The Systemantics of Meat in Dietary Policy Making, or How to Professionally Fail at Understanding the Complexities of Nourishment

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The Systemantics of Meat in Dietary Policy Making, or How to Professionally Fail at Understanding the Complexities of Nourishment

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Abstract: As the most comprehensive system yet devised, global food production lies at the core of human existence. The universal need to benefit from this system, combined with its heavy reliance on natural and human resources, has raised heightened attention from governments and civil society. An overview is provided of how food systems co-evolved with human societies from prehistoric times until today, as well as a summary of theories on how to (and how not to) influence complex systems, illustrated with examples of technocratically imposed transitions that ended in disastrous outcomes. One should be skeptical about a new wave of well-resourced, influential coalitions that are attempting to aggressively overhaul the food system with interventionist policies. One of such initiatives is the EAT-Lancet Commission's "Great Food Transformation." Based on a Planetary Health Diet template, this grouping advocates a dramatic cut in red meat and other animal-sourced foods. Vegan-tech industries are called upon to partially bridge the ensuing nutrient shortfalls by promoting plant-based alternatives (e.g., faux meat and dairy) and novel technologies (e.g., cultured meat, precision fermentation), solutions that remain unproven at scale and are largely rejected by today's markets. In their wake, self-styled food system experts, often influenced by Malthusianism and ecotopian ideologies, fail to grasp the unpredictability and intricacy of food systems, leading to oversimplifications, misguided policies, and unintended societal harm. Their preference for centralized planning and top-down blueprints curtails the individual and societal freedoms that would be the real proven levers to improvement. An alternative path forward, more in line with productive systems theory, is embodied by the Dublin Declaration of Scientists on the Societal Role of Livestock, the Denver Call for Action, and the Nourishment Table concept. Together, these initiatives set the boundaries for agricultural reform and dietary guidance while keeping human prosperity at the center of the debate.

Key words: food systems, dietary policy, nutrition, public health, nourishment, vegetarian
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Introduction

Aiming to explore the interconnectedness of food networks spanning from production to consumption, food systems theory emerged as a formal scientific discipline in the 1990s within academic and civil society dialogues across fields like agriculture, nutrition, economics, and environmental science (Blay-Palmer et al., 2020). However, its roots stretch back much further—at least to the proposition by Malthus (1798), in his *An Essay on the Principle of Population*, that (without technological innovation) population growth outpaces food production, leading to famine, war, and disease, acting as natural population controls.

Malthusianism has shaped over 2 centuries of reflections on what could be a sustainable "carrying capacity" of the planet, leading to heated debates (Mann, 2018). It served as a basis for the Club of Rome's influential *Limits to Growth* report (Meadows et al., 1972), which used computer-generated scenarios to link the depletion of system "inputs" (resources) to an increase of harmful "outputs" (pollution). Extreme voices have included the human population itself as part of the system's toxicity (Ehrlich, 1968), with some having portrayed it as a system bug, or even as a malignant neoplasm (Hern, 1993).

Before World War II, Malthusianism blended with 19th-century positivism and early 20th-century theories of scientific management. In pursuit of progress, these views sought to subordinate human traditions and values to novel operational frameworks devised by experts (Wells, 1928; Burnham, 1941; Selcer, 2018). Malthusians often aligned with conservationists in their technocratic outlook, which was at times infused with misanthropic or even eugenicist language. As expounded by Mann (2018), "Prizing the expert governance of resources, they found little difference between protecting forests and cleaning up the human gene pool."

After the war, efforts to curb population growth were integrated with arguments for more efficient production and a sharply reduced consumption of resources (Mann, 2018). The latter, in particular, required a shift in worldview and gradually translated into left-wing ecotopian activism and degrowth ideology (Darwall, 2019), promoted by such organizations as the Tellus Institute and Stockholm Environment Institute (Raskin, 2016). To do so, futurists connected pleas for rational, technocratic design to more fuzzy notions of Gaian esotericism and "planetary consciousness" (i.e., a teleological vision of collective transcendence towards a higher level of awareness) (Leroy and Hite, 2020; Nordangård, 2024). This seemingly paradoxical approach arose from the recommendation by post-war social engineers to package "Spaceship Earth" metaphors of expert-led guidance and global governance as more engaging narratives, able to captivate the imagination of the public (Selcer, 2018). For instance, systems philosopher Ervin Laszlo specifically created the New Age-inspired Club of Budapest to serve as a spiritual counterpart to the Club of Rome.

When confronted with advocacy for a grand food system transition scheme, it is therefore advisable to not only critically assess its technical assumptions, but also its ideological ones. Pleas for a shift to a "plant-based" future commonly suffer from such irrational biases indeed (Leroy and Hite, 2020). Already during the Progressive Era (1890s–1920s), part of the Food Reform movement in the USA intermixed scientific arguments for dietary guidance and temperance with the earlier religious view that meat is an impure food that "excites" the bodily passions and may lead to carnal proclivities and violence (Stuart, 2006; Shprintzen, 2013). This pervasive belief traces back to the eschatological fervor of the Second Great Awakening, advocating a return to Eden-like diets, which was later amplified by Seventh-day Adventists and Theosophists (Leroy and Hite, 2020). Reformist campaigns for frugal meals based on whole grains, nuts, and fruits had lasting effects on the discipline of dietetics (Banta et al., 2018), shaping norms around "eating right" under the guise of scientific objectivity (Leroy et al., 2025). Starting from the premise that individuals are unable to manage their health effectively without expert interference, bland yet "rational" diets were thus preferred over traditional food choices. This long-standing moralization of food also paved the way for the elevation of "naturalness" as a normative ideal (Sánchez-Siles et al., 2019).

It was mostly during the 1970s that radical views related to the "management" of meat consumption started to emerge. In 1972, during the same year of *Limits to Growth* and the United Nations Stockholm Conference on the Human Environment, a Rockefeller Commission report called for a dietary shift "away from the consumption of animal livestock towards vegetables and synthetic meats" and "a closed system of agriculture—food from factories" (Commission on Population Growth and the American Future, 1972). It argued for an "international economic order, capable of dealing with natural resources and environmental conditions on a world scale," implemented by a body with "assigned central responsibility," and acting as a "lobby for the future."

Today, such interventionist anti-livestock views have become even more widespread (Leroy et al., 2023a,b). Transnational pressure groups aiming to overhaul agrifood systems under the pretext of "planetary health" management have succeeded in influencing policymaking by operating as large public-private partnerships and by weaponizing activist experts and non-governmental organizations (NGOs) to increase impact (Darwall, 2019). Far from merely having consultative status, these experts and NGOs play a role in constructing a curated "reality" and in defining problems that require transnational governance, thereby merging science, finance, law, and politics into a framework designed to assert a supranational epistemic and moral authority. This effective strategy was first initiated at scale during the 1992 United Nations "Earth Summit" in Rio, under the leadership of Maurice Strong, who had significant connections to the Business Council for Sustainable Development (now World Business Council for Sustainable Development [WBCSD]) and the World Economic Forum (WEF) (Chatterjee and Finger, 1994; Selcer, 2018).

Notwithstanding an omnipresent "Follow-the-Science" rhetoric, typical actors in these influential networks are unable to move beyond the somewhat schizophrenic combination of neo-Malthusian, technocratic, and ecotopian paradigms (Raskin, 2016), and the usually unstated but never distant eugenicist implications (Ntim, 2021). This legacy has profoundly shaped the economic theories of system experts and their focus on resource allocation, leading to problematic visions on how global food systems should be managed, regulated, and incentivized, including calls for authoritative control over what should (and should not) be seen as acceptable science (Cribb, 2023).

Among these ecotopian views, pan-ecological ideologies have often attributed intrinsic moral value to nature itself. Such positions risk obscuring the epistemic clarity required for effective food governance, replacing deliberative ethics with a form of moral absolutism (Pulina, 2023). More recently, there has also been a growing integration of animal rights ideology into food systems debates, further amplifying interventionist zeal (Leroy et al., 2023a,b). In the legal sciences, animal rights ideology is paradigmatically seen as a form of dehumanization, and the increasing space it takes in food system debates showcases the intellectual undercurrents of certain system transformation advocates (Deckha, 2023; Cantens, 2025).

A recent report in support of the European Union's Green Deal serves as just one example among many of how all this may materialize into future policy scenarios, with options ranging from full-blown technocracy to ecotopian degrowth (EEA, 2025; Table 1). Of note, all 4 "imaginaries" outlined in the report aim to shift away from livestock through fiscal measures, primarily taxes, illustrating the narrow imaginative scope of central planners.

Aim of This Article

To be clear, not all is problematic about food systems theory. At its most effective, its methodologies have enhanced our understanding of how system elements interact and how policy changes have impacted stakeholders, either negatively or positively (Blay-Palmer et al., 2020). As illustrated below, it has served as an adequate scheme for retrospective analysis, providing post-hoc reflections on major system transitions that occurred within the human past, linking major environmental changes with technological progress. However, its predictive accuracy leaves much to be desired. At its worst, food systems theory has led to oversimplifications, misguided policies, and societal damage. This article aims to unpack how a systems approach can deepen our understanding of dietary

Table 1. Overview of the "imagined futures" scenarios contained in the "Imagining a sustainable Europe in 2050: Exploring implications for core production and consumption systems" report by the European Environment Agency (EEA, 2025).

	Technocracy for the Common Good	*Unity in Adversity*	*The Great Decoupling*	*Ecotopia*
General political climate	State governance is top-down, digital, and based on real-time data in all areas, including all production and consumption systems	A society managed by an "authoritative EU," applying stringent regulations, taxation, and resource distribution	A society in which disruptive green innovations come to the rescue	A decentralized degrowth society
Implications for the role of animal-sourced foods in future food systems	Animal-based nutrition is marginal and mostly replaced by lab meat, whereas "healthiness" of diets is prioritized over taste and food culture; governments control food shortages through digital recognition and "reallocate wealth to improve access to nutritious and healthy food for the poor"	Alternative proteins like insects, algae, artificial meat, and plant-based dairy alternatives have increased to an industrial scale and are subsidized, while dietary choices are affected by a culture shift and policy instruments (taxes, subsidies, carbon pricing)	Multinationals control much of the food production, but the internalization of environmental externalities is steered by policy and pricing incentives shift dietary choices away from animal products towards artificial meat, insects, pulses, algae, and eggs	Organic farming enhanced with collectively utilized digital innovations is the primary food production method, leading to seasonal and plant-based (legume-rich) diets low in animal products (rendered expensive due to taxes), a shift "motivated by ethical and ecological reasons"

transitions, with a specific focus on the role of meat and other animal-sourced foods in human diets. It will also explore the pitfalls of incautiously applying a "Great Food Transformation." The conclusion will provide recommendations for a more robust approach to drive dietary change to support human and planetary health.

Exploring (Food) System Transitions

Food system (in)stability from a multi-level perspective

A given food system is a complex system-of-systems, interconnected through feedback loops (Jager, 2024). Based on multi-level perspective (MLP) methodology, it can be described as a dynamic constellation of 3 sub-systems, namely its 1) *macro* level, or socio-ecological landscape of *longue durée*, shaped by environmental change, demographical trends, political ideologies, societal values, and macro-economic patterns, 2) *meso* level, in which societal interactions, food production, and dietary behaviors are part of a stabilized "regime," and 3) *micro* level, where potentially disruptive niche innovations are taking place (Figure 1).

The meso level is the one focused on during food system transitions, as this is where regime shifts take place. A regime is a superposition of cultural, scientific, economic, technological, and policy sub-regimes, which are deep structures embodying rules that orient and coordinate human foodways (Geels, 2011). They correspond with food system states that are resilient due to lock-in mechanisms ("attractors"), such as shared beliefs, mores, and folkways (Sumner, 1906), scale economies, power relations, political lobbying, and institutional commitments. As such, the concept shares features with that of a Foucauldian *episteme*, particularly in how knowledge and power are structured and stabilized (Leroy et al., 2020).

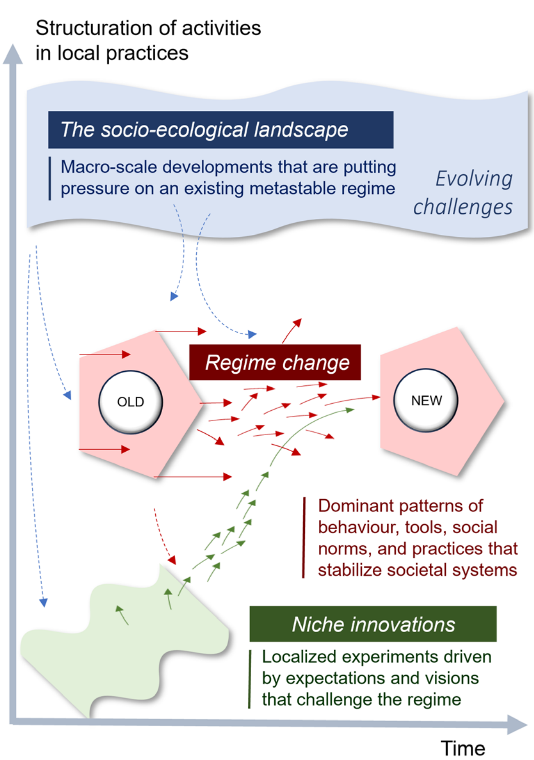

Figure 1. Multilevel perspective (MLP) analysis of (food) system transitions, as affected by the socio-ecological landscape and niche innovations.

Dietary traditions usually act as barriers, resisting change whether beneficial or detrimental (Jager, 2024). Meat consumption, for instance, remains a deeply rooted element of diets across cultures, even as the forms of these traditions vary widely and evolve over time (Leroy and Praet, 2015). Far from being inclined to abandon meat as a preferred food, most humans pursue creative strategies to preserve its role wherever possible, even when confronted by pressures for change. In today's context, this unfolds paradoxically: Efforts by food system experts to diminish meat's prominence overlap with their unintended reaffirmation of its dietary significance, as seen in their support of meat alternatives, e.g., lab-grown muscle (meat) and plant/fungal-derived faux meat (Leroy, 2019).

However, major changes at the socio-ecological landscape level can put enough pressure on the regime to destabilize it, creating opportunities for transformative niche innovations at the micro level. As in Heraclitus' "polemos pater panton," all peace is but an unstable equilibrium while everything is in flux (see also DeLanda, 2021). When there is enough turbulence, a food system can tip over to a new configuration (Geels, 2011). However, within any complex societal system, collapse may occur under the pressure of socio-ecological impact whenever a prevailing regime is overly rigid and hierarchical, stifling experimentation and individual agency, for instance, due to heavy bureaucracy or authoritarianism (Deutsch, 2011). To quote Arendt (1973), "Total domination does not allow for free initiative in any field of life."

Assemblage theory: Non-linearity and virtuality

For readers interested in food systems methodologies, "assemblage theory" provides an underexplored yet promising alternative to MLP (Deleuze and Guattari, 1980; DeLanda, 2016). Any food system (or its sub-systems, such as a dietary regime) can in principle be understood as an *assemblage* (Leroy et al., 2020), i.e., a historically contingent constellation, which consists of both materials (e.g., resources, bodies, tools) and expressive elements (e.g., symbols, norms). DeLanda (2021) has described such assemblages as "transitory hardenings," coagulations or decelerations, in the historical flux of matter, energy, and information. Thus, they become *stratified* (i.e., genetically or linguistically coded into identity) and/or *territorialized* (i.e., homogenized into conformity) to various degrees, whereby the density of interactions between their constituting parts is more important than the parts themselves. For instance, within food systems, dietary habits and rituals act as stabilizing factors, through their coding of food culture and interconnection of past and future through repetition.

Nonetheless, stressors can disturb a regime apparatus, which, through downward causality, behaves as a source of limitations and opportunities for disruptive innovations. Upon the loosening of a complex system's interactions beyond a threshold, autocatalytic loops become self-sustaining, and a qualitatively new type of regime emerges.

Importantly, because assemblages are emergent and cannot be reduced to their constituents, the future state of a regime *cannot* be robustly predicted. Even so, it is possible to specify (and reflect on) the individuation processes that generate and (de)stabilize it. Biological coding through genetics generally lends long-term stability to a regime, lacking flexibility beyond evolutionary timescales (as is the case for evolutionary appropriate diets), whereas language and, especially, technology have intensified the potential for "deterritorialization," enhancing plasticity (see also Deutsch, 2011). As will be shown below, early food system transitions unfolded slowly over vast spans, while recent transitions have proven far swifter.

One of the most liberating features of assemblage theory is its refusal to reduce complex system transitions to fixed, teleological steps. Instead, emergent structures "add themselves to the mix of previously existing ones, interacting with them, but never leaving them behind as a prior stage of development (although, perhaps, creating the conditions for their disappearance") (DeLanda, 2021). Moreover, complex systems are seen as coexisting potentialities within a virtual solution space, even if some organizational forms materialized earlier in history. For example, the seeds for a Neolithic shift to farming were already embedded within the Mesolithic hunter-gatherer model, with pathways to change virtually available, yet actively resisted. As food surpluses provide a pathway to taxation and the formation of elites (Scott, 2017), their ceremonial burning could have been a tactic to block the emergence of centralized authority (DeLanda, 2016). This perspective finds support in empirical evidence of the fluidity and diversity of early human societies (Ungar, 2017; Graeber and Wengrow, 2021).

By highlighting the value of individual agency and experimentation, assemblage theory offers a more libertarian counterpoint to complex system frameworks infused by deterministic thinking. This resonates with the eloquent condemnation by Wright (1926), a century ago, of the narrow Malthusian interpretation of human populations as if they were merely behaving as predictable "fruit flies in a bottle," arguing instead that "the form of the population curve is, in the main, merely a reflection of progress in the ability of man to deal with nature."

Examples of (pre)historical food system transitions

For illustrative purposes, some examples of past food system transitions are provided in Table 2, while relating them to the dietary nutrient density and processing levels (Figure 2). Diets are multifaceted entities that can be defined based on many factors, e.g., environmental impact, safety, affordability, culinary appeal (e.g., flavor), cultural significance, ritual roles, or ethical considerations. Among those, nutrient density (broadly tied to animal-to-plant ratios, since animals are situated at a higher trophic level; Leroy et al., 2025) and the extent of processing (due to technological advances) have been key drivers of human dietary transitions. They have not only shaped dietary change as such but also played a critical role in distinguishing humans from other primates (Kaplan et al., 2000).

This exercise comes with a disclaimer: the transitions outlined below are sketched in broad strokes, focusing on global "revolutionary" events. More granular analyses of food system transitions in specific regions (e.g., in a Pacific, Subarctic, or Amazonian context), or for specific moments in history (e.g., the transitioning of the centralized Inca food system after the conquest by Pizarro in 1533), would offer their own valuable insights (see, for instance, Kiple [2007] for a historical discussion of global foodscapes). Moreover, the sequence shown in Figure 2 should not be seen as a universal, teleological chain of events, but rather as a messy patchwork of transitions that occurred to different degrees, affecting different communities, in different parts of the world, at different moments in time.

Table 2. Overview of key food system transition according to multiple-level perspective analysis (see Figure 1). For a more detailed discussion and references in support, see the "Exploring (Food) System Transitions" section in the main text, as well as detailed discussions by Drummond and Wilbraham (1958), Bulliet (2005), Kiple (2007), Wade (2007), Ulijaszek et al. (2012), Lieberman (2014), Scott (2017), Ungar (2017), Graeber and Wengrow (2021), and Bratman (2022).

System Transition	Time	Socio-Ecological Landscape (Macro Level)	"Niche Innovations" (Micro Level)	Dietary Regime
1. Emergence of early *Homo* species	About 2-3 million years ago (mya)	• Climate change (colder, drier) • Decline in forest cover and plant food availability • Expansion of open ecosystems	• Exploration of the savannah niche • Opportunistic/power scavenging • Extraction of 'inside-bone' nutrients • Primitive tools (digging, butchering, . . .) • Cooperative endurance hunting • Sharing (of knowledge and food)	Transition from fibrous diets based on fruits, stems, leaves, insects, and small prey to savannah-based diets with underground storage organs (bulbs, roots, tubers), enriched with meat and fat
2. Upper Paleolithic transition	About 40-50 thousand years ago (kya)	• Cycles of glacial/interglacial periods • Reduced availability of plant foods • Abundance of large herbivores	• Social complexity, nomadic lifestyles • Cognitive revolution: sophisticated thought, rituals, art, and mature language • Hunting: ambushing, traps, spears • Tools for hunting and butchering • Controlled routine use of fire	Adoption of fat-centered carnivory based on megafauna, complemented with plant foods (when available, and usually as a fallback option)
3. Broad Spectrum Revolution	About 10–20 kya (depending on region)	• Following the Last Glacial Maximum, with more fragmented habitats • Population pressure • Megafauna migration and extinction	• Tools to hunt smaller, faster game • Exploitation of aquatic resources and use of canoes • Processing of seasonal plants (nuts, seeds, . . .) • Forward-planning (storage pits, . . .) • Semi-sedentism (on a seasonal basis) • Social experimentation and trade	Adoption of a more diversified diet (fish, seafood, a large variety of gathered plants, small animals, . . .)
4. Neolithic Transition	About 10–12 kya	• Start current interglacial (Holocene) • More stable seasonality • Reduced wild food availability	• New social structures and religious cults • Settlements in fertile regions • Structured land use for crops • Stone tools for farming, food storage (pottery), and food processing • Management of harvest surplus	Adoption of diets dominated by cereal staples, with limited consumption of meat
5. Secondary Products Revolution	About 5–6 kya ago	• Malnourished, growing populations • Diminishing land fertility (over-farming) • Population pressure and competition for arable land	• Bronze and, eventually, iron tools • Diversification into higher-yield cropping • Improved animal husbandry (incl. traction) • Trade and other interactions between farmers and nomadic pastoralists • Introduction of new dairy technologies	Adoption of more varied crop-based diets, increasingly enriched with animal-sourced foods (with a particular role for dairy)
6. Second Industrial Revolution	1870–1914	• End of agrarian rural dominance • Rapid population growth in urban centers • Trade, colonialism, and new markets	• Technological breakthroughs • Cheap energy, electricity, and steel • Increased agricultural efficiency (selective breeding, seed drill, etc.) • Logistic developments (transportation) and introduction of the cold chain	Adoption of Western diets with higher access to animal-sourced foods and the introduction of refined products
7. Post-industrial transition	Second half of the 20th century, especially since the 1970s (Third Industrial Revolution)	• Globalization and market expansion • Fast-paced and individualized lifestyles • Demand for convenience and diversity	• Automation and high-tech processing • New additives and packaging methods • Sophisticated marketing tools and a more effective media landscape • Global distribution at low costs • Nutritional guidance as 'scientific management' (e.g., low-fat diets)	Adoption of ultra-processed diets, with high levels of oils and refined carbohydrates

(Continued)

Table 2. (*Continued*)

System Transition	Time	Socio-Ecological Landscape (Macro Level)	"Niche Innovations" (Micro Level)	Dietary Regime
8. Future	?	• Triple burden of malnutrition • Environmental pressure (climate change, biodiversity losses, . . .) • Evolving human-animal relationships	• Emerging process technologies (cultured meat, precision fermentation, . . .) • 'Sustainable development' • Digitalization and e-technologies • Food delivery and retail innovations • . . . ?	?

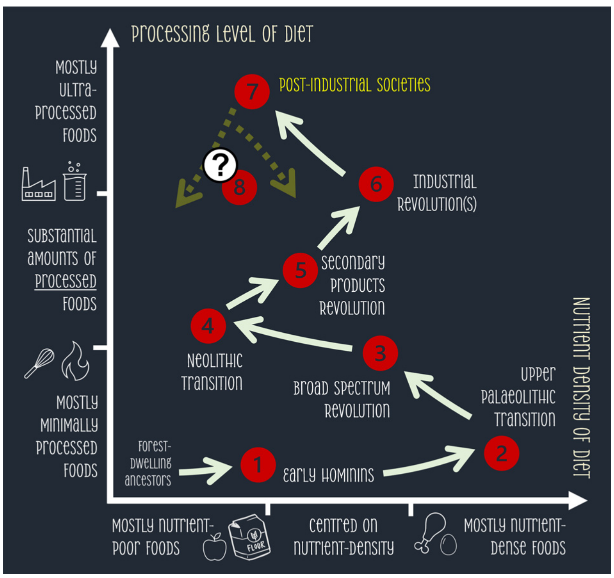

Figure 2. Major food system transitions across (pre)history, plotted against dietary processing and nutrient density levels.

Pre-agricultural food systems: From forest-dwellers to Mesolithic foragers

Across a wide lens, 3 major pre-agricultural food system shifts can be identified and tied to socio-ecological changes and niche innovations. About 2–3 million years ago (mya), a first transition was triggered by gradual climate change that had already begun 7–8 mya with the closing of the Panama Isthmus (Bacon et al., 2015), and led to widespread forest loss, eventually pushing semi-vegetarian early hominins out of shrinking woodlands and into the expanding savanna (Lieberman, 2014; Ungar, 2017). A dietary shift from fruits and fibrous plants to a grasslands-based diet favored an increased consumption of underground storage organs (roots, tubers, and bulbs), alongside a growing reliance on animal foods.

Initially, these animal resources came from (aggressive) scavenging and modest hunting, but as tools improved for extracting inside-bone nutrients (marrow and brains), they became more critical dietary components (Thompson et al., 2019). Surviving in a new high-pressure environment with foods that were harder to obtain, especially in the presence of dangerous predators, required multiple evolutionary adaptations (Ulijaszek et al., 2012; Lieberman, 2014; Ungar, 2017). For instance, by reducing the fermentative capacity of the digestive system and adapting it towards more nutrient-dense diets, larger brains could be developed (Aiello and Wheeler, 1995). Such biological adaptations occurred in parallel with an ability for proto-language, cooperation, a more sophisticated theory of mind, and possibly an emerging morality (Tomasello, 2019; Bratman, 2022). The expansion of technological skills allowed proto-humans to hunt and butcher animals with more advanced tools by 2 mya and make deliberate use of fire (by 700–400 kya, possibly earlier) (Lieberman, 2014). *Homo erectus*, an adaptable yet obligate co-operative hunter and dietary generalist, was able to target diverse prey (including ungulates) across varied habitats, while also incorporating a variety of starchy plants in the diet through processing (i.e., roasting/boiling, pounding/grinding, soaking/leaching, or fermenting) to make them more digestible and nutritious while mitigating their toxicity (Ungar, 2017; Bratman, 2022; Mercader et al., 2025).

As climate cycles began to compromise plant availability in some regions, the human lineage evolved into one of "fat hunters" targeting large game (Ben-Dor et al., 2011), which came with more risk but also with higher nutritional returns. Against that background of meat- and fat-rich diets, anatomically modern *Homo sapiens* emerged, some 300 kya (Lieberman, 2014). To be able to hunt, butcher, and process these sizeable animals, new technologies were needed, which by 80–40 kya included the use of arrowheads. Moreover, the "Upper Paleolithic Revolution" (50–40 kya) caused a surge in creative expression, suggesting a cognitive or social tipping point into behavioral modernity (Wade, 2007). During the Ice Ages, at least a part of the *Homo* population behaved as megafauna-focused hypercarnivores (Ben-Dor et al., 2021). In Upper Paleolithic Eurasia (45–30 kya), mammoths and other megafauna provided most of the caloric intake (Wade, 2007), which was later also the case in North America for the carnivorous Clovis people, 13 kya (Chatters et al., 2024).

However, intensive hunting pressure in combination with widespread ecological change, at least partially caused by the gradual disappearance of the hunted megafauna, forced a new food source transition which was only successfully adopted by *Homo sapiens* (while other *Homo* species were not able to adapt and eventually vanished). Indeed, during an earlier climatic bottleneck around 130–100 kya, a small population of *Homo sapiens* may have survived along the southern coast of Africa by relying on a stable marine-based diet rich in shellfish and other coastal resources (Marean, 2014). This dietary niche offered a more predictable food source when inland environments became increasingly inhospitable, playing a critical role in the survival and later expansion of our species.

During the millennia following the peak of the last Ice Age glaciation (approximately 20 kya), Eurasian diets transitioned toward smaller game, birds, aquatic resources, and diverse plants due to climate change, fragmented habitats, and megafauna extinctions in the Epipaleolithic Near East, and later in Mesolithic Europe (Weiss et al., 2004; Ben-Dor and Barkai, 2023; Scerri et al., 2025). As glaciers retreated, coastal waters over continental shelves provided rich and accessible fisheries, while a return of forests resulted in an abundance of wildlife and edible plants.

This "Broad Spectrum Revolution" led to diets with a wider range of foods, including previously ignored or less desirable items, favored more agile hominins, who began experimenting with a large variety of new social structures and semi-sedentism, driving innovations in hunting tools, fishing gear, and food processing and storage techniques (drying, smoking, salting, etc.) (Graeber and Wengrow, 2021). With the appearance of surplus resources and food preservation (for instance, of harvested wild cereals and nuts), occasional departures from the previous hunter-gatherer model with its small group sizes, egalitarianism, and loose territorial boundaries led to larger and more structured communities with stronger yet still somewhat flexible hierarchies (Wade, 2007; Bratman, 2022).

Agricultural food systems: From cereal staples to industrialized diets

Building on an Epipaleolithic context of experimentation, for reasons that are still debated and may well go beyond the effects of abrupt climate change, including social and cultural motives (Ungar, 2017), a shift to agrarian societies happened separately in different places around the globe (Ulijaszek et al., 2012; Lieberman, 2014). After its emergence around 12 kya in Neolithic Anatolia, farming spread into Europe over the next millennia. Domesticated cereals became staples at the expense of the more nutrient-dense foods of foragers, resulting in reduced stature, dental erosion, and nutrient deficiencies that are indicative of low-protein diets with high glycemic loads (Larsen, 2006; Ulijaszek et al., 2012; Grasgruber et al., 2016; Latham, 2016; Perkins et al., 2016; Scott, 2017; Williams and Hill, 2017), even if such negative health impacts differed between regions and periods (Ungar, 2017). In parallel, a sequence of population booms and busts took place, whereas denser living conditions and proximity to domesticated animals increased pathogen exposure, posing global challenges ever since (Ulijaszek et al., 2012; Lieberman, 2014; Larsen, 2023).

Over time, the role of meat regained significance, at least in some areas (Hendy et al., 2018). Moreover, following a "Secondary Product Revolution" (a widespread set of innovations in Old World farming to include the exploitation of livestock for renewable "secondary" products, i.e., beyond "primary" meat production), food supplies stabilized and diversified (Sherratt, 1983; Münster et al., 2018). Besides meat, livestock also yielded dairy and wool, traction, manure, and cultural value, paralleling advances in farming and improved nutritional inputs from both animals and plants. Catalyzed by interactions with pastoralists, dairy became foundational to the nourishment of many farmers (Stock et al., 2023).

Forager, farmer, and pastoralist legacies diversified Eurasian genetics and dietary cultures (as well as language, technology, and economic, political, and social models; Wade, 2007; Spinney, 2025), so that diets eventually evolved into Antiquity, the Middle Ages, and Early Modernity along intricate food system trajectories (including major events like the Columbian Exchange, which would require their own dedicated analysis; Kiple, 2007). These varied substantially by region, resources, and social status—wealthier groups enjoyed meat and fish, while the poor regularly faced malnutrition (see, e.g., Drummond and Wilbraham, 1985). A detailed description would exceed the scope of this article but, eventually, the post-1850 Second Industrial Revolution broadened access to animal-sourced foods in the West and led to improvements in nourishment (visible for instance in stature increase; Lieberman, 2014), which was followed post-WWII by the global Green Revolution and the rise of industrialized diets (Ulijaszek et al., 2012; Leroy and Degreef, 2015).

Contemporary post-industrial food systems and beyond?

Following hyper-industrialization of the food system, urbanization, shifting social structures, and economic drivers, traditional communal meals have declined (Leroy and Degreef, 2015). Once centered on cooking with primary produce, meals have increasingly been replaced by individualized, convenience-based options dominated by snacks and ultra-processed foods (Monteiro et al., 2013; Lieberman, 2014; Raubenheimer and Simpson, 2021). While low-income regions continue to struggle with malnutrition due to carbohydrate-based diets, their urban centers are now adopting Westernized foods. Meanwhile, even in high-income countries, the poorest households often face food insecurity, with a significant rise in food banks.

Today, global malnutrition is severe, with widespread overconsumption of calories paired with an insufficient intake of essential nutrients, driving chronic conditions and neurodegenerative diseases, as well as nutritional deficiencies (Ulijaszek et al., 2012). Around 150 million children under 5 are stunted, 50 million are wasted, and almost 40 million are overweight (FAO, 2024). More than half of preschoolers and two-thirds of nonpregnant women lack essential micronutrients (Stevens et al., 2022). Adult obesity rates have doubled since 1990, while childhood obesity has quadrupled. Over one billion people are obese, twice the number that are underweight, and most of the world's population is projected to be overweight by 2035 (NCD-RisC, 2024).

Given this unsustainable trajectory of public health combined with critical environmental damage caused by agriculture, food systems theory has been called upon to explore potential transitions and future pathways (Willett et al., 2019). However, as will be discussed below, many of the proposed solutions come with pitfalls and trade-offs that are often overlooked.

The Problem With Complex Systems (and Their Experts)

Systemantics, or the mismanagement of complex systems

Before we explore the problem of misguided food system transitions in particular, a closer look at the dynamics of complex system failure and its link with policymaking will be presented. Unfortunately, even in the context of a crisis, setting up a grand system transition scheme can be a decisive first step toward disaster. Gall (2012) coined the term "systemantics" to describe the widespread mismanagement of complex systems in general. He also lambasted the technocratic class for its over-systematization, bureaucratization, and inflated sense of control, at the expense of practical experience and real-world needs. This disconnect leads to a Kafkian mindset: what goes unreported ceases to exist, while system-declared "facts" are officialized and accepted as reality. Though many system design and transition strategies originated as noble efforts to improve living conditions, sparked by religious or social ideals, they may "eventually end up as elaborately self-referential thickets of other-worldly dogma."

Gall's Operational Fallacy asserts that novel large systems rarely achieve their stated goals, and the people within them seldom perform the roles officially assigned to them. Today's near-religious faith in systems theory blinds experts to glaring design flaws. "Failure to function as expected is to be expected," since newly designed or radically modified systems in general typically operate in a state of dysfunction, producing unpredictable outcomes as they push back (Gall, 2012). Their unpredictability stems from an intricate interplay of feedback signals, alongside the flawed assumption that a large system will simply behave like a smaller one but on a larger scale. Also, a single element in a system simultaneously belongs to countless other systems (DeLanda, 2016, 2021), complicating the anticipation of its behavior. To make matters worse, complex system behavior is often quantified based on overly simplistic algorithms. For instance, the *Limits to Growth* report has been critiqued by Smil (2019) for having a "world model" that aims to simulate the entire human population and its use of planetary resources, and which can at the same time be condensed into fewer than 150 lines of programming code while relying on "indefensible simplifications and misleading assumptions."

The difficulty of system evaluation and how to avoid its malfunction

Large systems easily run out of control because malfunction may not be detectable for long periods. The mode of failure cannot ordinarily be determined from its structure, and crucial variables are usually discovered only by accident. Meaningful information is likely to emerge spontaneously, at a late stage, and often when it is no longer needed. As per Gall (2012)'s Inaccessibility Theorem: "The information you have is not the information you want. The information you want is not the information you need. The information you need is not the information you can obtain." Moreover, persistence in long-term data-gathering can be self-defeating and may lead to passivity, used as a means of not dealing with the actual problem.

Evaluating complex system performance is further "compounded by the difficulty of finding proper criteria for such evaluation." Regardless of which formal Goals and Objectives bureaucrats have come up with as the system's stated purpose, a complex system develops a will of its own the instant it comes into being (thereby trying to maintain itself). As systems expand, "new functions appear suddenly, in stepwise fashion," while some of the basic functions are lost.

How then, according to Gall (2012), should system-based policymaking move forward (i.e., in general, and not limited to food systems)?

- Do not interfere with working systems, or at least not in radical manners: "In setting up a new system, tread softly. You may be disturbing an actual system that is working."
- Build on existing systems; systems designed from scratch do not work. If a system does not work, resist "pushing on the system" (bad design cannot be overcome with more design).
- Cherish your system failures and learn from them, taking responsibility for failure.
- Work *with* human tendencies and align with their motivations; do not operate against them.
- To enhance resilience, give room to innovation and always work to increase your options.

The problem with "systems-people"

Why is it that the above-mentioned rules for good practice are all too often not respected, despite being based on common sense? Gall (2012) ascribes the problem to the fact that "systems attract systems-people," whom he portrays unflatteringly. Functionaries and experts are said to be detached from reality, lacking any self-insight ("a person who knows all the facts except how the system fits into the larger scheme of things"). Rather than acknowledging design flaws, they are prone to attribute system failures to "operator error" or external factors, while overestimating their own competence. According to Dunning (2024), "when it comes to their mistakes, experts make them with at least as much confidence if not more than their less knowledgeable peers." Because systems-people are shielded from the world most people inhabit, they are dealing with a "filtered, distorted, and censored version" of it (Gall, 2012). When acting as a group in a political context, this results in misinformation and a disrespect for alternative hypotheses, a problem ascribed to white-hat and allegiance biases, propaganda scholarship, and social pressure to present (or not present) research related to cherished policies (Darwall, 2019; Leroy et al., 2023b; Ederer, 2024; Jussim et al., 2024). Moreover, systems-people operate while lacking accountability, leading to overreach.

As a consequence of all the above-mentioned problems, when experts design a system to solve a given problem, they typically spawn a host of new issues tied to the system's function, or simply its existence (Gall, 2012). These new problems do not dissipate over time but instead persist as the system resists correction, thereby growing, encroaching, and multiplying the challenges. Colossal systems foster colossal errors, which tend to escape notice (and if noticed, may be excused to salvage what has been created).

Unfortunately, the issue is not merely incompetence, hubris, or bias. In the worst cases, naive systems people are deliberately exploited and cultivated as a loyal intelligentsia to serve more sinister agendas (Wolin, 2017; Darwall, 2019).

Systems theory as a cover for central planning

Systems theory is not innocent. Gall (2012) warns: "If it puts a weapon in your hands, it is aiming at some kind of violence." The larger the system, the more the individuals inhabiting it become dispensable abstractions, leading to the many documented horrors of high modernism (Scott, 1998). As such, "systems thinking" can effectively pave the way for governance frameworks that are able to bypass democratic debate, simply by invoking existential threats too complex, global, and technical for public scrutiny.

When a crisis is framed as systemic, urgent, and non-negotiable, power is transferred to unelected and unaccountable entities, such as public-private partnerships, transnational forums, non-governmental organizations (NGOs), think-tanks, media, financiers, and special interest groups (Selcer, 2018; Darwall, 2019). These dense networks are tightly connected to state bureaucracies and legitimize themselves through an astute combination of formalized response goals (e.g., ESG metrics) and moral appeals (e.g., "equity," "justice," or "inclusivity"), using handpicked NGOs as ethical arbiters. By demanding not just belief in the system but also in universal participation, an insistence on "leaving no one behind" is typically seen (as in the aligned rhetoric of the 2030 Agenda for Sustainable Development and the World Economic Forum). Claiming widespread societal legitimacy and approval, governments can then act by taxing, regulating, legislating, and administrating accordingly (Darwall, 2019). Ultimately, this leads to the faceless anonymity of a "managed democracy," whereby ideas are traded for fabricated clichés in a monochromatic mediascape, and whereby dissent is ignored or eradicated. An "inverted" totalitarianism is the eventual outcome, one where leaders are the result of the system and not their architects (Wolin, 2017).

For an effective transfer of power, a systemic crisis should ideally meet 3 criteria. First, it must be monetizable through supranational governance, by framing the "common good" as an investment opportunity for "sustainable development," based on land grabs, offset trading, or the setting up of infrastructure monopolies (Chatterjee and Finger, 1994). Second, system models should be based on opaque and self-validating assumptions established by approved experts and presented as too technical for public comprehension, while allowing for flexible adjustments to parameters and outputs over time. Finally, the presented crisis must be perpetual and intrinsically unsolvable, only manageable, so that it can be controlled indefinitely by the power brokers who defined it. As Arendt (1973) pointed out, "the obsession of totalitarian movements with "scientific" proofs ceases once they are in power," eventually "raising ideological scientificality and its technique of making statements in the form of predictions to a height of efficiency of method and absurdity of content because, demagogically speaking, there is hardly a better way to avoid discussion than by releasing an argument from control of the present and by saying only the future can reveal its merits."

Top-down system planning and the suppression of liberty

Gall's *Systemantics* can hardly be called a scholarly work. Yet, beneath its witty surface lies a deeper intellectual resonance. In *The Road to Serfdom* and *The Constitution of Liberty*, Hayek (1944, 1960) has similarly argued that a centralized system design inevitably leads to perverse consequences. Even if initiated with good intentions, it leads to tyranny; when authorities take over the allocation of resources, they have no choice but to suppress dissent to enforce their plans. As planning expands, it gradually concentrates power in the hands of a few until, eventually, a totalitarian state emerges. Instead, successful and resilient complex systems that can lead to prosperity emerge from decentralized experimentation and liberty ("spontaneous order"), never from top-down design. Hayek was a keen (and shaken) observer of the breakdown of civility during World War II and the sociological processes towards it. One of his core convictions from these observations was the "pretense of knowledge," which became also the title of his Nobel Prize award speech in 1974, in which he criticized the pervasive misunderstanding that complex phenomena could be understood by empirical measurement (Hayek, 1974).

Accordingly, Popper (1945) has claimed that societal systems can only thrive when they embrace openness. Authoritarian systems fail because they are constructed on a faith in "historicism" (the belief that system transitions are deterministic and can be predicted). To create productive system change, experts should refrain from utopian engineering and instead proceed more cautiously with "piecemeal engineering," i.e., based on small, testable reforms.

Scott (1988) has made the argument that the failure of many grand transition schemes stems from their dismissal of *metis* (i.e., local knowledge and human adaptability) in favor of the "thin simplifications" of *techne* (i.e., the formalized and universal knowledge, standardized metrics, and blueprints favored by high-modernist system planners). These projects, driven by a desire for legibility and control, overlook the decentralized wisdom of individuals and communities, leading to inefficiency, resistance, or outright disaster. In contrast, farming skills can be seen as an archetypal example of *metis*, where mastery comes from experience and adaptability rather than abstract instruction.

The Systematics of Food Systems

Food systems as complex systems

The notions of systems theory and (mis)management mentioned in the previous section refer to complex systems in general but are also applicable to food systems specifically. As with any complex system, the radical engineering of food systems—or, worse, their complete *de novo* design—will inevitably give rise to unintended side effects, systemic breakdowns, restriction of liberties, and unforeseen inefficiencies that could destabilize the delicate balance of ecological, economic, and social factors that naturally evolved food systems are more able to address. By replacing evolved practices with a novel and artificial system, we risk stripping away the hard-won adaptability of food traditions, introducing instead a fragile, top-down paradigm or blueprint that is disproportionately vulnerable to collapse under pressure from unexpected challenges.

History provides a sobering litany of examples demonstrating that large-scale, centralized planning efforts that override local dietary habits generate blind spots and precipitate risks to food and nutrient security, threatening entire populations (see below). Such imposed policies dismiss the experiential and informal knowledge that is woven into the fabric of local dietary traditions and community practices, a wisdom rarely codified in formal rules or captured fully by scientific models (Leroy et al., 2020). This knowledge, passed down through generations, reflects adaptations to specific environments and social needs, yet it is undervalued by planners enamoured with grand, universal solutions (from agricultural collectivization to misguided nutritional mandates; Scott, 1988).

Alarmingly, new and even bolder initiatives are emerging that aim to establish experimental food systems on a planetary scale, with potentially dire implications for the future diets of global populations. To illustrate this trend, the specific case of EAT-Lancet's Great Food Transformation will be examined below, as a proposal for a globally standardized diet.

Beware of central planners: Some warnings from history

State-led projects often pursue the creation of "legible" and orderly systems, driven by a desire for control and uniformity. In doing so, they dismantle the adaptive elements that render local systems resilient and effective. Examples of tragic failures abound throughout history, and the 20th century in particular (Scott, 1998). In the 1930s, collectivization campaigns in the Soviet Union herded millions of farmers onto state-controlled collective farms, stripping away individual agency and traditional practices. The result was catastrophic: widespread crop failures, supply chain breakdowns, and a famine that claimed millions of lives. During the same decade, devastating impacts of "technocratization" were seen in the Great Plains of the United States, which contributed to the creation of the Dust Bowl (McLeman et al., 2014). In the 1950s, the Chinese Great Leap Forward policy compelled farmers into vast communal farms under rigid state directives. This led to extreme vulnerability to insect infestations, massive crop losses, and a famine so severe it ranks among the deadliest in human history, killing tens of millions. In the 1960s, Tanzania's Ujamaa policy sought to collectivize agriculture to create a self-sufficient, socialist economy. Local communities were uprooted from their lands, forced to abandon traditional farming methods, and relocated into collective villages. The outcome was dire, with severe food shortages, economic collapse, and widespread poverty. During the 1970s, the Cambodian regime pursued an agrarian utopia by deporting urban populations to rural labour camps, mandating adherence to the state's agricultural blueprints. Approximately 2 million Cambodians died from starvation, disease, or execution. A decade later, in Ethiopia, Mengistu Haile Mariam's government imposed forced collectivization policies to centralize agricultural control. Compounded by drought and poor planning, this triggered a catastrophic famine in the 1980s, killing over a million people. More recently, in 2021, Sri Lanka's government pushed the country to become the first entirely organic farming nation, triggering widespread crop failures, economic collapse, public backlash, and policy rollback, once again underscoring the dangers of swift, drastic food system changes (Nordhaus and Shah, 2002). Even national dietary guidelines, often assumed to be neutral tools for public health, have shown the potential to cause harm when imposed through centralized planning. In the United States, the introduction of the Dietary Guidelines for Americans in the 1980s coincided with a dramatic rise in obesity and chronic disease, raising concerns about the scientific validity and public health impact of such top-down recommendations (Hite et al., 2010).

Current plans for food system disruption: A focus on meat

Although these failures from a not-too-distant past serve as a cautionary tale, contemporary proposals for central planning are being pushed forward. Remarkably, and for reasons detailed elsewhere (Leroy, 2019; Leroy and Hite, 2020), such efforts exhibit a disproportionate fixation on the role of animal-sourced foods. In pursuing such agendas, interventionist measures target the various socio-cultural (e.g., by shaping public opinion toward vegetarianism via media campaigns), market/user (e.g., by nudging consumers toward plant-based foods in retail settings), policy (e.g., by proposing the introduction of a meat tax or buying out farmers), technological (e.g., by advancing lab-grown 'meat'), and science (e.g., by stimulating an academic anti-meat discourse) regimes of the food system (Leroy et al., 2023).

At the system's macro level, proponents argue that climate change, evolving models of human-animal interactions, and the public health crisis will destabilize the existing regime. At the micro level, reliance on disruptive technologies is central to this vision, epitomized by the concept of "food from factories". Precision fermentation, lab-grown "meat," "plant-based" faux animal-sourced food mimics, and algae- and insect-derived foods aim to descale livestock agriculture, freeing up land for alternative uses (such as conservationism) while replacing animal-sourced foods with novel substitutes (EEA, 2025). This is not a strawman argument; for an overview of how extreme such proposals for disruption can be and how seriously they are considered at the highest levels, see Leroy et al. (2023b).

The underlying expectation seems to be that enough people will adopt these changes, normalizing the new paradigm and triggering cascading effects once a critical tipping point is reached within society (Centola et al., 2018). Yet, when a transition lacks broad acceptance, it risks provoking polarization and revolt (Leroy, 2019). This tension is amplified by the converging agendas of ecotopian and animalist ideologies, both of which tend to impose prescriptive moral frameworks onto food systems. While the former promote technocratic dietary reform for planetary health, the latter frame livestock farming as ethically illegitimate, leveraging the concept of sentience to justify the systemic elimination of animal-based foods.

The Great Food Transformation

EAT-Lancet and the Planetary Health Diet

Today's embodiment of top-down food system transformation toward a centrally designed blueprint is provided by the EAT-Lancet Commission's Great Food Transformation (Lucas and Horton, 2019; Willett et al., 2019). The Commission proposes a semi-vegetarian Planetary Health Diet, allowing only for small amounts of animal-sourced foods, especially meat (matching the level of countries like India and Indonesia). To implement this diet globally, it advocates a highly interventionist top-down approach. More specifically, the EAT-Lancet report stipulates that "countries and authorities should not restrict themselves to narrow measures or soft interventions" because "the scale of change to the food system is unlikely to be successful if left to the individual or the whim of consumer choice" (Willett et al., 2019). For instance, the C40 Cities initiative has set an "ambitious goal" to remove meat and dairy from public meals in several global cities by 2030, based on the EAT-Lancet report (C40 Cities, 2019).

The Great Food Transformation sets a target for red meat at 5 kg/p/y (within a window of 0-10 kg/p/y) and a total meat intake of 16 kg/p/y (within a window of 0–31 kg/p/y, for red meat and poultry combined). The suggested caloric contribution by all animal-sourced foods is a mere 14%. Only small daily rations of beef or pork (each at 7 g) and eggs (13 g) are prescribed, in addition to some poultry (29 g), fish (28 g, but limited to 40 kcal), and dairy (250 g, limited to 153 kcal). For comparison, the limit for refined sugar was set at 31 g (120 kcal). The Commission also endorses a meatless vegetarian or vitamin B12-supplemented vegan approach as a valid option.

It is important to consider that the above-mentioned dietary estimates were "not set due to environmental considerations, but were solely in light of health recommendations" [as per EAT's former science director, Fabrice DeClerck; Mitloehner, 2019]. This contrasts with what is commonly assumed about the Planetary Health Diet and how it is usually promoted as a diet with an environmental rationale. Even if there has been an assessment of how the diet aligns with "planetary boundaries" (a concept coming with its own criticism; Montoya et al., 2018), its actual composition is based on health theory, as mostly designed by Harvard University's Walter Willett. Yet, the claimed protective health effects were shown to be methodologically flawed, to neglect the proper standards for transparency and replicability, and to not hold up empirically when explored at the global level (as checked for using data from the worldwide PURE cohort), which undermines the validity of the entire setup (Zagmutt et al., 2019, 2020; Mente et al., 2023; Stanton, 2024).

Origins of the Great Food Transformation

The technocratic framework of the Great Food Transformation traces back to EAT's origins within the World Economic Forum (WEF) ecosystem (for details, see Leroy et al. 2023a, b). Initially established by a WEF Young Global Leader, EAT/WEF's various private-public partnerships span influential groups like the WBCSD, the World Resources Institute (WRI), C40 Cities, the Club of Rome, and the Food and Land-Use Coalition. Beyond these, EAT maintains operational ties with vegan-tech industries (e.g., the Good Food Institute), embedding itself within a network of activists (Ederer, 2024). This network extends to academics (e.g., NYU's Center for Environmental and Animal Protection and Harvard's Animal Law Department), journalists (e.g., Sentient Media), NGOs (e.g., 50by40), financial players (e.g., FAIRR, KBW Investments, and Open Philanthropy), and think tanks (e.g., RethinkX) (Leroy et al., 2023a).

The proposal for a global shift to a Harvard-designed, low-meat diet predates EAT-Lancet by a decade, first proposed as a "Healthy Diet" transformation for the 2010-2030 period (Stehfest et al., 2009). The "Planetary Health" concept emerged from the New Nutrition Science project around 2000, culminating in the Giessen Declaration (Cannon and Leitzmann, 2006). More broadly, the "Great Food Transformation" aligns with a continuum of grand transition schemes, echoing the WEF's "Great Reset" and "Great Transformation" vocabulary (WEF 2012, 2020), the eco-utopian "Great Transition" initiatives of the Tellus Institute and the U.S. seat of the Stockholm Environment Institute (an organization at the basis of the Stockholm Resilience Centre) (cf. Raskin, 2016), and the "Great Transformation" of the German Advisory Council on Global Change (WBGU, 2011, 2013).

The founding chair of WBGU, Hans Schellnhuber, was also the founding director of the Potsdam Institute for Climate Impact Research and was succeeded in 2018 by Johan Rockström, then director of the Stockholm Resilience Centre and a co-founder of EAT (Turow-Paul, 2016). Being a member of the Club of Rome, as well as an influential figure within certain factions of the EU, the Vatican, and the UN, he embraces the idea of global governance (for instance, by establishing a UN-led Global Council and Planetary Court; Schellnhuber, 2013). Together with WBGU, Schellnhuber was a prominent actor at the 2019 "Great Transformation" conference in Essen, Germany, during which the compatibility of conventional democracy with the need for sustainability scenarios was questioned (Darwall, 2017). Participants argued that a transformation akin to the Neolithic and Industrial Revolutions was inevitable but, unlike those spontaneous shifts, would require engineering through global governance, facilitated by NGOs, scientific experts, and "change agents". With respect to diets, WBGU's "Great Transformation" proposal involves meat-free days, much less livestock, and the promotion of insect consumption (WBGU, 2011, 2013), in line with similar output by the WEF (2018, 2019, 2020).

What can and (most likely) will go wrong?

In a biopolitical context, systems-ignorant public interventions can have serious ethical repercussions on individual responsibility and freedom, cause iatrogenic harm, and affect societal well-being (Mayes and Thompson, 2015). Although it is impossible to predict the full impact of a sweeping Great Food Transformation, several foreseeable issues can already be identified:

Public resistance and cultural erosion. Overruling the "whim of consumer choice," as proposed by the EAT-Lancet Commission and some of its allies, will be met with fierce resistance, given that meat is one of the most highly valued foods worldwide. Livestock and animal-sourced foods are deeply embedded in the religious, culinary, and other traditional practices of many societies. Restricting access to these foods could erode cultural heritage, alienate communities, progress rural decline and urbanization, and undermine social cohesion (Smaje, 2023). In the past, reduced meat access has already contributed to the democratic revolutions of the late 18th and 19th centuries, the violent Chilean food riots in 1905, and the nationwide protests of 1980 in Poland, when the price of meat was raised by the Communist government (Leroy and Praet 2015).

Nutritional inadequacy. The Planetary Health Diet is both cereal- and oilseed-heavy and low in animal-sourced foods, features that typify the dietary situation in low-income countries. Its global adoption would aggravate deficiencies in key nutrients that are already limiting worldwide (Beal et al., 2023; Leroy et al., 2025). Within high-income countries, a track record of nutritional risk associated with macrobiotic and other comparable diets serves as a further warning (Dagnelie and van Staveren 1994; Leroy et al., 2022a, 2023c). Also, the long-term health impacts of consuming novel "alternative" foods as dietary staples, such as lab-grown "meat" or plant-based faux animal-sourced foods, are not understood. Faux products usually rely on highly processed ingredients, additives, or synthetic compounds, which could pose unforeseen health risks.

Economic vulnerabilities and food insecurity. Livestock are deeply interwoven with the socio-economic and food (and nutrient) security context of global households, especially in low- and middleincome countries (Ederer et al., 2023), but also in high-income regions (Gundersen et al., 2025). They play a key role through effects on soil fertility and crop yields, valorization of low-quality resources (i.e., use of marginal lands and the upcycling of crop waste and other inedible materials), and contribution to purchasing power (i.e., rural development, asset savings, empowerment of women) (Leroy et al. 2022a). Assuming that these roles can readily be replaced by upscaling crop agriculture and novel bioreactor-based technologies is wishful thinking.

Poor food system resilience. Centralized ecomodernist approaches introduce fragility, as they tend to prioritize efficiency over the flexibility needed to adapt to diverse and changing conditions (Smaje, 2023). Although, on the surface, the Planetary Health Diet seems to be built on whole-food approaches, both the *modus operandi* and the partnerships of the EAT Foundation, including the vegan-tech lobby of the Good Food Institute, indicate that filling the food gaps created by decimation of livestock herds would require reliance on a narrow set of novel production technologies and "alternatives" (Leroy et al. 2023b). Similar expectations are discernible in the European Environment Agency's "Imagining a sustainable Europe in 2050" document (EEA, 2025), among others. Rapidly replacing existing agricultural practices with an untested and likely centralized "food from factories" model would probably weaken resilience and food sovereignty, leading to an even more uniform and corporatized food system, dominated by high-tech players, patents, and multinationals (Leroy et al. 2022a; Smaje, 2023). This could exacerbate inequalities, making nutritious food less accessible for low-income populations. Moreover, scaling up crop-based and bioreactor-based food systems would depend heavily on globalized supply chains for key inputs (e.g., monoculture crops, fertilizers, or bioreactor substrates), which will further increase vulnerability to systemic disruptions, such as climate shocks, technological malfunctions, and geopolitical conflicts (Smaje, 2023).

Uncertain environmental impact. A large-scale transition to "alternatives" will, despite improvements in some environmental parameters, e.g., agricultural methane emissions, also come with ecological tradeoffs. Lab-grown "meat" and microbial protein, for instance, are energy-intensive, and their long-term environmental footprints are not understood (Smaje, 2023; Risner et al., 2025). This may have a disproportionate ecological cost if adopted at scale (supposing technological constraints ever allow for that, which is not to be taken for granted; Smaje, 2023; Wood et al., 2023). Moreover, removing animal husbandry, despite the harm some of its variants are clearly causing, would also negate its positives and further potential for improvement, based on the closing of nutrient cycles (e.g., nutrient stripping of manures for renewable N and P sources), soil health, and the provision of ecosystem services. Environmental benefits of livestock-mediated herbivory can be inferred from livestock-abandoned landscapes when compared to pastoralist cultural landscapes, especially with respect to biodiversity, wildfire prevention, and soil restoration (Leroy et al., 2022a). To remain productive, radical shifts to plant-based agriculture would expand fossil fuel-driven monoculture cropping of key staples, harming topsoil and landscapes. In a Danish context, for instance, full adoption of the EAT-Lancet diet would cause substantial losses of soil organic carbon while increasing N_2O emissions, due to a reduction of animal manure applications, an increase in the use of inorganic fertilizers, and a ploughing up of grasslands (Michailidis et al., 2025). Land-use efficiency is also quoted as a key benefit of reducing global livestock production, but this is an over simplification as livestock predominately utilize land unsuitable for growing crops (i.e., rangeland and grassland), by-products of crop cultivation (i.e., unsuitable for human consumption), or crops for human consumption which have failed to meet human food requirements (e.g., milling or malting standards for cereals) (Wilkinson and Lee, 2018). Furthermore, while some forms of livestock farming can be water-intensive (especially when based on irrigated feed), large-scale (monoculture) cropping for plant-based diets or feedstocks for alternative proteins will also require substantial water use, worsening scarcity in arid regions (Meier and Christen, 2013).

Lack of suitable alternatives for co-products. Drastically reducing livestock will not only lead to a reduced production of animal-sourced foods but also limit the production of societally important services and co-products (hides, wool, bone, serum, etc.), which will need to be replaced by other resources that are not necessarily net beneficial. For instance, a shift from biodegradable textiles from animals to artificial fibers could contribute to the spreading of microplastics (Leroy et al. 2022a). Furthermore, the removal of tallow (animal fats) has significantly increased demand for palm oil, with perverse ecological impacts and biodiversity decline driven by the expansion of palm oil plantations.

Recommendations for More Robust Ways Forward

What is known from a food systems perspective?

Viewed through a multi-level food systems lens, consensus on the future trajectory of food system transformation is achievable among varying perspectives when it comes to *macro-level* factors. The strain on today's food system is clear, driven by climate change and other environmental pressures, the growing and unsustainable public health crisis, and the trend towards new forms of human-animal relationships (particularly concerning livestock welfare, but also with respect to One Health). Eventually, this will contribute to a shift in the prevailing regime (*meso level*). Where opinions diverge is on the preferred *micro-level* strategies and niche innovations.

As outlined above, the "Great Food Transformation" makes a case for interventionist policies, technocratic design, and universalized solutions (the "Planetary Health Diet," which is *de facto* an expert-designed dietary blueprint intended for global adoption). This approach prioritizes urgency over certainty, pushes for low amounts of animal-sourced foods (shifting diets in the domain of low-density, cereal and oilseeds-heavy options), and seeks to curtail livestock farming (Figure 3). A lot is all too optimistically expected from the potential of (high-tech) novel foods (Smaje, 2023). In its most simplistic variant, the belief is that these innovations will inevitably trigger societal change, similar to the Marxist assumption that mere technological change alters the production relations within society and, subsequently, its superstructure (von Mises, 2010). For instance, the think tank RethinkX (2019) has boldly predicted that precision fermentation will lead to the collapse of the dairy and cattle industries by 2030 (RethinkX, 2019). Similarly, the activist journalist George Monbiot has claimed that "lab-grown food will soon destroy farming–and save the planet" (Monbiot, 2020). Of note, both Monbiot and the founder of RethinkX (James Arbib) have held a seat on the Advisory Board of the EAT Foundation. For a detailed critique of this "Ctrl-Alt-Del" approach to food system reform and the ecomodernist push for "manufactured foods," see Smaje (2023).

An alternative vision advocates for the sustainable and context-specific transformation of a wide diversity of already established, time-tested practices, adapting them to future challenges through evidence-based innovation (Leroy et al., 2022b; FAO, 2023). Global food cultures hold a wealth of local, practical knowledge that serves societal needs in ways a top-down, engineered food system would overlook (Smaje, 2023). From a food systems perspective, dietary traditions are relatively stable because they arose gradually, have been tested by the practical demands of their environment through trial and error, and reflect generations of adaptation to local conditions, values, and cultural preferences, nourishing both bodies and identities—in short, they can be seen as "systems that work" (Leroy et al., 2020). Furthermore, traditional food systems are often more decentralized and diverse, giving them greater resilience in the face of crises (Smaje, 2023). This does not imply that one should be blind to the need for productive innovation (Geyzen et al., 2019); on the contrary, but only that high enough standards of evidence

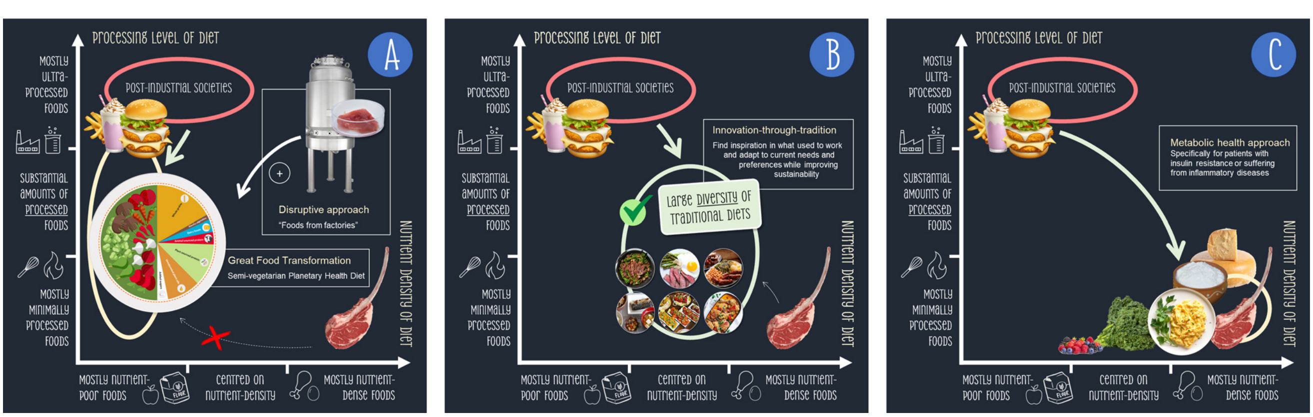

Figure 3. Strategies to exit the post-industrial diet paradigm, including (A) a shift to a Planetary Health Diet approach, which implies sharply reduced levels of key nutrient-dense foods (incl. red meat) and supplementation with "foods from factories," (B) the option of "innovation-through-tradition," based on innovating a rich legacy and diversity of traditional diets towards contemporary needs (middle), or (C) specific pathways for metabolically compromised individuals, based on diets with high average levels of nutrient-dense foods.

are required when introducing change (strong interventions require strong evidence). Both tradition and innovation are critical for success (after all, tradition is nothing more than a collection of innovations that have been successful and therefore maintained over time), not in the least because policies and practices must allow space for localized creativity and be actively adapted to region-specific contexts. In animal husbandry, for example, this means developing optimal land-use strategies alongside existing monitoring tools and technologies (Maree et al., 2025).

The Dublin Declaration and Denver Call for Action

An alternative vision to the Great Food Transformation finds its formal expression in the 2022 "Dublin Declaration of Scientists on the Societal Role of Livestock," supported by over 1,200 scientists (https://www.dublin-declaration.org; Leroy and Ederer, 2023). The Declaration cautions against "simplification, reductionism, or zealotry" and asserts that responsibly managed livestock are essential for healthy and sustainable food systems. Rather than endorsing untested, large-scale societal overhauls, it advocates for practical, evidence-based improvements driven by scientific progress, technology, and farmer-led practices. The Declaration supports a decentralized and adaptive framework, favoring traditional knowledge (*metis*) and context-tailored solutions: "Livestock is the millennial-long-proven method to create healthy nutrition and secure livelihoods, a wisdom deeply embedded in cultural values everywhere. Sustainable livestock will also provide solutions for the additional challenge of today, to stay within the safe operating zone of planet Earth's boundaries, the only Earth we have."

In 2024, the "Denver Call for Action" was launched and signed by 45 senior scientists, reaffirming the Declaration's foundations while sharpening its focus into 3 actionable demands for policymakers (for the original text, see https://www.dublin-declaration.org/the-denver-call-for-action):

- Nourishment-oriented policy: calling for a shift away from patronizing interventions that aim to discredit nutrient-dense animal-sourced foods (e.g., nudging, taxing meat consumption, removing options), arguing instead for dietary guidance rooted in robust scientific evidence and cultural relevance.
- Recognition of system complexities: rejecting one-dimensional portrayals of livestock as inherently harmful, while calling for more comprehensive and nuanced assessments of harms, benefits, and a multitude of system-specific improvements.
- High standards of evidence: demanding transparent, rigorous scientific methods, free of dogma, to guide decisions.

Publicly confronting the problem of systemantics in agricultural and food policy, as well as academia, is navigating a minefield. It not only challenges the systems that people invested in these matters but also threatens the vested interests driving systemic governance. Such threats are usually neutralized by enforcing a "scientific consensus" through academic capture, digital governance, and media filters (e.g., via "fact checkers"), while dissent is suppressed through reputational attacks, deplatforming, and preemptive delegitimization, rendering it effectively invisible. The Dublin Declaration managed to become highly visible, nonetheless. Predictably, and despite being endorsed by many reputable scientists globally, the Declaration was heavily attacked by vocal groups with anti-livestock sentiment, encompassing activists within media and academia (Leroy et al., 2023a). These attacks had the clear intent to undermine the credibility of both the initiators and supporters of the Declaration by accusing them of conflicts of interest and being contrary to science. For instance, Krattenmacher et al. (2024) called for a retraction of the Dublin Declaration based on their framing of the Declaration as biased due to alleged industry links (for a rebuttal to such accusations, see Leroy et al., 2023a and Belk et al., 2025). Such responses fall within the category of what Jussim et al. (2024) have described as academic "book burning," i.e., appeals to retract or destabilize scientific publications, "usually at the hands of academic outrage mobs (typically via social media)" because they "made claims that violated the social justice sensibilities of the mob" (social justice should here be understood as ecotopian or animal rights ideology).

The Nourishment Table

Building on the Denver Call for Action, the Nourishment Table was introduced as a flexible yet evidence-based dietary framework (Leroy et al., 2025; Figure 4). Amid macro-level pressures like climate change and population malnourishment, it prioritizes human nutritional needs and thriving, carving out

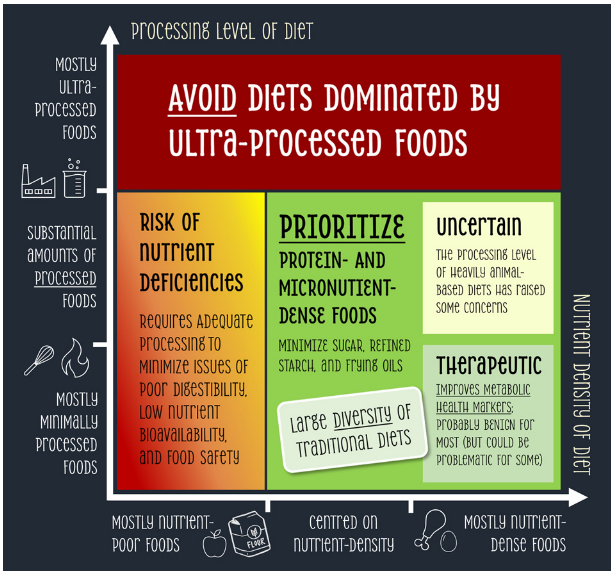

Figure 4. The Nourishment Table allows for dietary flexibility but within the evolutionary boundaries of the human species-adapted dietary solution space, and with added emphasis on the therapeutic potential of diets dominated by nutrient-dense foods (modified after Leroy et al., 2025).

a significant role for sustainably produced animal-sourced foods while steering clear of ultra-processed options. "Nourishment" is a context-specific outcome building on practical knowledge embedded in cultural foodways, not a standardized prescription. Far from either blindly endorsing industrial livestock or fully embracing "alternatives," the Table advocates for refining and enhancing what already proves effective.

By doing so, it marks a departure from conventional food pyramids and dietary guidelines, by redefining the core objective as an evidence-based approach to dietary adequacy. Where the former historically chased "healthy" eating—a vague, disease-prevention-focused ideal rooted in "moderating" food groups, the Nourishment Table glorifies food and elevates "nourishment" as a richer goal (Provenza, 2018).

"Healthy" often meant caloric balance or avoiding chronic conditions like heart disease, based on uncertain, low-quality evidence such as observational studies linking saturated fat or unprocessed red meat to health risks, later nuanced or overturned (Johnston et al., 2023). In contrast, the concept of nourishment prioritizes thriving through nutrient adequacy (especially prioritized nutrients such as protein or calcium, which drive nutrient-specific appetites; Raubenheimer and Simpson, 2021), not debatable correlations. The Nourishment Table embraces self-selection and context-specific outcomes rooted in practical, place-based foodways, rejecting prescriptive dogma for an evidence-driven framework that empowers rather than dictates.

Just as we recognize that other mammals thrive on species-specific diets, human dietary choices must align with our biological needs (Raubenheimer and Simpson, 2021). Yet, the human diet is extraordinarily flexible, unless there are specific medical reasons (e.g., food intolerances or the now very prevalent chronic conditions of metabolic syndrome and type-2 diabetes), and provided the diet stays within evolutionary boundaries (Ulijaszek et al., 2012). The latter implies the need for a balanced nutritional adequacy, especially of priority nutrients, and the minimization of ultra-processed foods to which the human body is poorly adapted (Raubenheimer and Simpson, 2021; Leroy et al., 2025). As stated by Bratman (2001) in his seminal work on orthorexia nervosa: "After a certain point of reasonable dietary improvements, neither happiness nor health comes from increasing strictness."

As has been observed for hunter-fisher-gatherers, as well as for adequate traditional food systems derived from pastoralism and/or agricultural produce, nourishing diets can vary from being animal-heavy to being plant-rich, as long as a minimum level of nutrient-richness is guaranteed within meals. In practical terms, Leroy et al. (2025) have argued that for nutritional robustness, and in the absence of careful supplementation and/or fortification, at least 20–30% of the caloric intake, or half of the protein, needs to come from animal-sourced foods (in line with our evolutionary background). Additionally, plant-based foods should mostly be sourced from wholesome and moderately to highly nutrient-dense sources, such as legumes and dark leafy vegetables (rather than being based on refined starches, sugars, or oils).

Meals need to minimize ultra-processed foods to ensure that the normal physiological mechanisms for satiety and the self-selection of foods according to personal nutritional and metabolic needs are not hacked and overruled by food-like concoctions that are designed by leading food corporations to do exactly that (Moss, 2014; Schatzker, 2016, 2022; Raubenheimer and Simpson, 2021). When subjects are confronted with buffets that are dominated by ultra-processed foods, they will typically overeat (Hall et al., 2019), leading to overweight, energy toxicity, and the development of chronic diseases.

In the case of individuals that already went down the road of chronic inflammation and hyperinsulinemia (e.g., type-2 diabetes, metabolic syndrome, inflammatory bowel diseases, and mental disorders such as depression and Alzheimer's disease), suitable diets need to be tailored to one's metabolic status, often implying that they need to be unprocessed or only moderately so, highly nutrient-dense per calorie and satiating, and devoid of foods that trigger problematic responses. Debates whether such diets ideally need to be low-fat or high-fat, or mostly animal-based *versus* mostly plant-based are ongoing (Zinn et al., 2018; Hall et al., 2021; Dyńka et al., 2015; Teicholz et al., 2025).

Conclusions

Current dietary patterns are recognized as unsustainable, contributing to both environmental degradation and a worsening public health crisis. In response, influential bodies like the EAT-Lancet Commission push for aggressive, top-down policies aimed at transforming the global food system, with a particular focus on drastically reducing animal-sourced food consumption, especially meat. These initiatives advocate for replacing traditional livestock farming with "alternatives" such as cultured meat, plant-based faux animal-sourced foods, and precision fermentation. However, these technologies remain unproven at scale, and their promotion often relies on food systems theory —a framework that, while useful for understanding past dietary transitions, struggles to guide the creation of novel systems. This limitation risks oversimplification, misguided policies, and unintended consequences, as the complexity and unpredictability of food systems defy rigid, centralized blueprints. Even well-intentioned national dietary guidelines, when designed through rigid top-down schemes, have in the past contributed to public health setbacks, underlining how expert-driven planning can backfire when detached from empirical outcomes and human realities.

Interventionist approaches favored by many food system experts prioritize technocratic control over individual agency and societal diversity. Historical evidence demonstrates that such centralized planning frequently leads to food insecurity, nutritional deficits, and social upheaval. The EAT-Lancet Planetary Health Diet, emblematic of this mindset, imposes a semi-vegetarian model that overlooks cultural preferences and unjustifiably downplays the nutritional contributions from animal-sourced foods as well as the ecological benefits of livestock, potentially exacerbating global malnutrition and undermining food system resilience. This view may push the food system back into the malnourished and evolutionary-inappropriate dietary space of early Neolithic meals (Figure 3), whereas an optimistic reliance on untested high-tech "food from factories" would introduce its own vulnerabilities, including environmental trade-offs and the erosion of traditional practices that have long sustained diverse communities.

In contrast, the Nourishment Table offers a more reliable and cautious path forward. Rooted in the principles of the Denver Call for Action, it emphasizes nourishment as a context-specific goal, prioritizing nutrient adequacy, satiety, and the self-selection of foods. This approach supports a decentralized, flexible framework that enhances human thriving and resilience, safeguards freedoms, and mitigates the dangers of overreaching systems. Far from rejecting governmental oversight as such, it recognizes the necessity of establishing firm boundaries (e.g., to curb deforestation, pollution of waterways, and animal mistreatment), provided such guidance is based on rigorous scientific evidence. By focusing on evidence-based improvements and the diverse needs of global populations, the purpose of the Nourishment Table is to reorient the debate toward a foodscape (and thoughtscape) that is human-centered, while avoiding the pitfalls of ecotopian engineering and the inevitable backlash from newly designed and untested systems.

Competing Interests

This manuscript was written in the absence of conflicts of interest. Nonetheless, for full transparency, we declare that all authors serve, on a nonremunerated basis, on the scientific boards of the World Farmers' Organization and the European Parliament's Sustainable Livestock Intergroup (F.L., P.E., M.L., and G.P.). Moreover, F.L. is a nonremunerated board member of various academic non-profit organizations, including the Belgian Society for Food Microbiology (president), the Belgian Association for Meat Science and Technology (president), and the Belgian Nutrition Society, as well as the UN's Food and Agriculture Organization (FAO)/COAG Sub-Committee on Livestock. P.E.'s research organization, GOALSciences, receives funding from a variety of public and private sources to develop interactive display tools on its websites and conduct research on topics related to livestock. The funding is not tied to any particular research result and has neither direct nor indirect influence on the research activities. M.L. is a nonremunerated President of the European Federation of Animal Science Livestock Farming Systems Commission. He represents the UK on the Animal Task Force, a Public-Private think-tank informing the EU parliament in Brussels, and is co-chair of the UK Universities Climate Network – Net

Zero group. He is a member of a Technical Advisory Group of the UN's FAO and represents Harper Adams University on FAO LEAP (Livestock Environment Assessment and Performance). M.L. also sits on the BBC's Rural Affairs Committee and the Agriculture Advisory Group convened by the UK's Climate Change Committee. G.P. is the nonremunerated president of the non-profit Sustainable Meats Association.

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Author Contribution Statement

F.L.: conceptualization, original draft writing, editing; P.E.: review, editing; M.L.: review, editing; G.P.: review, editing.

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