapped onto the value dimensions commonly used for monetary food values assessments (Bandel et al., 2020). While the environmental, social, and health value dimensions can cover a substantial amount of the basic human values, some are only partially addressed or not represented at all. For instance, the environmental value dimension directly addresses *universalism* which is defined as the "*… protection for the welfare of all people and for nature*" (Schwartz, 2012). The social dimension can be associated with the human value for *"restraint of actions […] likely to upset or harm others and violate social expectations […]" (conformity)*, whereas the health dimension carries elements of *security* by providing *"safety, harmony, and stability of society, of relationships, and of self."* However, these three value dimensions do not manage to cover deeply engrained anthropological motivators such as *"excitement, novelty, and challenge in life"* or *"pleasure or sensuous gratification for oneself"* which translate to Schwartz's basic human values *stimulation* and *hedonism*, respectively. We hence conclude that an additional value dimension would be needed to adequately address these non- or underrepresented basic human values. Given that those values unanimously carry a strong focus on the individual and subjective experience, we propose "personal" as a summarizing category for a fourth value dimensions to meaningful include associated anthropological values.

1.6 Step 3: Circles of ethics

Taking the initial three food value dimensions, *environmental*, *social*, and *health*, commonly used in TCA (Bandel et al., 2020) and extending them by a fourth category, *personal*, derived from basic human values (Schwartz, 2012), summarizes the first two steps in our development of a value framework for food. The goal of the third and last step was to arrange those four value dimensions in a meaningful way that provides a comprehensible structure and showcases the relationship of value dimensions as well as possible interactions and overlaps. On a fundamental level, the described value dimensions were

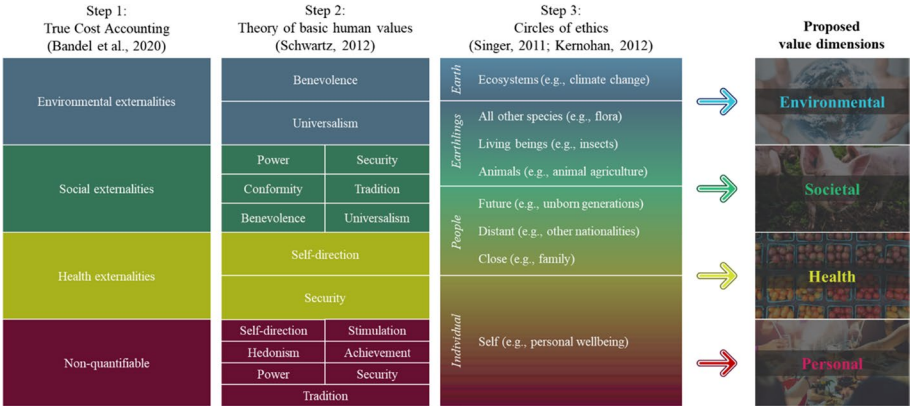

Fig. 2 *Derivation of value dimensions for the Food Value Framework (FVF).* Proposed value dimensions combine True Cost Accounting (TCA) with psychosocial perspective of Basic Human Values and Circles of Ethics (Bandel et al., 2020; Kernohan, 2012; Schwartz, 2012; Singer, 2011)

derived from a clear anthropocentric perspective, be it the monetary valuation of TCA or Schwartz's Theory of Basic Human Values. While this perspective can be criticized in its own right (Kopnina et al., 2018), it does provide the desired focus for designing a framework that is highly likely to be applicable for all societal stakeholders, from policy makers to producers and consumers. The term anthropocentric in this case is not implying that human values should reign supreme and or have an inherent moral high ground within the confines of our planet. Rather, we try to utilize a human-centered design approach (Kurosu, 2011) by considering the evolutionary emergence and essential behavioral component of values and ethics that developed anthropocentrically but continue to include more and more animate and even inanimate entities (Kernohan, 2012).

Given this human-centered approach, one factor must not be neglected: the human perception, and psyche. While values are undeniable drivers for social interactions and individual actions, empirical evidence often highlights that their predictability for actual human behavior remains dubious and dependent on numerous factors. Especially in the context of sustainable behavior, a significant *value-action gap* between individuals' values and their observed behavior is evident (Blake, 1999). In his book *The Expanding Circle,* the philosopher Peter Singer looks at ethics and moral psychology through a lens of sociobiology (Singer, 2011). He argues that morality and altruism were an initial genetic driver to protect oneself and close community members such as family. However, evolutionary psychology shows that our capacity for reasoning allowed for moral progress of society and created an expanding circle of ethics that continues to include more and more entities in an individual's moral considerations. The congruent *Circles of Ethics* theory illustrates this distance in moral consideration driven by physical space, time, or biological and cultural differences. Accordingly, an individual's ethics most strongly apply to oneself, or close family members given the likely proximity in space and time as well as sociobiological factors (e.g., ethnical or cultural similarity). This hence forms the center and inner layer of the circles of ethics. On the other end of the spectrum (the outer layers of the circle), an individual's concern for a foreign future generation should be significantly lower but continues to gain societal relevance over time. Further research states that growing moral concern of other living beings such as animals or even more abstract and inanimate entities such as ecosystems or the environment as a whole could also be explained by the circles of ethics theory (Kernohan, 2012). Given the inherent connectedness of ethics and values, Singer's theory provides a tangible frame for food value assessments. Values guide humans when establishing desirable goals and then consequently motivate behavior, whereas ethics generally form the other side of the coin by constraining behavior through moral judgment. This morality serves as a filter by assessing if the end of our value-based goals remains justifiable by the associated means, potential consequences, or conflicting values associated with achieving set goals (Chippendale, 2001). While the in-depth scientific discourse on values, ethics, and morality continues in philosophy or even linguistics, we believe that Singer's work provides a valuable perspective and empirically relevant structure for a value framework. We hence applied the circles of ethics to the earlier defined four value dimensions of food. Hereby, the personal value dimension forms the inner circle as it is predominately considering values that affect oneself and personal wellbeing. The next layer encompasses the health value dimension given that health is still a predominantly personal concern but can extend to close people (e.g., family members) and beyond. At this point, values start to incorporate more and more distant societal members such as other nationalities, future generations, and eventually even other living beings. Such layers are hence focused on the social value dimension. Lastly, the most outer layer of the circle corresponds with the environmental value dimension as concerns around topics such as climate

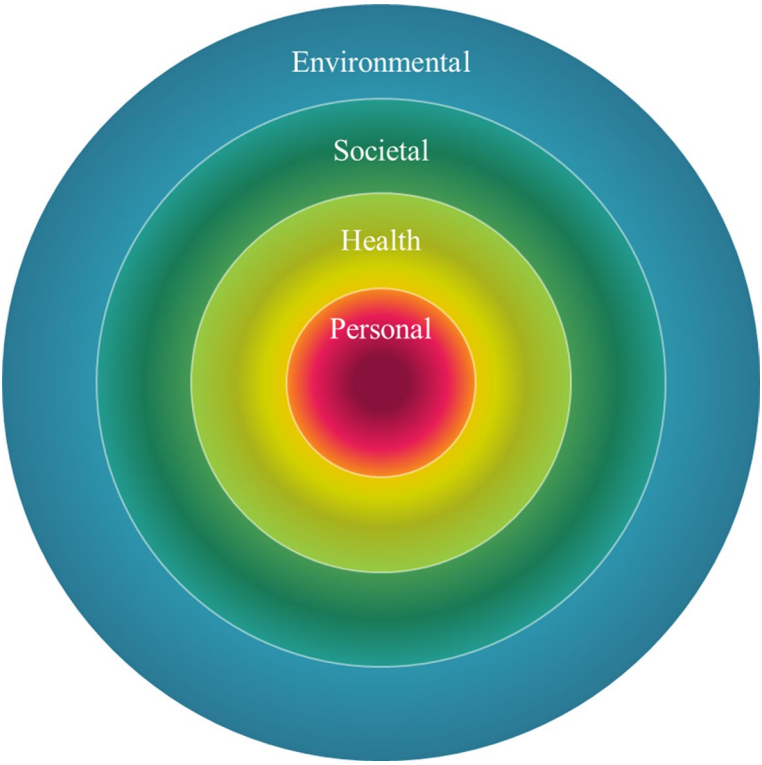

Fig. 3 *Introducing the Food Value Framework (FVF).* Anthropocentric arrangement of four value dimensions (environmental, societal, health, and personal) aimed to holistically capture value elements associated with food. Color scheme (blue, green, yellow, red) and grading indicates overlapping nature of value dimensions

change generally yield the largest temporal, spatial, and sociobiological gap. As the interlinkage between the four value dimensions for food and the circles of ethics creates more of a spectrum rather than adamant layers, we tried to showcase this permeability by utilizing color gradients (see Fig. 2).

1.7 Deriving of the Food Value Framework (FVF)

Guided by the initial research question, we present our proposed Food Value Framework (FVF) built around four core value dimensions of environmental (blue), societal (green), health (yellow), and personal (red) in Fig. 3. We decided on the term *societal* as it emphasizes the relevance of institutions (e.g., economic), complex and long-term societal developments (e.g., human rights), and the inclusion of a broader scope of societal members (e.g., animals) compared to the more small-scale human interaction associated term *social* which has been predominantly used in the references of prior chapters. These four value dimensions were derived by combining monetary evaluation approaches such as TCA with basic human values (Schwartz, 1994). The circular shape is inspired by Singer's circles of ethics (2011) highlighting the outward trend of ethical value concerns in human behavior. The color grading aims to reflect the inherent

overlap of given value dimensions: Certain values like wellbeing can spill from the personal to the health dimension; a well-nourished population is beneficial for health on an individual level but also affects the societal dimension (e.g., a healthy workforce), whereas animal welfare could bridge the gap between the societal dimension and the benefits it yields for biodiversity on the environmental dimension. We acknowledge the existence of complex systematic interactions meaning that one value element is likely to influence all four value dimensions. For instance, climate change, partially caused by the emissions from food production and consumption, is associated with the environmental value dimension but will also lead to, e.g., an increase in heat waves and therefore likely heat strokes which in turn relates to the health value dimension. These indirect impacts are important to consider but we suggest focusing on direct impacts and respective categorization first while gradually conquering the complexity of meaningful interactions going forward.

The FVF aims to facilitate transdisciplinary research on food systems and can be related to several corresponding frameworks in the field of sustainability science. A pronounced affinity and corresponding circle arrangement of sustainability values can be found in the so-called *Wedding Cake* figure for the 17 SDGs proposed by the Stockholm Resilience Institute which was explicitly utilizing food as an illustrative example (Stockholm Resilience Centre, 2016). The outer two Wedding Cake layers *Biosphere* and *Society* thereby inherently map onto the FVF's environmental and societal value dimensions. The third and last inner circle *Economy* does provide a suitable umbrella term for the remaining SDGs, we do, however, see benefit in the more distinctly anthropocentric value dimensions of health and personal described in the FVF. Given the strong psychological, biological, and behavioral component of food consumption, these two value dimensions arguably provide a greater depth for respective research, labeling, or policy-making that goes beyond the SDG scope.

Another corresponding framework for nature and ecosystem valuation was developed by Pascual et al. (2017) in the context of the *Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)*. The authors suggest a similar value structure for nature ranging from anthropocentric relational (e.g., cultural identity) and instrumental (e.g., habitat creation) values toward non-anthropocentric intrinsic values (e.g., animal rights). This approach would hence allow for the FVF to be incorporated into respective valuations while still enabling a more distinct assessment of the psychological and behavioral view on basic human values and moral psychology surrounding food.

Lastly, linkages to the widely accepted and globally utilized sustainability approach of *One Health* for research and policy-making can be drawn (Mackenzie & Jeggo, 2019). Acknowledging the interdependence and transdisciplinary collaboration demand to attain optimal environmental, animal, and human health, the FAO, OIE, and WHO all endorsed the objectives of One Health. Once again, the FVF value dimensions of environmental, societal, and health conceptually lend themselves to embed respective systemic value assessments.

In summary, the FVF can incorporate SDGs, nature and ecosystem evaluations, as well as other prominent policy and research guiding frameworks, such as the One Health approach, to empower global policy-making or transdisciplinary research collaborations. This could make it a valuable tool for combining our deep yet fragmented scientific knowledge on food, values, resilience, and sustainability, ultimately providing a unified approach to transforming the global food system (Vermeulen et al., 2020).

2 Discussion

Based on the sustainability issues raised in the opening chapter of this paper, we see three major benefits for scientists, policy makers, food producers, and consumers when trying to move global food production and consumption in a more sustainable and value-driven direction:

2.1 Provide a holistic lens on food value and create a shared perspective when developing value assessments

The FVF incorporates the three value dimensions environmental, societal, and health to provide a common structure for monetary evaluations of food such as TCA. As shown in the ground beef example (see Fig. 1), this can be done from a single product perspective all the way to entire global food system evaluations as demonstrated by the UN Food Systems Summit publication (Hendriks et al., 2021). Acknowledging that several value elements within those three dimensions are hard or arguably impossible to monetize, we propose adding a fourth value dimension for personal value elements, to allow for further potential non-monetary quantitative or qualitative assessments. Quantifiable impacts such as GHG emissions or water footprint can be neutrally provided on a food products or food system level basis and fit into the environmental value dimension. Additionally, more subjective yet systematic scoring-based approaches such as the Nutri-Score, currently utilized in seven European countries, could provide a quantitative non-monetary value assessment of the health value dimension (International Agency for Research on Cancer, 2021). The FVF aims to provide researchers and institutions with a theoretical foundation to create comparable research alongside a shared view on food value for sustainable production and consumption.

2.2 Create a practical and beneficial tool for policy makers, food producers, and consumers alike

All stakeholders in the food value chain face their own complex challenges. As described in the opening chapter, it is a tremendous task for policy makers to create pragmatic yet justifiable food and agriculture legislation. Utilizing the FVF provides an opportunity to offer a consolidated view on the potential monetary evaluations (e.g., health care system costs), scoring systems (e.g., EU PEF) or qualitative values (e.g., national dishes) that could ultimately guide taxation or subsidies for certain food groups. It could also allow for more nuanced policies by providing a clear rationale and transparency for the different impact that, e.g., regionally produced and free-range certified poultry has compared to imported beef produced under undisclosed conditions. Hence, rather than putting a general tax on meat (Simmonds & Vallgårda, 2021), a more elaborate scaling could be implemented.

This would also have a direct impact on businesses and farmers as they could more reliably plan their production and expenditures. Utilizing the FVF would make food products more comparable and hence easier to create a comprehensible and honest value proposition. Even food retailers could incorporate the value dimensions and respective monetary or scoring evaluations into their business model, e.g., by embedding them into customer loyalty programs. Consequently, consumers would not only benefit directly from more sustainable food consumption but would also have more transparency to make informed purchasing decisions. Utilizing the FVF to provide consumers with comprehensive scores

along the four value dimensions (e.g., a 9 out of 10 "Environmental score" showcasing a highly positive ecological footprint) would address the sense of feeling overwhelmed that many people experience (European Commission, 2020). For instance, rather than being swamped by numerous certificates and labels on groceries such as FSC, MSC, or Fairtrade, the societal value dimensions of the FVF could give a summarizing evaluation of a product's certified labels (see Fig. 4) while providing more detailed information on the product's backside or behind an easily accessible QR code. This approach would support the food industry in their efforts of creating more transparent corporate social responsibility (CSR) and opens the door to educate consumers on the manifold impacts of their consumption choices. The potential of such an evaluation system is highlighted by a recent study on European food consumers showcasing the linkage of knowledge on socio-environmental context and socially responsible consumption (Boccia & Sarno, 2019).

Figure 4 is to be seen as a hypothetical example of visualizing such a potential scoring-based evaluation tool; we will continue exploring this approach in our future work, addressing essential questions such as the feasibility, reasonability, and necessity of actually scoring the subjective personal value dimension. We see this evaluation approach as a unique opportunity to consolidate, align, and simplify several subsystems of food value assessment.

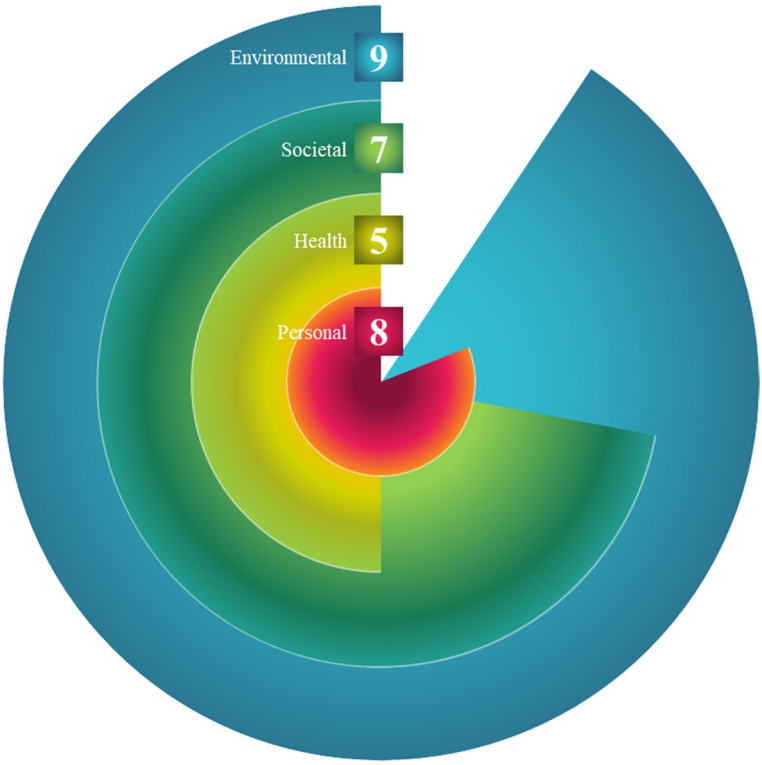

Fig. 4 *Potential visualization of the FVF as a comprehensive scoring-based evaluation tool.* Exemplary scores on a 10-point rating scale and accompanying visual based on the FVF. Rating rationale will be developed as part of future research efforts. Ultimate goal would be to have a scientifically sound evaluation method that is comprehensive for all stakeholders and could, e.g., be used as a front-of-package label

2.3 Encourage a standardized evaluation framework applicable to the global food market yet adjustable to temporal, regional, and individual differences

Behind the ambition of uniting researcher and all food value chain stakeholders in their efforts of building more sustainable future food systems, a global applicability of the FVF is an essential success factor. Utilizing the basic human values theory (Schwartz, 2012) and the internationally utilized TCA approach (Gemmill-Herren et al., 2021), should hence form a strong foundation. However, given the inherent complexity, connectedness, and flux of the global food system, a certain flexibility within the framework must be ensured. The FVF has the potential to provide this adaptability and resilience by allowing for temporal, regional, and individual value adjustments. Putting it into more concrete terms, a form of flexible weighting between the different value dimensions and elements should be apparent. Due to technological advancements, certain externalities and values could become less relevant over time; carbon capture technologies might drive down the relative importance of a product's carbon footprint, whereas biodiversity could become an even more critical planetary boundary and value concern (Rockström et al., 2009). Similarly, regional differences need to be accounted for as certain commons, such as fresh water, vary significantly in local availability and respective value. Last but not least, individual value concerns must not be ignored either. For instance, nutritional needs can vary significantly between individuals. Consequently, people with conditions such celiac disease likely have an inherent higher value assessment of gluten-free food products. Evaluations based on the FVF should provide the respective transparency and potential for adjustments on an individual basis. Ultimately, the FVF should allow stakeholders across the world and time to prioritize a universal list of value elements; for example, showcasing the prioritized value elements of *food producers in Europe in 2023* (e.g., using a survey assessment), and being able to compare the results to the prioritized value elements from a future assessment of *consumers in India in 2030.*

Taking these benefits and considerations into account when utilizing the FVF for food evaluation, several methods should be successfully applicable. A solid foundation is provided by the compliance with the three major TEEB principles for TCA assessments (Bandel et al., 2020). In our opinion the FVF should be *universal, relevant to and understood by all stakeholders (1st principal)*. It furthermore clearly addresses produced, natural, human, and social capital in its four value dimensions, adhering to the 2nd principal of being *comprehensive, including all relevant impacts of all four capitals.* We also tried to optimally build the FVF to not conflict with the 3rd principle of being *inclusive, using equitable methods and tools, quantitative and qualitative to assess impacts and dependency pathways and evaluate impacts*. Including the ground beef examples and other forms of potential evaluation such as the Nutri-Score for the health value dimension offers an initial insight into applicable methods and tools. The arrangement and overlap of the FVF value dimensions can highlight dependencies when assessing impacts on a quantitative and qualitative level. However, we categorically acknowledge that more explicit examples and detailed empirical applications need to be explored in future research.

3 Conclusion

The ambition of this research and the FVF is to provide common ground for the collaboration of all relevant stakeholders moving toward more sustainable food production and consumption. Incorporating the expertise and challenges of these stakeholders is

imperative in order to create a theoretically sound and empirically practical foundation for the FVF. Hence, a truly interdisciplinary approach would mean combining relevant knowledge and practices of the four value dimensions, such as the input from psychologist, sociologists, and anthropologists for the personal values or the view of nutritionists on health evaluations. At the same time, different evaluation methods should be addressed, mainly monetary evaluation (e.g., TCA), alternative quantitative evaluations such as scorings systems (e.g., Nutri-Score), as well as impartial quantitative and qualitative informative evaluations (e.g., virtual water or cultural relevance). We therefore consider the following four research areas as quintessential to validate and further develop the applicability of the FVF going forward:

1. Value dimensions: *Are the FVF value dimensions exhaustive, understandable, and applicable across cultures?*
   While the FVF was derived from environmental and anthropological externalities (Bandel et al., 2020) as well as basic human values (Schwartz, 2012), all of which are backed up by scientific evidence showing applicability across the globe and populations, the framework must yet be empirically tested for its applicability. Most prominently, the FVF must gather evidence for how holistically encompassing its value dimensions truly are. A potential way of assessing this would be a cross-cultural survey that inquires participants' association of food values and test the respective comprehensiveness of the FVF to provide a first indication of importance, weighting, and feelings toward the framework's value dimensions and elements.
2. Monetary evaluation: *Does the FVF allow for product- and system-level monetary evaluations such as TCA?*
   Given the lack of a broadly accepted and used framework for the monetary evaluation of food systems and products (de Adelhart Toorop et al., 2021), the FVF would need to provide evidence for its usability to potentially serve as such. While three of the four value dimensions are based on the TCA Inventory Report, a collaboration with experienced accountants and organizations such as TEEB would still be highly desirable. Going a step further and utilizing the FVF to evaluate food products together with businesses and farmers, such as examples piloted for environmental costs of selected food products at a German discounter brand (Michalke et al., 2022), could further indicate the framework's empirical robustness and economic usefulness.
3. Scoring evaluation: *What scoring systems and certifications could be integrated into the FVF?*
   Acknowledging the limitations of monetary evaluations, the FVF should also have the potential to include other quantitative valuation methods. This would require engaging with stakeholders and researchers within the four value dimensions to identify relevant value elements and potentially sub-frameworks or scoring systems. One example for the health value dimensions would be the Nutri-Score which has been implemented in several European countries (International Agency for Research on Cancer, 2021). With its simple to understand traffic light system based on a A-E rating scale, the label aims to alleviate complexities for consumer purchasing decisions. On the environmental value dimension, the standardized sustainability label known as *Product Environmental Footprint (PEF)* could be embedded in the FVF (Marrucci et al., 2021). The label also has an underlying quantitative scoring system and a comparable traffic light approach. Several challenges would have to be addressed in collaboration with policy makers when incorporating such scoring systems and perhaps even forming a new meta score with

respective weightings within and between the value dimensions. Nonetheless, the FVF could allow for such initiatives and provide a fitting conceptual and visual presentation (see Fig. 4). Identifying changes and mismatches in consumer behavior compared to relative scorings could also help to better understand and eventually bridge the value-action gap of food consumption.

4. Qualitative and informative evaluation: What are the most relevant value elements per value dimension?
   Beyond monetary and scoring evaluation methods, the FVF could also form the foundation for qualitative and quantitative evaluations detached from a rating concept. Deriving an extensive and informative longlist of potential value elements across the FVF value dimensions would provide stakeholders with the knowledge and transparency to address whichever aspects they deem most relevant. This could also form the basis to comprehensibly inform voters on policy programs or consumers on previously underrepresented farmer concerns. Respective value elements could also be ranked and adjusted across time, regions, and populations based on relevant research (e.g., planetary boundaries).

Several crucial factors surrounding the FVF such as regional application, in-depth monetary valuation, positive externalities, complexity of subsidies, the value of survival, or food security are not exhaustively discussed in this paper and need be addressed within and beyond the proposed research areas. Furthermore, the FVF should aim to be as resilient as possible and hence adjustable across time, populations, and individuals as we see that the societal value concerns for food are shifting. The primary concern of food consumption used to be individual survival but over time and across cultures and demographics, cultural values and even moral concern for other species continue to grow in importance (Kernohan, 2012; Singer, 2011).

By further developing and applying the FVF together with and across stakeholders along the aforementioned research areas, we see a unique opportunity to create transparency and awareness for the value of food, foster a holistic view on the sustainability challenges that are connected to the proposed value dimensions, and bridge the value-action gap of sustainable food consumption—for our planet's environment, global society, public health, and personal prosperity.

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Author contribution A.B. analyzed the secondary data and visualized the framework. K.F. supervised the manuscript preparation. A.B. wrote the original draft. All authors reviewed the results and edited the manuscript.

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Data availability This manuscript only contains secondary data sources which are all publicly and freely available and cited throughout the manuscript.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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