

GLOBAL FOOD SYSTEMS & SDGs REPORT 2025

A Systematic Stocktake of Food-System Issues

Research Center for Shiology, Renmin University of China
Beijing Shiology Research Institute
Secretariat of the World Shiology Forum



MESSAGE FROM THE UNITED NATIONS SECRETARY-GENERAL

for the Fourth World Shiology Forum

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MESSAGE FOR THE FOURTH WORLD SHIOLOGY FORUM

Haikou City, 10 October 2023

I am pleased to send my greetings to the Fourth World "Shiology" Forum.

We are facing a global food crisis.

Around the world, 780 million people are going hungry and more than three billion cannot afford healthy diets. Meanwhile, one-third of all food produced is lost or wasted.

Unsustainable food production, packaging and transportation are feeding the climate crisis – generating colossal greenhouse gas emissions, using over two-thirds of the world's freshwater, and accelerating biodiversity loss.

We must urgently transform food systems to make them more sustainable, equitable and resilient. Governments and businesses must work together to scale up climate-friendly investments. We must also support the women and men who bring food systems to life. And we must leverage science and technology to improve access to healthy foods while reducing the use of water and the carbon footprint.

Together, we can address the root causes of the food crisis, build systems that put people over profit, and end hunger once and for all.

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MESSAGE FROM THE UNITED NATIONS SECRETARY-GENERAL

for the Fifth World Shiology Forum

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THE SECRETARY-GENERAL

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MESSAGE FOR THE FIFTH WORLD SHIOLOGY FORUM

Haikou, 29 October 2025

I am pleased to send my warm greetings to the Fifth World Shiology Forum.

Global hunger is at last declining, after being driven up by a global pandemic, raging conflicts and faultering economies. This is a welcome sign of progress. Yet an estimated 673 million people still go to bed hungry each night.

In many regions, food prices are continuing to climb, and famine has taken hold in Gaza and Sudan.

In our quest for zero hunger, we must invest in agriculture that nourishes people without destroying the planet. That means farming in ways that safeguard water and biodiversity, reduce deforestation and pollution, and help us to mitigate the climate crisis.

With less than five years to achieve the 2030 Agenda, we must act together to create food systems that sustain both people and planet.

The holistic principles of Shiology can help light the way. By recognizing our interconnectedness, we can build resilience across communities, ecosystems, and economies.

Let us seize this moment to confront the root causes of hunger — and ensure healthy, affordable, sustainable food for all.

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Preface I:

Sustaining Food Systems for Health and Peace

The 5th World Shiology Forum is taking place at a crucial time, as the global community accelerates efforts to achieve the 2030 Agenda for Sustainable Development. I sincerely commend the outstanding contributions from collaborators in over 100 countries to the Global Food Systems and SDGs Report. This report reflects the spirit of multilateral cooperation and shared mission—qualities essential for addressing today's urgent food system challenges.

In recent years, our understanding of food systems has changed significantly. What began as a focus on agriculture and supply chains has expanded to include the needs, rights, and behaviors of people as food consumers. A key milestone came on November 18, 2021, with the first United Nations Food Systems Summit (UNFSS), marking a global shift in attention—from food itself to the systems that shape food. This historic shift signals a new phase of comprehensive problem-solving in the food system domain.

Public understanding of food systems has evolved through three main stages: first, from "farm to table"; then, from "farm to consumption"; and now, toward a broader view that includes human food needs and behaviors. This new perspective goes beyond production and consumption to include the full post-consumption cycle—digestion, waste processing, and the return of organic matter to the earth—creating a closed ecological loop between humans and nature.

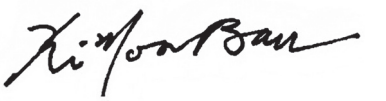
Today, the world faces mounting food system challenges. Around 780 million people suffer from hunger, while more than 3 billion cannot afford a healthy diet. At the same time, one-third of all food produced globally is lost or wasted. Unsustainable food production, packaging, and transportation contribute to the climate crisis, generate

significant greenhouse gas emissions, consume over two-thirds of the planet's freshwater, and accelerate biodiversity loss. Alarmingly, only 17% of the SDG targets are progressing on schedule, and over one-third are either stalled or regressing.

The problems within food systems are deeply complex. We face older issues such as insufficient food supply, along with newer ones like polluted soil and water. Visible problems like food waste coexist with hidden ones such as chronic diseases caused by overconsumption. To tackle these challenges, we need a comprehensive knowledge framework that covers the entire food system. Shiology offers such a framework—integrating "eaters, food, and food order"—and provides a full-chain approach to understanding food system issues.

As the 2030 deadline draws closer, this report—developed as a three-year, three-phase global initiative—arrives at just the right moment. I call on governments, institutions, researchers, and civil society to join forces in building more resilient, fair, and sustainable food systems.

Looking ahead, let us move forward with strong commitment: a sustainable food system is not only a development goal—it is a vital link connecting peace, health, sustainability, and human dignity. I hope this report contributes meaningfully to our shared global efforts to build a more inclusive and sustainable food system community and to shape a new order for food systems worldwide.



Ban Ki-moon
8th Secretary-General of the United Nations
August 8th, 2025

Preface II:

Jointly Addressing Challenges within Global Food Systems

Human challenges arise largely from human needs, and the issues within food systems are no exception. Every person possesses five fundamental eater needs: eating enough, eating with variety, food-safe eating, eating for health and longevity, and sustainable eating. When these Five Eater Needs are not fulfilled, they give rise to issues within the food system. At their core, the challenge of eating enough concerns food quantity; eating with variety concerns food-type diversity; food-safe eating concerns food quality; eating for health and longevity concerns body–food coupling; and sustainable eating concerns the long-term continuity of food supply. These Five Eater Needs thus provide a comprehensive lens through which to understand the multifaceted issues that arise across food systems globally.

Over millions of years of human evolution and the lives of billions of individuals, people have survived, adapted, and evolved in the ongoing effort to meet these essential eater needs. In response to food-system issues, human groups migrated across six continents, developed systems of knowledge and ritual, and established the three major subsistence cultures of agriculture, pastoralism, and hunting–gathering. At the same time, many group conflicts and changes of dynasties were driven by the inability to satisfy basic food security and nourishment needs. This demonstrates that the fundamental issues within the food system long predate civilization, and that the evolution of human societies has progressed hand in hand with efforts to understand and manage these issues.

Humanity has a history of food domestication extending back around 10,000 years, the earliest complex civilizations emerged around 5,000 years ago, and industrial civilization has developed over the past roughly 300 years. Today, 8 billion people

live in 195 countries and regions. Nevertheless, issues within the food system remain widespread. About one in ten people faces hunger; two in ten people suffer from diet-related chronic diseases; and about three in ten people are threatened by food safety risks. At the same time, one-third of all food is lost or wasted, soil and water pollution continue to deteriorate, conflicts fueled by unequal food resources and distribution persist, and rapid population growth places unprecedented strain on global food systems. These stark realities reveal both the complexity and persistence of food-system issues.

Of the United Nations' 17 Sustainable Development Goals (SDGs), 13 are related to issues within the food system. Without comprehensive solutions to these interconnected issues, the SDGs cannot be achieved. Today, humanity's technological capabilities have advanced by leaps and bounds: at the macro scale we can explore the farthest reaches of the universe, and at the micro scale we can probe subatomic particles. Yet why have food-system issues at the meso level not been fully resolved? It is not for lack of technology, but rather a lack of comprehensive understanding of the underlying issues and a corresponding need for disciplinary reflection and reconstruction.

For too long, efforts to address food-system issues have relied primarily on the theoretical framework of agricultural science. Organizations such as the Food and Agriculture Organization of the United Nations (FAO) also use agricultural science as a principal theoretical foundation. This reflects a broader methodological dilemma: existing solutions are rooted in an agricultural paradigm focused on food production, which does not fully encompass eater health, longevity, and systemic harmony. To fundamentally address the diverse issues within food systems, the essential solution lies in developing a more complete understanding of these issues and constructing a discipline that transcends agricultural science. By taking the Five Eater Needs as its foundational framework, and building upon agricultural science, this new discipline incorporates agricultural science, natural sciences, engineering, medical science, management science, economics, law, and education to form an interdisciplinary domain—Shiology.

Shiology integrates the full spectrum of human eater needs into a unified cognitive framework. It systematically encompasses the relationships between population growth and food resources; food-resource ownership and social conflict; food production and food utilization (including eater health); food acquisition and ecological protection; the interests of food producers and the interests of eaters; the survival attributes and commodity attributes of food; the intrinsic nature and nutritional composition of food;

food loss and waste; diet-related illness and food-based therapies; food-system efficiency and broader social efficiency; and the systemic governance of food-system issues and transformations in human civilization paradigms, among others. Only through such a comprehensive understanding can the multifaceted issues within food systems be fully addressed—there is no alternative.

To advance the United Nations 2030 Agenda for Sustainable Development, and grounded in the theoretical framework of Shiology, we have prepared the Global Food Systems and SDGs Report. Based on the Five Eater Needs of 8 billion people and focused on food-system issues across 195 countries (comprising the 193 UN Member States and 2 observer states), this report has been developed with the participation of scholars from 115 countries. This initiative represents a multi-year systematic research effort. The theme for 2025 is A Systematic Stocktake of Food-System Issues, undertaking the first comprehensive review, analysis, and coding of food-system issues worldwide. The theme for 2026 is Constructing a Food-System Index, which will enable comparative analysis of food-system issues across regions. The theme for 2027 is Systemic Governance of Food-System Issues, providing comprehensive governance frameworks for all 195 countries. Addressing food-system issues in a holistic manner will contribute to a fundamental paradigm shift in human civilization.

We extend our deepest gratitude to H.E. Ban Ki-moon, the eighth Secretary-General of the United Nations, for his concern, guidance, and for writing the preface to this report. We also express sincere appreciation to all institutions and individuals who participated in the research and writing of the Global Food Systems and SDGs Report, and to our partners whose active cooperation in data collection, surveys, and interviews has provided strong support for the successful completion of this work.



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Methodology

This report was inspired by the message of UN Secretary-General António Guterres to the Fourth World Shiology Forum, as well as by the collective commitment of all UN Member States to achieve the Sustainable Development Goals (SDGs). Building on this momentum, the report provides both a comprehensive study and a practical tool to support countries in addressing food-system challenges and advancing their SDG agendas. The report follows a triennial cycle, with each annual report having its own distinct theme. Within the current 2025–2027 cycle, the work unfolds in three annual stages. In 2025, under the theme A Systematic Stocktake of Food-System Issues, we establish the framework for understanding food-system issues, position the 193 United Nations Member States plus 2 observer states ("193+2"), and deliver preliminary mappings of issues by country as well as linkages between issues and solutions; in 2026 we deepen these correspondences and launch the Global Food Systems Sustainable Development Index for the 193+2 to enable cross-country comparison, trend tracking, and tiered governance guidance; in 2027 we propose 2050 goals, group countries by relevant natural and economic contexts, and outline action pathways linking national trajectories to global objectives. The following section presents the methodological note for the 2025 Report, to be launched at the Fifth World Shiology Forum and formally presented to United Nations representatives.

Objectives

The report aims to establish an encoded, system-wide taxonomy and knowledge base of food-system issues, while also diagnosing and completing country–issue mapping. It further catalogs existing global responses to each issue and, where gaps remain, proposes Shiology-based complementary measures to create integrated issue–response portfolios that provide actionable guidance for policy and practice.

Scope and Coverage

This report covers 193 United Nations Member States and 2 observer states ("193+2"), with the aim of global comparability to support cross-country comparison and tiered governance recommendations. However, for reasons of statistical consistency and sample independence, Vatican City is not analyzed separately. Vatican citizenship is of a jus officii (role-based) temporary nature and often coexists with another nationality; the relevant statistics are already covered under countries of origin, and inclusion would result in double counting. Therefore, the effective analytical sample in this study is 194 countries.

Data Sources and Quality Control

Primary reliance is placed on authoritative open data (e.g., FAO, WHO, World Bank, and related UN databases), supplemented by national open-data portals, industry statistics, and survey questionnaires from 115 countries. Standardization, comparability checks, and missing-data treatment are applied to address definitional differences across sources.

Global Expert Collaboration and Validation

More than 120 experts and scholars from 115 countries contributed to data collection and report drafting, covering Africa, the Americas, Asia, Europe, and Oceania, with deliberately diverse disciplinary backgrounds. Regional and national experts supported the interpretation of results and the refinement of the issue typology. This collaborative process effectively served as a peer-review mechanism: it grounded the analysis in local realities, enhanced credibility and accuracy, and ensured that the recommendations are both operable and context-appropriate.

Process of Compilation

I. Data Collection

Aligned with the three pillars—Eater Needs, Food Production & Supply, and Food System Order (Governance)—country-level datasets were compiled for the 193+2 countries (effective analytical sample: 194), totaling 240+ datasets. Coverage includes nutrition and health outcomes, agricultural production and supply-chain efficiency, economic and infrastructure conditions, and governance quality (e.g., relevant policies, institutional capacity, stability).

II. Issue Framework Construction

Based on the Shiology framework and the collected data, overt and latent issues in global food systems were identified and classified, and an eater-centered, six-level issue framework covering Survival, Health, and Sustainability was established. Each issue was analyzed in four aspects: causal mechanisms, observable manifestations, potential impacts, and response pathways.

III. Indicator Development and Issue Determination

Using the six-level framework, Level-4 issues were taken as the determination unit and corresponding indicators were developed (each composed of several underlying datasets). With reference to international standards and data distributions, country-level thresholds were set for the presence or absence of each issue, thereby completing country–issue mapping and national burden stratification.

IV. Issue–Response Correspondence Catalogue

A response framework spanning 14 dimensions—law, governance, population, trade, price, investment, subsidies, taxation, technology, digitalization, education, aid and international cooperation, eater self-check, and medical and public health—was established. Following a two-step approach: (1) take stock of and evaluate existing global responses for each issue; (2) propose feasible complementary measures where gaps remain, with emphasis on Shiology-informed governance concepts and methods, forming an issue–response correspondence catalogue directly matched to issue categories.

V. Expert Review

Three rounds of online/offline review and methodological verification were organized with 120+ experts from 115 countries, focusing on data quality, threshold setting, result robustness, and policy transferability, to enhance the credibility and interpretability of the findings.

Executive Summary

Despite extensive global efforts to address food system challenges, the outcomes have fallen short of expectations. As **UN Secretary-General António Guterres pointed out in the message to the Fourth World Shiology Forum**: "We are facing a global food crisis. Around the world, 780 million people are going hungry and more than three billion cannot afford healthy diets. Meanwhile, one-third of all food produced is lost or wasted. Unsustainable food production, packaging and transportation are feeding the climate crisis – generating colossal greenhouse gas emissions, using over two-thirds of the world's freshwater, and accelerating biodiversity loss."

1. The Five Eater Needs (5E)—and Where They Fall Short

A people-centred lens defines what food systems must deliver for everyone: **The Five Eater Needs (5E)—Eating Enough; Eating with Variety; Food-Safe Eating; Eating for Health and Longevity; Sustainable Eating.**

Global evidence shows persistent shortfalls against all five: hundreds of millions still lack basic adequacy; dietary diversity remains unaffordable in many settings; food-safety incidents and non-structural pollutants undermine trust; diet-related NCDs erode healthspan; and production–consumption patterns continue to overshoot ecological limits. The 5E thus serve both as a normative compass and an operational checklist for diagnosis and action across the full chain—from production and processing to distribution, consumption, waste, and governance.

2. The World-FSQM: A Quick Overview of the Global Food System

The World Food-System Quadrant Map (World-FSQM) positions countries by combining agricultural resource endowment (a proxy for structural production capacity) with life expectancy (a composite outcome reflecting health, diet, and system performance). This yields four strategic quadrants: Quadrant I—Dual Advantage (resource-rich, high longevity); Quadrant II—Efficiency under Scarcity (resource-scarce, high longevity); Quadrant III—Double Constraint (resource-scarce, low longevity); Quadrant IV—Conversion Gap (resource-rich, low longevity). Building on this positioning, we distinguish four complementary flow modalities and set an overarching global development goal—upward convergence in life expectancy:

- **Sustenance-oriented flows (staples):** stabilize basic adequacy and prices; typically flow **I/IV → II/III** via trade and, where needed, aid.
- **Enrichment-oriented flows (nutrient-dense):** raise diversity and diet quality; circulate **across all quadrants**, relying on cold chains and standards equivalence.
- **Capability-diffusion flows (technologies, regulatory practices, food education):** spread system capabilities across quadrants, with **I and II** often major providers; digital networks amplify effects.
- **Food-system-induced population flows:** driven by resource endowments and agri-food opportunity gradients, populations tend to move from **II/III → I/IV**, reflecting land/water constraints and value-chain carrying capacity.

Global goal: strengthen food systems as an integrated, cyclical whole to lift average life expectancy in every quadrant while narrowing inter-quadrant longevity gaps

3. Shiology: From Concept to Operational Architecture

Shiology is a 5E-based, system-wide knowledge architecture that elevates "food systems" from policy slogan to **implementable governance framework**. Anchored in the **Eater–Food–Order** schema, it links individual wellbeing to population-level sustainability and ecological limits. Its **"3–15" structure** comprises three primary domains—**Eater Health**, **Food Acquisition**, and **Food-System Order**—under which

fifteen tertiary subfields cover the full cycle from bodies and foods to rules and institutions. As an interdisciplinary field, Shiology synthesizes **agricultural science, ecology, biomedicine, engineering, management, economics, law, and education** into a coherent toolkit oriented to fulfilling the **5E**. Conceptually, it is grounded in **two realms of principles**—those governing **eater health** and those governing **food-system order**. Taken together, these elements provide a comprehensive knowledge base that **standardizes definitions and metrics, supports cross-country benchmarking, and supplies a common language** for governments, firms, civil society, and researchers.

4. Establishing a Food-System Issue Framework

The issue framework uses the **5E** as operational axes—not slogans—to pinpoint where and why food systems fail people. Each problem is located by its **primary unmet need**—quantity (Eating Enough), diversity (Eating with Variety), hazards & fraud (Food-Safe Eating), diet-related disease/suboptimal methods (Eating for Health and Longevity), or social–ecological overshoot (Sustainable Eating)—and the 5E are organized into **three categories**: **Survival** (Needs 1–3), **Eater Health** (Need 4), and **Eater Sustainability** (Need 5).

The taxonomy is **six levels** deep, **mutually exclusive and collectively exhaustive**, and spans the full lifecycle from production and processing through distribution, consumption, and waste. It distinguishes **individual-level** issues (Survival, Eater Health) from **collective/system-level** issues (Sustainability), enabling targeted yet system-aware interventions. A lightweight **hierarchical coding** scheme (e.g., SI-xxxxxxx) assigns a unique identifier to each node, supporting consistent metrics, cross-country comparability, and interoperable mapping between burdens and policy responses—turning disparate problems into a coherent, diagnosable, and stageable governance landscape that keeps the eater at the center while aligning national and global objectives.

5. Dual Mappings: From Diagnosis to Response

Built on the report's 5E-based food-system issue framework, two complementary, interoperable mappings are constructed for 193 UN Member States plus 2 observers (effective sample 194) to move from evidence to execution.

- **Country–Issue Mapping (burden atlas):** shows **where** specific food-system

burdens concentrate and **how many** issues each country faces. It supports prioritisation (e.g., top burdens per region), sequencing (what to tackle first), and coalition-building (shared problems across neighbours/peers).

- **Issue–Solution Mapping (modular solution matrix):** links each encoded issue to a **portfolio of solutions**. Rather than forcing actions into one silo, portfolios combine instruments from fourteen families where relevant—**law, administration, population policy, trade, pricing, investment, subsidies, taxation, R&D, digitalization, education/food literacy, aid and international cooperation, eater self-check, medical & public health**—so countries can assemble **context-specific, staged packages**.

Headline findings (selected) derived from the mappings and underlying analyses:

- **Structural interdependence.** Using the WWF Livewell **seven food groups**, only **one** country attains **≥100% structural self-sufficiency in all seven**. On **domestic edible production alone** (no trade), **no** country meets all seven Livewell thresholds; when **international trade is included** (imports added to edible supply), **32** countries meet all seven.
- **Burden counts are uneven but tractable.** Most countries face a mid-range number of issues, with a long tail of concentration. Landlocked and climate-vulnerable states—especially some Small Island Developing States—show **stacked risks** that amplify volatility.
- **Behaviour and food education shift outcomes.** Eater behaviour ("seven couplings" of quantity, variety, speed, temperature, frequency, sequence, doneness) materially influences health outcomes independent of income; targeted **food-education** can yield **above-income** gains.
- **Food safety and environmental pressures are coupled.** Non-structural pollution (residues, micro-pollutants, pathogens) interacts with structural change (land-use conversion, biodiversity loss), requiring **joint governance** across agriculture, environment, and health.
- **System order is a multiplier.** Laws, administration, finance, and emergency coordination (the "Order" dimension) determine how quickly shocks (geopolitics, pandemics, trade restrictions) transmit through energy, logistics, and cold-chain

nodes into prices and affordability.

Together, the **dual mappings** operationalize the issue framework into a **policy-ready bridge** from diagnosis to design—supporting fair benchmarking, peer learning, and the assembly of tailored, staged response portfolios.

6. A Community with a Shared Future for Human Food Systems

The report concludes with a call to build a **Community with a Shared Future for Human Food Systems**—grounded in sovereign equality, international rule of law, multilateralism, and an eater-centred ethic. A pragmatic cooperation agenda includes:

- **Common language & open standards:** adopt encoded issue/response taxonomies to make learning cumulative.
- **Knowledge and technology commons:** accelerate diffusion of food safety, nutrition, and climate-smart tools, with attention to SME uptake.
- **Fair and shock-resilient trade:** promote transparency, emergency coordination, and rules that keep nutritious food accessible during crises.
- **Education for healthspan:** mainstream food literacy (labelling, schools, workplaces) aligned with national dietary guidelines.
- **Ecology first:** protect biodiversity, curb loss/waste, price externalities sensibly, and align finance with nature-positive pathways.



Food Systems Today:

Shortfalls in the Five Eater Needs

Food systems sit at the heart of the Sustainable Development Goals: they shape nutrition and health, livelihoods and equity, climate and biodiversity, water and land use. As the UN's food-systems process underscores, today's food systems account for roughly one-third of human-caused greenhouse-gas emissions, use up to 70% of freshwater withdrawals, and are a major driver of biodiversity loss.

Yet progress towards the SDGs is alarmingly off track. As the Secretary-General cautioned at the launch of The Sustainable Development Goals Report 2025: "Only 35 per cent of SDG targets are on track or making moderate progress," with nearly half moving too slowly and 18 per cent regressing.

Building on this momentum, this report sets out to be both a comprehensive study and a practical tool—supporting countries to diagnose and address food-system challenges and to accelerate their SDG agendas.

1-1 The Five Eater Needs (5E) for 8 Billion People

Given the ultimate purpose of any food system is human wellbeing, it is analytically useful to place the eater at the origin—clarifying the ends before selecting the means. From this vantage point, a prior question follows: Which needs must be satisfied for every person—what, in essence, should a food system deliver? As a pragmatic baseline, we propose a clear, minimal set termed The Five Eater Needs (5E):

1. Eating Enough

Stable and sufficient access to food—quantity with reliable continuity over time and space—so that no one is hungry. This is the non-negotiable baseline of food security, the first stage of eater needs, and a precondition for social stability and development.

2. Eating with Variety

Diverse food types and categories that allow nutritionally adequate diets to be assembled from a broad spectrum of culturally meaningful components (e.g., grains, legumes, fruits, vegetables, and animal-source foods). This concerns variety per se, beyond mere adequacy.

3. Food-Safe Eating

Food that is non-toxic and non-harmful, with end-to-end integrity and risk control—posing no acute, sub-acute, or chronic hazards. Assurance spans primary production, processing, storage and transport, retail, and consumption (including accurate labelling, traceability, and hygiene).

4. Eating for Health and Longevity

Scientific, reasonable, and person-adapted eating methods—not only what to eat, but also when, how, and how much—so as to couple food and physiology, prevent disease, enhance functional capacity, and support healthy ageing.

5. Sustainable Eating

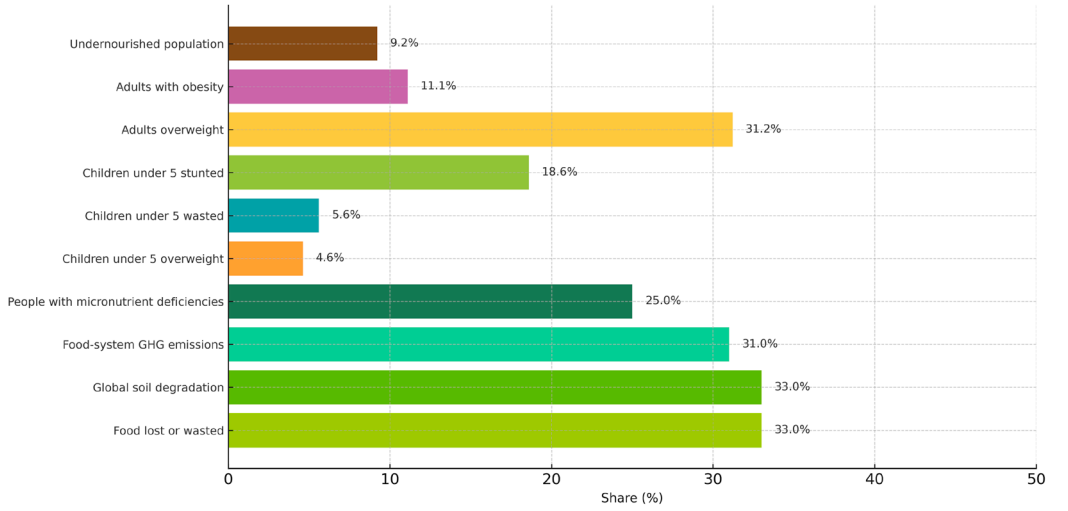
A food system that meets present needs without compromising those of future generations—binding individual choices and system practices to environmental health, social equity, and economic viability within planetary boundaries and a resilient rules-based order.

Taken together, the Five Eater Needs form a progressive "values ladder." Needs 1–3 constitute an Eater Survival Tier (sufficient, diverse, and safe food). Need 4 forms the Eater Health Tier (method-guided coupling of diet and physiology). Need 5 anchors the Eater Sustainability Tier (intergenerational continuity of access and use). The tiers are cumulative and interactive: failures in safety erase gains in adequacy and variety; poor diet patterns overload health systems despite adequate supply; unsustainable practices degrade the very resource base on which adequacy, variety, and safety depend

The 5E are not being met—signals from current stresses.

In fact, global food systems face a profound crisis (Key percentage pressures are summarized in Figure 1-1).Progress against hunger and malnutrition has stalled and, in some places, reversed. After decades of decline, hunger is again rising: 713–757 million people were undernourished in 2023 (mid-range 733 million), an increase of 152 million since 2019 [FAO/IFAD/UNICEF/WFP/WHO, 2024]. Around 2 billion people suffer micronutrient deficiencies that undermine health and development [Lowe, 2021]. At the same time, over-nutrition is accelerating: adult obesity has more than doubled since 1990 (WHO, 2025), and roughly one-third of all food produced is lost or wasted each year—signaling deep inefficiencies alongside unmet need. These contrasting forms of malnutrition, from undernourishment to obesity, expose systemic imbalances in how food is produced, distributed, and consumed.

Figure 1-1. Global Food-System Threats at a Glance (Shares, %)



Sources: FAO/IFAD/UNICEF/WFP/WHO (2024); WHO (2025); IFPRI (2022); UNEP (2021).

Environmental limits are tightening in parallel. Food systems are a leading driver of environmental degradation— the primary driver of biodiversity loss through habitat conversion and intensification (Chatham House/UNEP, 2021); about one-third of the world's soils are moderately to highly degraded (FAO, 2015/2022); and, taken as a whole, food systems account for roughly one-third of global anthropogenic greenhouse-gas emissions, with agriculture and land-use change the largest contributors. Agricultural expansion and intensive practices continue to deplete water and erode soils. As UNEP notes, unsustainable production not only contributes to climate change and pollution but also leaves food systems themselves more vulnerable (UNEP, Rethinking food systems, 2021).

Inequities further compound the burden. In 2022, 149 million children under five were stunted, 45 million wasted, and 37 million overweight (WHO, 2024). Women and marginalized groups often have poorer diets; smallholders—who produce much of the world's food—typically earn far less than larger producers, and women farmers earn less than men in most contexts. Thus, even as aggregate output grows, many remain food insecure.

Recent shocks have magnified vulnerabilities across the chain. The COVID-19 pandemic disrupted livelihoods and supply networks; climate extremes—from droughts to floods—damaged crops across regions; and the war in Ukraine, a major grain and fertilizer exporter, triggered price spikes, supply disruptions, and a surge in export restrictions (from 3 to 16 countries by early April 2022), fueling "food nationalism" and

geopolitical use of food [IFPRI, 2022]. These converging crises have eroded hard-won gains, driving millions more into hunger.

Moreover, resilience and governance gaps persist. Supply chains have proved highly shock-sensitive, with many regions lacking adequate storage, transport, or social protection to buffer disruptions. Policy and institutional fragmentation—across agriculture, environment, health, and trade—continues to impede coherent responses, as UN/FAO processes have repeatedly observed.

Viewed in aggregate, the present evidence shows that universal attainment of the 5E remains out of reach. Fragile adequacy, structural limits on diversity, material safety failures, rising diet-related NCD burdens, and tightening ecological–institutional constraints together define the prevailing state of food systems, even as additional pressures remain under-detected.

1-2 Global Quadrant Typology of Food Systems Across 195 Countries[1]

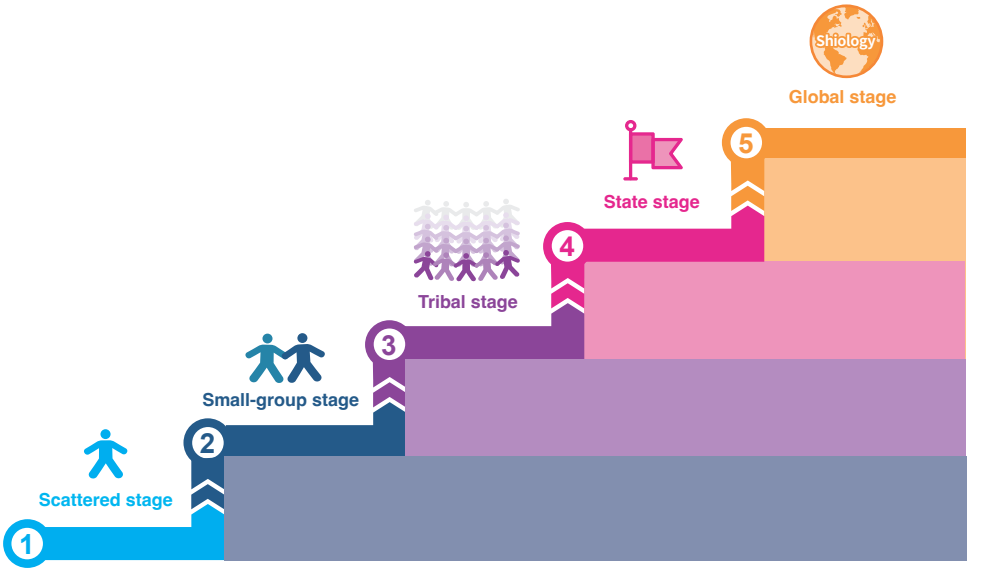
The Five Eater Needs have never been static. Over the course of history, their fulfillment has unfolded through successive stages, defined by the scale of organization, the way food is obtained, and the time horizon over which needs are addressed. In the earliest scattered stage, food was secured mainly through individual foraging, oriented toward immediate consumption. The small-group stage emerged as individuals coordinated in limited teams, enabling cooperative acquisition and short-term buffering over days or weeks. In the tribal stage, food provision became embedded in stable communities, combining multiple local sources with seasonal management and storage. The state stage marked a further expansion, as food systems were organized through national production, regulation, and redistribution, allowing longer-term and cross-year planning.

Today, food systems are entering a global stage, in which no single country can independently secure the Five Eater Needs. Food is increasingly produced, moved, and governed through interconnected global networks, while the relevant risks and constraints unfold over multi-decadal and intergenerational horizons. This transition from predominantly national governance toward growing global interdependence makes it necessary to step back and examine the current configuration of global food systems as a whole.

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1 Counted as 193 UN Member States + 2 UN non-member observer States

Figure 1-2. Stages in Meeting the Five Eater Needs



1-2.1 Four-Quadrant Classification of Global Food Systems

The Five Eater Needs (5E) define the ends of food systems—what they should ultimately deliver for people. Accordingly, we plot 193+2 countries (effective analytical sample: 194) with agricultural-resource endowment as the input (horizontal axis)—largely nature-given enabling conditions—and average life expectancy as the output (vertical axis)—a population-level result of diet quality, food safety, and the long-run coupling of food and physiology—presenting a global, comparable World Food-System Quadrant Map (World-FSQM) that shows where each country currently sits relative to those ends. The map thus places countries in an inputs–outputs space: a compact view of (i) the natural inputs that condition what can plausibly be delivered and (ii) the realized outputs in people's lives. Read this way, the typology serves as a first-order classification: countries located in different regions typically face different binding constraints to achieving the 5E (e.g., constraints rooted in limited inputs versus constraints arising from under-realized outputs).

By jointly analyzing per-capita natural resources (inputs) and average life expectancy (outputs, sourced from the UN World Population Prospects), the map positions each country's food system within a common, transparent framework.

The quadrant map comprises two axes, four quadrant regions, and country data points:

- X-axis: Agricultural-resource endowment score for the food system (left → weak;

right → strong).

Specification: five inputs—per-capita cropland, inland-water share, mean annual temperature, mean annual precipitation, and annual sunshine duration. Indicators are drawn from harmonized international sources, normalized and aggregated into a single cross-country comparable score.

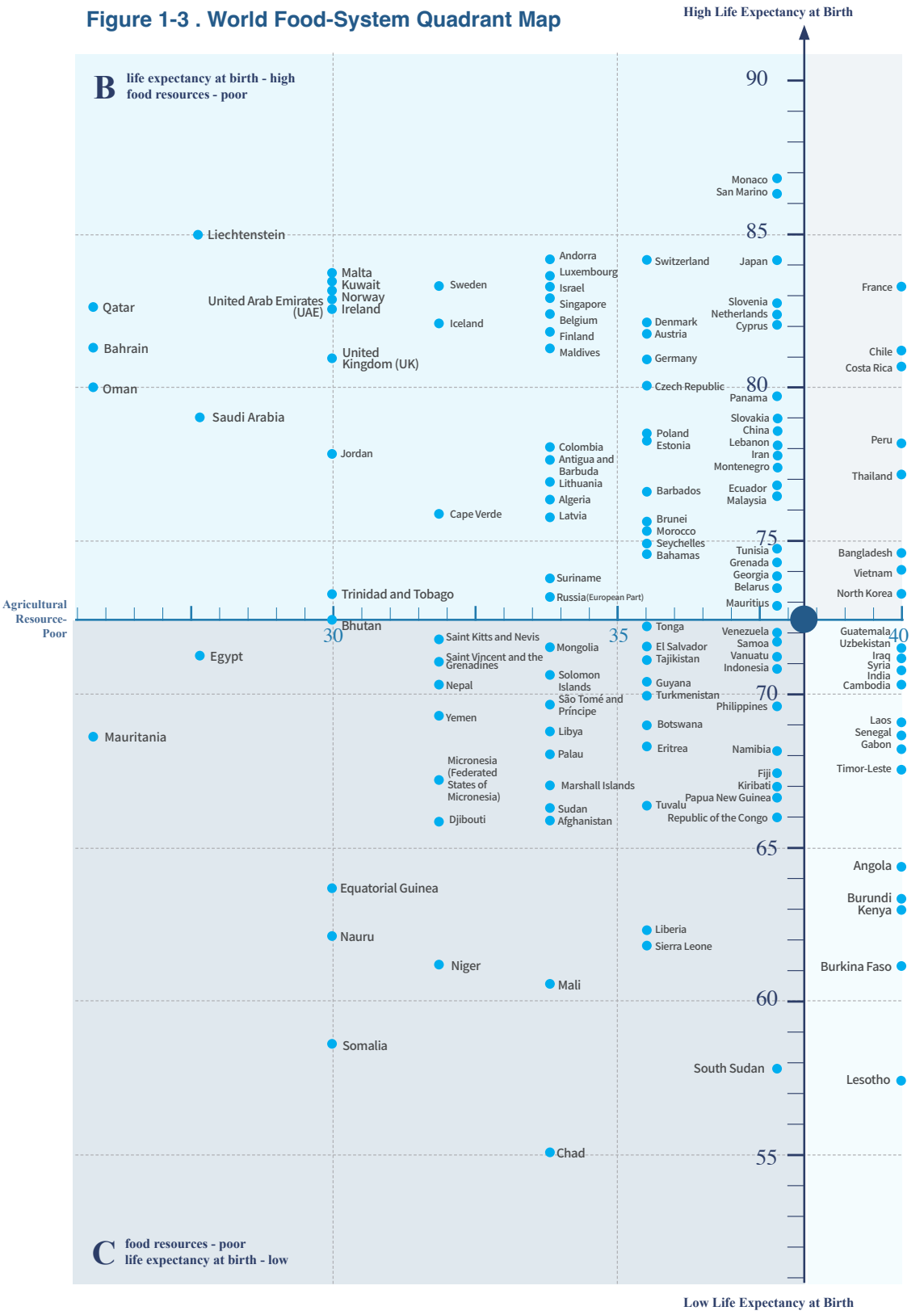
- Y-axis: Average life expectancy (bottom → lower; top → higher). In this section, life expectancy is interpreted as a system-level outcome closely tied to eater health and the degree of food–body coupling.

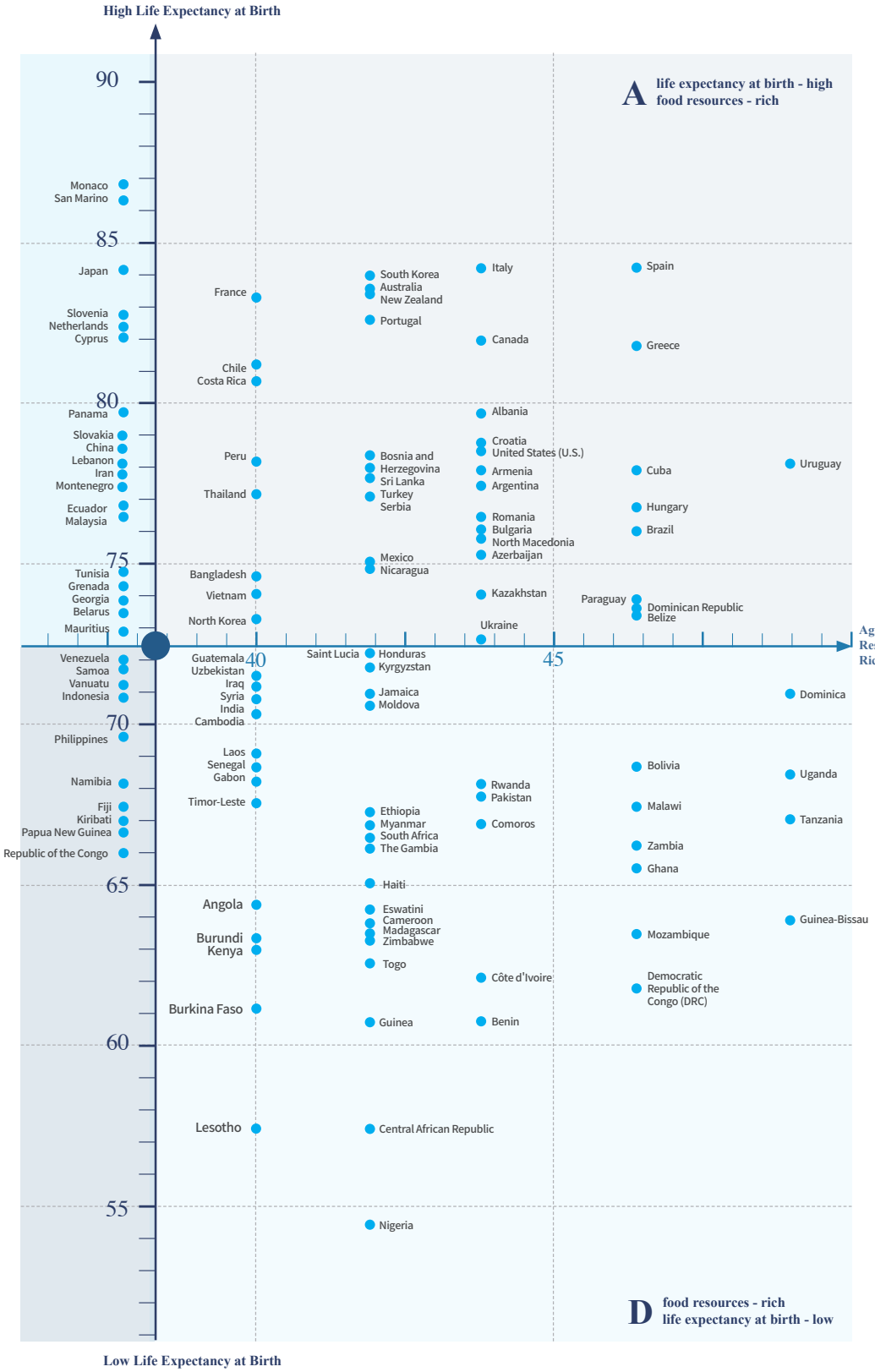
  Data note: reference year = 2023; source = United Nations, World Population Prospects (WPP) 2024 revision.

Each axis is split at the global median, partitioning the plane into four quadrants:

- Quadrant I (upper-right): Strong resources, high life expectancy — a "dual advantage" profile; policy focus on maintaining quality and equity.
- Quadrant II (upper-left): Weak resources, high life expectancy — signals efficient conversion and sound governance; valuable for sharing institutional and technological lessons.
- Quadrant III (lower-left): Weak resources, low life expectancy — a double constraint; prioritize basic security and capacity building.
- Quadrant IV (lower-right): Strong resources, low life expectancy — indicates conversion inefficiency or governance imbalance; prioritize health, education, and food-system governance reforms.

Figure 1-3 . World Food-System Quadrant Map




High Life Expectancy at Birth
90
85
80
75
70
65
60
55
A life expectancy at birth - high food resources - rich
Monaco
San Marino
Japan
Slovenia
Netherlands
Cyprus
Panama
Slovakia
China
Lebanon
Iran
Montenegro
Ecuador
Malaysia
Tunisia
Grenada
Georgia
Belarus
Mauritius
Venezuela
Samoa
Vanuatu
Indonesia
Philippines
Namibia
Fiji
Kiribati
Papua New Guinea
Republic of the Congo
France
Chile
Costa Rica
Peru
Thailand
Bangladesh
Vietnam
North Korea
Guatemala
Uzbekistan
Iraq
Syria
India
Cambodia
Laos
Senegal
Gabon
Timor-Leste
Angola
Burundi
Kenya
Burkina Faso
Lesotho
South Korea
Australia
New Zealand
Portugal
Bosnia and
Herzegovina
Sri Lanka
Turkey
Serbia
Mexico
Nicaragua
Saint Lucia
Honduras
Kyrgyzstan
Jamaica
Moldova
Ethiopia
Myanmar
South Africa
The Gambia
Haiti
Eswatini
Cameroon
Madagascar
Zimbabwe
Togo
Guinea
Central African Republic
Nigeria
Italy
Canada
Albania
Croatia
United States (U.S.)
Armenia
Argentina
Romania
Bulgaria
North Macedonia
Azerbaijan
Kazakhstan
Ukraine
Rwanda
Pakistan
Comoros
Côte d'Ivoire
Benin
Spain
Greece
Cuba
Hungary
Brazil
Paraguay
Dominican Republic
Belize
Bolivia
Malawi
Zambia
Ghana
Mozambique
Democratic
Republic of the
Congo (DRC)
Uruguay
Dominica
Uganda
Tanzania
Guinea-Bissau
40
45
Agricultural
Resource-
Rich
D food resources - rich
life expectancy at birth - low
Low Life Expectancy at Birth

Below is the country distribution across the four quadrants. Country names follow standard international usage; regional groupings are provided for readability.

Table 1-1. Table of Country Distribution Across the Four Quadrants

Quadrant	Americas	Europe	Asia	Africa	Oceania
Quadrant I – Resource-rich, high life expectancy	Uruguay; Cuba; Brazil; Paraguay; Dominican Republic; Belize; Canada; United States; Argentina; Mexico; Nicaragua; Chile; Costa Rica; Peru	Spain; Greece; Hungary; Italy; Albania; Croatia; Romania; Bulgaria; North Macedonia; France; Portugal; Bosnia and Herzegovina; Ukraine; Serbia	Armenia; Azerbaijan; Kazakhstan; Republic of Korea; Sri Lanka; Türkiye; Thailand; Bangladesh; Viet Nam; Democratic People's Republic of Korea	—	Australia; New Zealand
Quadrant II – Resource-scarce, high life expectancy	Panama; Ecuador; Grenada; Barbados; The Bahamas; Colombia; Antigua and Barbuda; Suriname; Trinidad and Tobago	Monaco; San Marino; Slovenia; Netherlands; Slovakia; Montenegro; Belarus; Switzerland; Denmark; Austria; Germany; Czechia; Poland; Estonia; Andorra; Luxembourg; Belgium; Finland; Lithuania; Latvia; Russian Federation; Sweden; Iceland; Malta; Norway; Ireland; United Kingdom; Liechtenstein	Japan; Cyprus; China; Lebanon; Iran (Islamic Republic of); Malaysia; Georgia; Israel; Singapore; Maldives; Kuwait; United Arab Emirates; Jordan; Saudi Arabia; Qatar; Bahrain; Oman; Brunei Darussalam	Tunisia; Mauritius; Morocco; Seychelles; Algeria; Cabo Verde	—
Quadrant III – Resource-scarce, low life expectancy	Venezuela (Bolivarian Republic of); Guyana; El Salvador; Saint Kitts and Nevis; Saint Vincent and the Grenadines	—	Indonesia; Philippines; State of Palestine; Tajikistan; Turkmenistan; Mongolia; Afghanistan; Nepal; Bhutan; Yemen	Namibia; Congo (Republic of the); South Sudan; Botswana; Eritrea; Liberia; Sierra Leone; Sao Tome and Principe; Libya; Sudan; Djibouti; Niger; Equatorial Guinea; Somalia; Egypt; Mauritania	Samoa; Vanuatu; Fiji; Kiribati; Papua New Guinea; Tonga; Tuvalu; Solomon Islands; Palau; Marshall Islands; Micronesia (Federated States of); Nauru

Quadrant	Americas	Europe	Asia	Africa	Oceania
Quadrant IV – Resource-rich, low life expectancy	Dominica; Bolivia (Plurinational State of); Honduras; Saint Lucia; Jamaica; Haiti; Guatemala	Republic of Moldova	Pakistan; Kyrgyzstan; Myanmar; Uzbekistan; Iraq; Syrian Arab Republic; India; Cambodia; Lao People's Democratic Republic; Timor-Leste	Uganda; Tanzania; Guinea-Bissau; Malawi; Zambia; Ghana; Mozambique; Democratic Republic of the Congo; Rwanda; Comoros; Côte d'Ivoire; Benin; Ethiopia; South Africa; The Gambia; Eswatini; Cameroon; Madagascar; Zimbabwe; Togo; Guinea; Central African Republic; Nigeria; Senegal; Gabon; Angola; Burundi; Kenya; Burkina Faso; Lesotho	—

1-2.2 Key Insights from the World-FSQM

All countries appear as scatter points according to their resource score and clife expectancy. Even within the same quadrant, positions vary—signaling different upgrade paths and policy mixes. The value of the map is not to "rank," but to offer a typological lens.

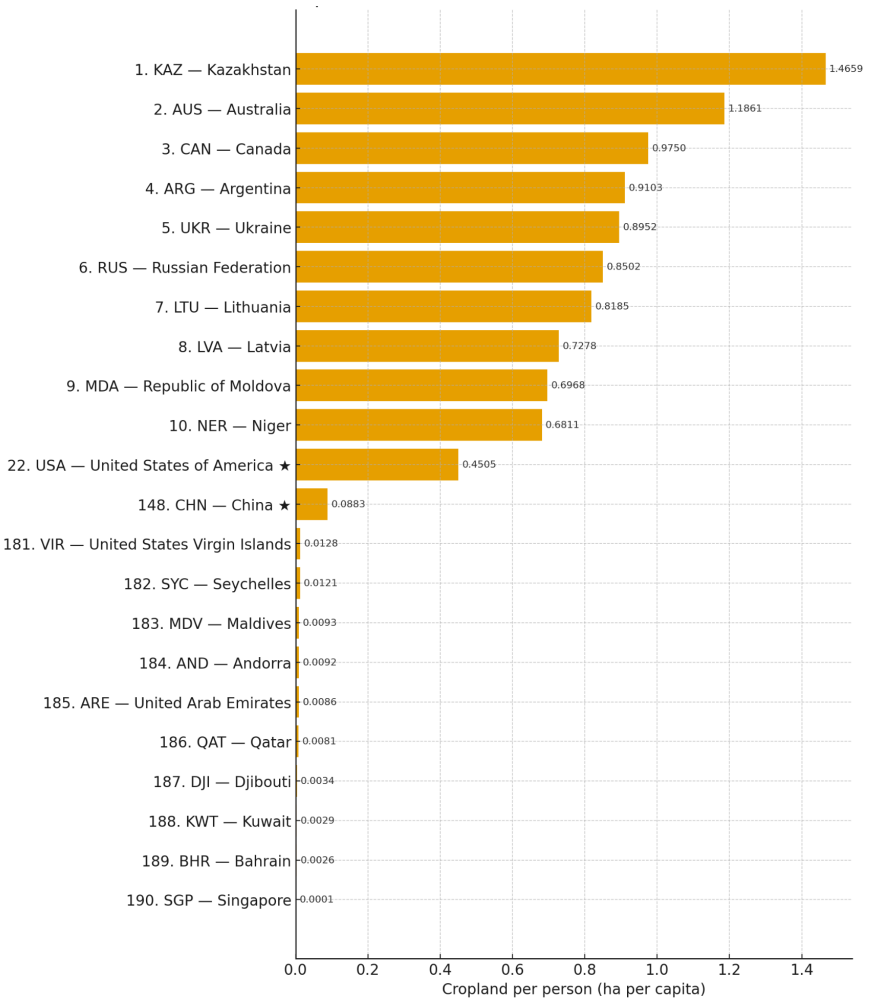
1. Large cross-country heterogeneity in per-capita agricultural-resource endowment.

"Agricultural resources" vary by the quality/quantity of land, pasture, and inland waters, as well as rainfall, sunshine duration, humidity range, latitude/longitude, and elevation. As shown in Figure 1-4, per-capita cropland can differ by orders of magnitude (e.g., Australia vs. China), shaping the natural input ceiling for Eating Enough and Eating with Variety.

2. Cross-border flows are intrinsic to food systems.

Cross-border flows are indispensable to food systems, reflecting persistent disparities in natural resource endowments across countries as well as growing demand for healthy and high-quality diets. Resource constraints limit what can be produced domestically, while dietary requirements—particularly with respect to diversity, safety, and nutritional quality—often cannot be met within national boundaries alone. Cross-border exchange therefore constitutes a structural feature of contemporary food systems.

Figure 1-4. Per-Capita Cropland: Top 10 And Bottom 10, Year 2023



Data: FAOSTAT, Arable land (1000 ha), reference year 2023; per-capita values computed using UN World Population Prospects 2024 population (year 2023).

3. The ultimate outcome lens is longevity.

Access to food is a prerequisite; the body-food coupling is the key to extending healthy life. Even longevity leaders have headroom relative to biological potential. Many high-income countries must curb over-consumption and diet-related NCDs. Hence the World-FSQM places life expectancy on one axis to anchor assessments in human outcomes.

4. Governance capacity differs—and often outweighs endowment gaps.

Some low-endowment countries (Quadrant II) achieve strong outcomes through institutions, standards, logistics, and social protection, while others with strong endowments (Quadrant IV) underperform due to conversion inefficiencies or

governance imbalances. On average, Quadrants III/IV face weaker governance capacity; Quadrant I is stronger; Quadrant II often excels.

5. Quadrant I represents a "dual-advantage" but maintenance-oriented food-system regime.

Countries in Quadrant I combine strong natural resource endowments with high life expectancy, indicating that resource wealth has been effectively converted into population health and well-being. Their dominant challenge is no longer basic adequacy or expansion, but preservation and optimization. Policy priorities therefore shift toward safeguarding food quality and equity, maintaining ecological foundations (soil, water, biodiversity), and enhancing resilience to climate shocks, so that achieved outcomes are not eroded over time.

6. Quadrant II demonstrates that high longevity can be achieved through efficiency under structural scarcity.

Countries in Quadrant II attain high life expectancy despite very limited per-capita natural resources, making this quadrant the most instructive and policy-relevant for global learning. Representative cases such as Japan, the Republic of Korea, Singapore, and Israel all exhibit extremely low per-capita arable land and constrained domestic resource bases, yet rank among the world's highest life-expectancy countries.

Their performance reflects not resource abundance, but system-level efficiency in converting scarcity into health outcomes. Through advanced agricultural technologies, high-standard food processing systems, and diversified, rules-based food import strategies, these countries secure food safety, dietary quality, and nutritional stability for their populations. Strong governance capacity, public health systems, and food education further reinforce this conversion process. Together, these features demonstrate that institutional quality and technological capability can compensate for natural endowment constraints, positioning Quadrant II as the most replicable and demonstrative pathway for countries facing structural resource scarcity.

7. Quadrant III reflects a compounded "double constraint" at the foundation of food systems.

In Quadrant III, resource scarcity and low longevity coincide, typically signaling multiple reinforcing challenges, including poverty, conflict, weak infrastructure and services, and limited market access. Food systems in this quadrant are constrained at the most basic level. Priority interventions focus on securing food adequacy and nutrition,

strengthening primary health care, improving market connectivity, and introducing scalable, context-appropriate agri-food technologies. External support—through international partnerships and targeted financing—remains a critical enabler for escaping this low-outcome trap.

8. Quadrant IV reveals a structural "conversion gap" between endowment and human outcomes.

Quadrant IV countries possess relatively abundant natural resources but exhibit low life expectancy, indicating inefficiencies or imbalances in translating endowments into health gains. This gap is often associated with weaknesses in governance and food-system order, such as institutional fragility, inequitable distribution, health-system shortcomings, or food safety and dietary risks. Policy priorities therefore lie in strengthening institutions, improving service delivery (especially health and water/sanitation), and enhancing both the efficiency and equity of resource utilization..

1-2.3 Global Structure and Operating Mechanisms of Food Systems

At the global level, food systems do not operate as a collection of self-contained national units. Instead, they function as an interconnected whole, structured and sustained through multiple forms of cross-border flows. These flows arise from differences in natural resource endowments, production capacities, and dietary demand patterns across countries, and together constitute the core operating mechanisms of the contemporary global food system. Through them, basic survival needs are secured, diet quality is improved, system capabilities are diffused, and population distribution is reshaped—ultimately determining the long-term trajectory of global food systems.

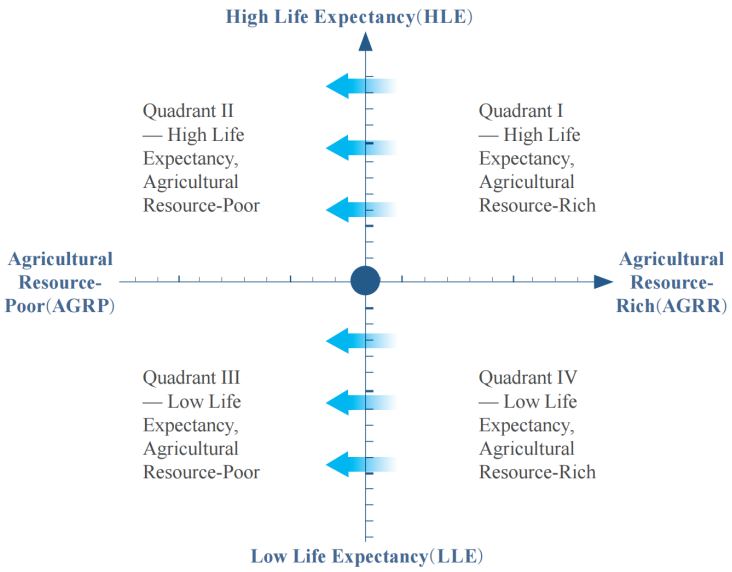
Building on the World Food-System Quadrant Map (World-FSQM), these structural features provide a basis for systematically characterizing the fundamental operating mechanisms of global food systems and for clarifying their long-term developmental objective, as elaborated below.

1. Sustenance-oriented flows (staple-based)

Sustenance-oriented flows center on basic staple foods, particularly cereals, and operate primarily through trade, supplemented by aid where necessary. These flows typically move from Quadrants I and IV toward Quadrants II and III, stabilizing basic food availability and safeguarding minimum survival needs. As such, they form the

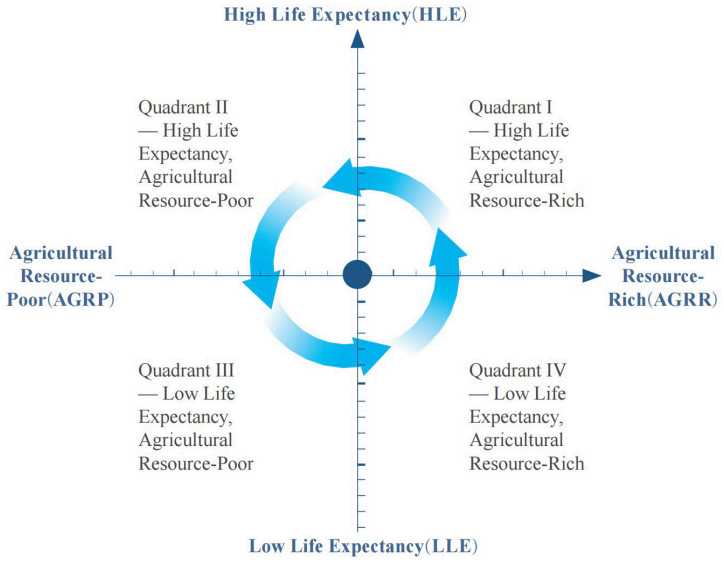
foundational safety layer of the global food system, ensuring that populations can at least "eat enough" under conditions of scarcity or shock.

Figure 1-5. Sustenance-oriented flows in food systems



2. Enrichment-oriented flows (covering all major food categories)

Figure 1-6. Enrichment-oriented flows in global food systems

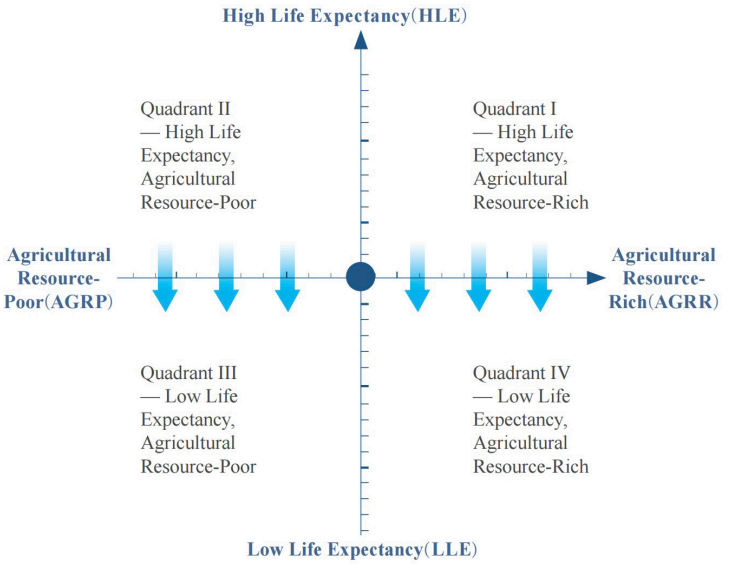


Enrichment-oriented flows encompass all major food categories, including grains, fruits and vegetables, animal-source foods, and aquatic products. They occur both among countries within the same quadrant and across all four quadrants through multidirectional exchanges. Their primary function is to enhance dietary diversity and diet quality, making them central to achieving "eating well." The effective operation of these flows depends on the cross-border alignment of cold-chain infrastructure, food safety systems, and quality standards.

3. Governance-capability diffusion flows (technology, regulatory practices, and food education)

Governance-capability diffusion flows involve the cross-border transmission of agri-food technologies, regulatory and institutional practices, and food education. Through these mechanisms, food-system operating capacity is diffused across countries and quadrants, with Quadrants I and II commonly acting as major sources. Digital technologies substantially expand the reach and efficiency of these flows, enabling institutional and knowledge transfers to amplify the impact of material food flows.

Figure 1-7. Governance-capability diffusion flows in global food systems

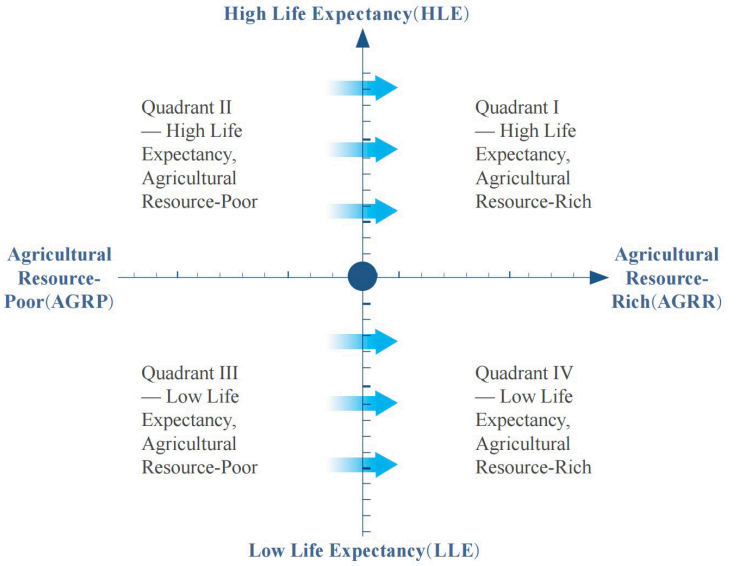


4. Food-system-induced population flows

From a structural perspective, population movements represent an outcome mechanism generated by disparities in food-system conditions. Differences in

agricultural natural resource endowments and food-resource abundance drive population flows from food systems characterized by relative scarcity and limited agri-food opportunities toward regions with stronger resource bases and higher value-chain carrying capacity. These movements reflect the profound role of agri-food resources and production systems in shaping the spatial allocation of human populations within the global system.

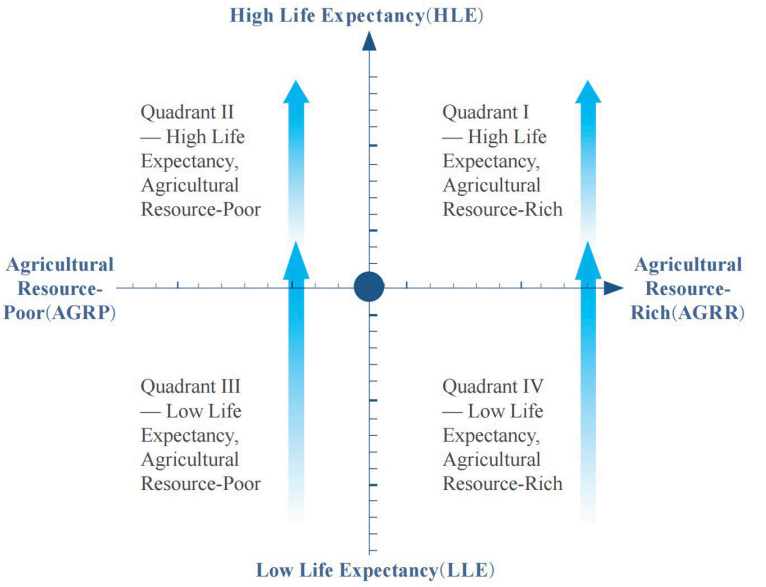
Figure 1-8. Food-system-induced population flows in global food systems



5. The 21st-century global objective of food systems: upward convergence in life expectancy

Taken together, these operating mechanisms shape the long-term evolution of global food systems. In the 21st century, the core objective extends beyond adequacy alone, toward improving how effectively food systems translate resources into human health outcomes. By optimizing global resource allocation and strengthening system operating capacity, food systems can evolve as integrated, cyclical wholes that promote effective coupling between the human body and food. Progress is ultimately reflected not only in higher average life expectancy worldwide, but in the narrowing of longevity gaps across quadrants—advancing a shared global aspiration for health and long life.

Figure 1-9. 21st-century global objective of food systems



1-3 Food Systems Linkages with 13 Key SDGs

The adoption of the SDGs marked a milestone in global development policy, consisting of 17 Sustainable Development Goals and 169 specific targets. The SDGs broaden the scope of global development efforts – addressing not only poverty, hunger, health and education, but also climate change, inequality, sustainable cities, peace, and partnerships, among others. Importantly, the SDGs are **integrated and indivisible**: progress on one goal is interlinked with progress on others, reflecting the complex, cross-cutting nature of sustainable development[2].

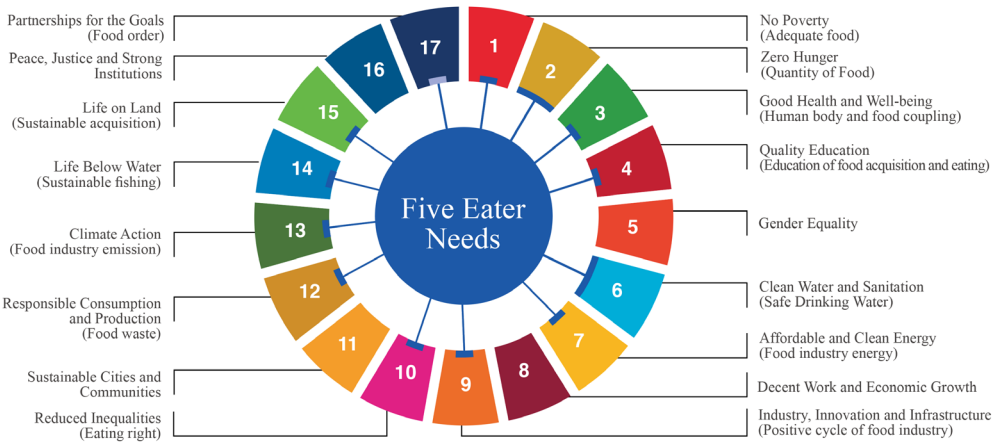
Crucially, food systems lie at the heart of this new agenda. Sustainable food systems are recognized as central to achieving the SDGs, and their purpose can be specified through the Five Eater Needs (5E). Framed by the 5E, sustainable food systems simultaneously underpin economic dynamism, social wellbeing, and environmental stewardship. At a minimum, 13 of the 17 SDGs are directly connected to food systems (Figure 1-10). Based on the 5E, the SDG–food system relationships are analyzed as follows.

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2 United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development* https://sdgs.un.org/2030agenda

Among these, SDG 2 (Zero Hunger) and SDG 6 (Clean Water and Sanitation) are intrinsically food-related objectives, whereas the remaining 11 SDGs are not food goals per se but are highly dependent on the structure and performance of food systems.

Figure 1-10. The SDG–Food System Relationship Based on the Five Eater Needs (5E)



1-3.1 Intrinsic Food Goals

SDG 2 – Zero Hunger: This goal is most directly related to the food system. Ending hunger requires a food system capable of providing all people, at all times, with sufficient, safe, and nutritious food. Achieving SDG 2 involves not only increasing food availability but also improving access, diversity, and stability of the food supply. The effectiveness and inclusiveness of the food system determine the degree to which hunger can be eradicated worldwide.

SDG 6 – Clean Water and Sanitation: Drinking water is not only essential for hygiene and food preparation, but is itself a fundamental component of the human diet. Safe, accessible drinking water is a form of food—directly vital to sustaining life and health. The quality and availability of potable water profoundly affect nutritional status, food safety, and life expectancy. Moreover, water resources are critical at every stage of food production and processing—as evidenced by the fact that approximately 70% of global freshwater withdrawals are devoted to agricultural use[3].

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3 Food and Agriculture Organization of the United Nations. (2011). *The state of the world's land and water resources for food and agriculture (SOLAW) – Managing systems at risk. Rome, Italy: Food and Agriculture Organization of the United Nations; London, UK: Earthscan. Retrieved from* https://www.fao.org/3/i1688e/i1688e.pdf

1-3.2 Food-System–Related SDGs

SDG 1 – No Poverty: Poverty remains a principal barrier to accessing sufficient, diverse, and safe food. In many regions, lagging economic development means that large populations are unable to secure adequate nutrition, making poverty a fundamental cause of hunger and foodborne diseases. The state of the food system is closely intertwined with poverty: limited resources restrict both the quantity and quality of food that individuals and families can obtain. Addressing food insecurity is thus essential for breaking the cycle of poverty, while poverty reduction strategies directly enhance the ability of communities to achieve and maintain food security.

SDG 3 – Good Health and Well-Being: Food and health are deeply interconnected. Food is the foundation for sustaining life and promoting good health, supplying the nutrients essential for human development. The dynamic interaction between dietary patterns and physiological needs is central to the prevention and management of chronic diseases, the enhancement of mental well-being, and the improvement of overall quality of life. A well-functioning food system is therefore fundamental to achieving the targets of SDG 3.

SDG 4 – Quality Education: Education about food and eating is a vital component of general education, directly influencing survival and lifelong health. Without adequate food and nutrition education, an educational system cannot be considered either complete or high-quality. Integrating food and nutrition literacy into school curricula, along with initiatives such as school meal programs, plays a crucial role in supporting cognitive development, academic achievement, and the ability to make informed dietary choices throughout life.

SDG 7 – Affordable and Clean Energy: Food systems account for about 30% of global energy use and around 31% of greenhouse gas emissions[4], largely due to their reliance on fossil fuels in production, processing, and distribution. Transitioning to renewable energy sources and improving efficiency across the food supply chain are critical for reducing environmental impact and supporting both affordable and sustainable food.

SDG 9 – Industry, Innovation and Infrastructure: Modern food systems depend

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4 Food and Agriculture Organization of the United Nations. (n.d.). *Energy and food production. FAO. Retrieved July 24, 2025, from* https://www.fao.org/energy/home/en/

on resilient infrastructure, innovative technologies, and inclusive value chains. Advances such as improved cold storage, digital traceability, and climate-smart agriculture not only reduce food loss but also promote equitable market access—directly supporting sustainable industrialization.

SDG 10 – Reduced Inequalities: Access to sufficient and nutritious food remains highly unequal, reflecting broader socioeconomic disparities. Food systems can play a central role in reducing inequalities by ensuring fair access to land, markets, and resources, especially for marginalized and vulnerable populations.

SDG 12 – Responsible Consumption and Production: Roughly one-third of all food produced globally is lost or wasted, representing significant inefficiency and resource loss. Target 12.3 of the SDGs explicitly aims to halve per capita global food waste and reduce losses by 2030. More sustainable production and consumption patterns in the food system—minimizing waste, optimizing resource use, and adopting environmentally sound practices—are essential for long-term food and environmental security.

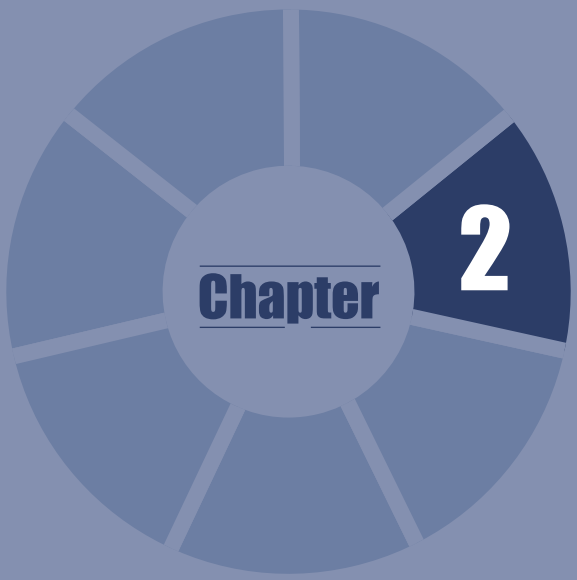
SDG 13 – Climate Action: The food system is both a driver of climate change and one of the sectors most vulnerable to its impacts. Agriculture and land-use change for food production are significant sources of greenhouse gases – food production accounts for about one third **of global GHG emissions** when you include farming, deforestation, livestock, fertilizer use, and other aspects. At the same time, shifting climate patterns (droughts, floods, heatwaves) threaten crop yields, fisheries, and livestock, putting food security at risk. Addressing SDG13 in the context of food means two things: **mitigation** – reducing the food system's carbon footprint – and **adaptation** – building resilience in food production to climate shocks.

SDG 14 – Life Below Water: The oceans and aquatic life are an important part of the food system, as fish and seafood provide protein and livelihoods for billions of people. Overfishing, marine pollution, and habitat destruction threaten fish stocks and the health of marine ecosystems, undermining a critical food source. Sustainable management of marine resources is essential to maintain healthy fisheries and long-term food supplies from the sea.

SDG 15 – Life on Land: Similarly, land ecosystems and biodiversity are fundamental to our food systems. Sustainable management of forests, soils, and terrestrial biodiversity directly supports agriculture and food production. Healthy terrestrial ecosystems provide services like pollination, fertile soil, water regulation, and pest control – all

crucial for farming. However, unsustainable agricultural expansion is a leading cause of deforestation, land degradation, and species loss. In essence, protecting life on land underpins our ability to feed the world sustainably, and sustainable food systems in turn support the conservation of land, soil, and biodiversity.

SDG 17 – Partnerships for the Goals: Finally, none of the above goals can be fully realized without strong partnerships (SDG17). Food system challenges are global in scope – from climate change to trade to technology – and require cooperation across nations and sectors. Strengthening international partnerships is a key aspect of the global food system. This includes sharing knowledge and best practices in agriculture, mobilizing financial and technical support for developing countries, and coordinating policies on issues like food trade, standards, and investment.



Shiology:

A Comprehensive Knowledge System for Understanding Food Systems

Shiology establishes an integrated, human-centered eater-food–governance cognitive framework that comprehensively covers the entire food system, and—crucially—serves as a holistic knowledge system for diagnosing and solving the food system's core challenge: the fulfillment of the Five Eater Needs (5E). This holistic knowledge paradigm asserts that only by embracing system-wide understanding and coordinated governance can we fulfill people's aspirations for well-being, contribute to global stability, and effectively advance the Sustainable Development Goals by 2030.

2-1 The Need for an Integrated Theoretical Framework

Food systems are among the most complex and far-reaching structures in human society. Their scope extends far beyond production and consumption to encompass culture and identity, politics and economics, and the sustainability of natural ecosystems; they operate across multiple scales, connect public and private actors, and function as a circular process "from farm to fork—and onward through waste, reuse, and ecological feedbacks." The issues embedded within them are even more intricate: interlocking challenges—spanning health and nutrition, food safety, equity and livelihoods, market structure and trade, environmental externalities, cultural practices and behaviors, and governance—form a dense, cross-cutting web that is difficult for any single discipline or policy instrument to unravel. At their core, these systems exist to meet the Five Eater Needs (5E), so an adequate framework must keep these ends in view.

Conventional approaches have struggled to match this complexity. For a long period, "food problems" were treated as matters of production and efficiency, or were siloed as commodity, public-health, or environmental issues. Such framing fragments policy and practice: corrective action at one point in the chain often produces unintended side effects elsewhere. In particular, a production-first perspective—prioritizing yield maximization and cost efficiency—has downplayed eater health and behavior, cultural

dimensions, environmental externalities, and the governance arrangements that shape incentives and outcomes along the entire chain. The result is institutional separation—agriculture detached from nutrition and health, environment from trade and social protection—yielding piecemeal fixes that leave system-level risks intact. For example, a narrow focus on productivity can promote overuse of fertilizers, pesticides, and water resources, leading to soil degradation, pollution, and declining food quality.

Over the past decades, the United Nations has invested heavily in improving food systems—anchoring efforts in three specialized agencies (the Food and Agriculture Organization, World Food Programme, and International Fund for Agricultural Development) with the World Health Organization and others working alongside—and has achieved substantial results; in recent years it has also formalized "food systems" as a policy framework. This shift has helped move debate beyond single-minded production targets toward integrated pathways spanning production, processing, distribution, consumption, waste management, environmental governance, and health outcomes (Figure 2-1). This evolution aligns with a 5E-oriented view: the "survival" needs of adequacy, variety, and safety must be met together, while methods that support health and longevity and practices that ensure sustainability are built in rather than added on.

Figure 2-1. Evolving Understanding of Food Systems



However, this conceptual turn has advanced faster than the knowledge base needed to implement it. At present, there is still no comprehensive knowledge system that can cover the full field and guide analysis, coordination, and decision-making. Think of the food system as an oversized cauldron. Taken together, the relevant disciplines form a stack of small lids: each can cover a portion of the opening. They overlap in places but leave gaps, and pressure and heat still leak through. Only a custom lid—an integrated knowledge system—can seal the pot and let us manage what's inside. Absent an integrated theoretical foundation, contradictions and negative spillovers are hard to avoid. Therefore, advancing sustainable transformation requires an interdisciplinary knowledge framework that can (i) represent the whole food system together acrossthe 5E, (ii) classify and code problems consistently across countries and contexts, and (iii) connect each problem to evidence-based responses while making trade-offs and co-benefits transparent.

Such a framework should synthesize insights from ecology, agricultural science, engineering, medicine and nutrition, sociology and anthropology, economics, law, and governance/management; unify core concepts and metrics; and provide a rigorous taxonomy for issue identification, coding, and mapping. In doing so, it can convert fragmented efforts into solutions that are effective, equitable, and durable, while providing the actionable intellectual infrastructure required to advance the United Nations' food-systems agenda.

2-2 Definition and Tasks of Shiology

2-2.1 Name and Concept

Shiology (from Chinese " 食学 ", shíxué) is a newly coined term combining the Mandarin shi (meaning "food" or "to eat") with the Greek-derived suffix "-ology," literally denoting the "science of eating + food". Shiology refers to an integrative discipline centered on food system affairs (shiance) – encompassing all human phenomena of obtaining and utilizing food – studied from the perspective of the eater rather than just the producer.

2-2.2 Basic Definition

Shiology is defined as a comprehensive knowledge system that reveals the objective laws of food system affairs (shiance) and is dedicated to solving human food system issues. In other words, it is not a single-topic science, but an entire framework of understanding food systems holistically, integrating insights about food, humans (as eaters), and societal order. As a science, Shiology meets the classical criteria of any scientific discipline: (a) it seeks to uncover objective laws (in this case, laws governing food, eating, and related behaviors); (b) it delineates a distinct subject matter (human-food relationships in all dimensions); and (c) it organizes this knowledge into a logical, rigorous system. Rather than examining food solely through the lens of agriculture, nutrition, or economics, Shiology encapsulates the "whole cognition" of food systems, positioning itself as a larger umbrella that includes traditional fields like agronomy but extends beyond them. Crucially, Shiology is eater-centric: it starts from the fundamental acknowledgement that without the eater, other components of the food system lose their purpose, thereby placing eater health and behaviors at the core of analysis. In summary, Shiology can be viewed as an innovative, independent knowledge system that holistically studies the relationships between people, food, and society in order to understand and govern food systems more effectively.

2-2.3 Core Tasks (What Shiology Must Do)

Solving the food system issues of humankind is the only reason for Shiology's existence. Accordingly, Shiology advances three core tasks:

1. Extend healthy lifespan at the individual level

Shiology's first task is to prolong each person's diet-related healthy lifespan by acting concurrently on:

(a) Quantity — secure sufficient, stable supplies (recognizing that persistent hunger reflects not only aggregate shortfalls but also inequality, waste, non-food diversion, and other imbalances);

(b) Quality — safeguard food integrity across production, processing, storage, transport, and retail, addressing contemporary threats such as pollution and excessive chemical additives;

(c) Method — promote proper eating, because eating can both cause and prevent disease. This entails managing eating before, during, and after meals and tailoring guidance to individual digestive and metabolic differences.

The ambition is to move toward the upper bounds of healthy human longevity through appropriate food choices and eating practices.

2. Optimize social order in food systems

Food-system order—how societies organize production, allocation, and consumption—is the bedrock of broader social order. Shortages and unequal control of food resources have historically fueled conflict. As science, markets, logistics, and trade accelerate the emergence of a world food order, Shiology asks how to shape that order for all 8 billion people, rather than for a narrow set of interests. The task is to build an equitable, transparent, and resilient order that balances production with distribution, reduces conflict over food resources, and enables everyone to eat enough, eat well, and eat for health—thereby advancing social harmony.

3. Maintain species-level continuity under ecological limits

As the global population approaches the ten-billion range, demand will test the productive ceiling of the planet's ecosystems. Arable land and ecological capacity are finite; when demand outstrips that capacity, human culture and civilization are placed at risk. Shiology's strategic task is to keep human food demand in balance with ecological support so that the human lineage continues without degrading the biophysical base that feeds it.

2-3 Shiology's Framework and Disciplinary Structure

2-3.1 Theoretical Triangle: Eater, Food, and the Order

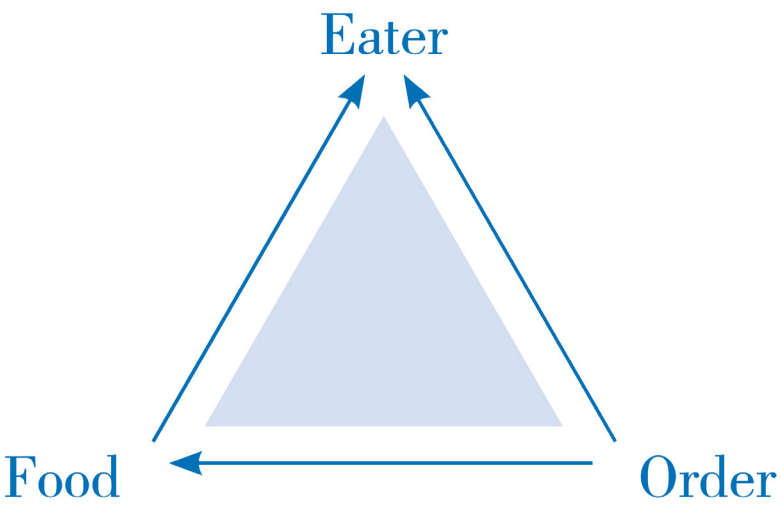
At the heart of Shiology lies a theoretical tripod that defines its scope: Eater, Food, and the Order. This triadic framework encapsulates the three fundamental elements that Shiology connects:

Eater: the human individual as a consumer of food (with biological needs, behaviors, and preferences).

Food: the material basis (all types of food and the processes of its acquisition/production).

Order: the organized systems, rules, and structures governing food and eating (including social, economic, and ecological order).

Figure 2-2. Shiology Triangle

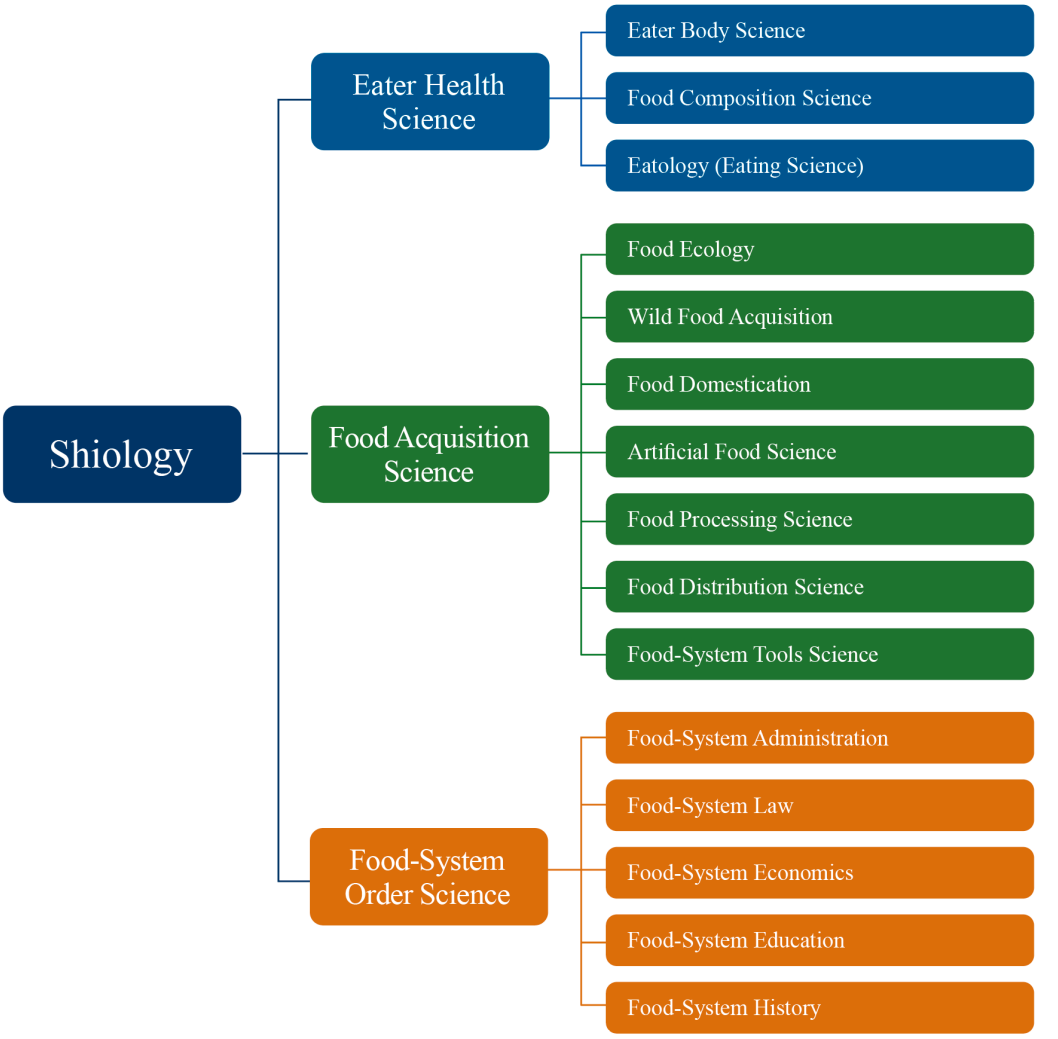


This "shiology triangle" posits that a comprehensive understanding of food systems must simultaneously consider the characteristics and needs of the eaters, the properties of food itself, and the ordering principles or governance structures that mediate between humans and food. Each vertex of this triangle corresponds to a major scholarly arena within Shiology, and together they ensure that no aspect of the food system is overlooked. Thus, the Shiology Triangle (Eater–Food–Order) thus provides both a theoretical foundation and an organizational schema for building a holistic understanding of food systems.

2-3.2 The 3-15 Structure of Shiology

Accordingly, the discipline of Shiology is organized into three primary branches, each focusing on one corner of the triangle:

Figure 2-3. The 3-15 Structure of Shiology



1. Eater Health Science

Eater Health Science is a people-centered knowledge system established from the perspective of human survival, health, wellbeing, and longevity, and it corresponds primarily to the Five Eater Needs (5E) requirement of Eating for Health and Longevity. Its purpose is to study and reveal the objective laws governing the relationship between the human body and food. To "eat for health and longevity," one must first understand the characteristics and needs of one's own body, then recognize the properties of different foods, and finally master correct eating methods, thereby achieving a high degree of coupling between body and food. As no two leaves are alike, so too no two human

bodies are identical; thus a complete knowledge framework for individualized healthy eating has historically been lacking. The construction of Eater Health Science requires both modern and traditional food knowledge; it must investigate the commonalities of group needs while also paying attention to individual differences. The ultimate measure of food utilization efficiency is reflected in the eater's health and lifespan. As a secondary discipline of Shiology, Eater Health Science comprises three tertiary fields: Eater Body Science, Food Composition Science, and Eatology (Eating Science).

2. Food Acquisition Science

Food Acquisition Science is established from the perspective of how human beings obtain food, and it studies the objective laws linking human survival to food procurement, corresponding to the Five Eater Needs (5E) of Eating Enough, Eating with Variety, and Food-Safe Eating. Securing food has always been the first necessity of life. From gathering and hunting to cultivation and animal husbandry, and from cooking and fermentation to modern food industries, humans have accumulated vast knowledge and experience over millions of years. Yet, how to sustainably obtain sufficient quantities and high-quality food remains a pressing challenge today. Food Acquisition Science is an expansion and refinement of disciplines such as agronomy and food science. It replaces narrow categories such as grain, vegetables, fruits, livestock, and aquatic products with the broader concept of "food," and substitutes the overarching idea of "acquisition" for narrower terms like domestication, production, processing, and circulation. In this way, it builds a comprehensive knowledge framework that covers the entire food system. As the largest subfield within Shiology, Food Acquisition Science is organized into seven dimensions—ecology, direct acquisition, domestication, processing, artificial food, circulation, and tools—each defined and named according to objective principles of food-related practice. It consists of seven tertiary disciplines: Food Ecology, Wild Food Acquisition, Food Domestication, Artificial Food Science, Food Processing Science, Food Distribution Science, and Food-System Tools Science.

3. Food-System Order Science

Food-System Order Science is established with the aim of reducing human conflicts over food, corresponding to the Five Eater Needs (5E) requirement of Sustainable Eating. It studies and reveals the objective laws of regularity and continuity in food-related behavior, recognizing that food-system order is the foundation of broader social order. Without food-system order there can be no social order; when food-system order collapses, society

itself descends into disorder. Food-System Order Science provides the theoretical basis for the principle that "food is the first priority of governance," and it underpins the stability and development of modern societies. Unequal distribution and unequal possession of food resources threaten social stability, and this discipline seeks to make the elements and behaviors related to food-system order more transparent and systematized, thereby optimizing order and promoting sustainable development. Its central mission is to correct improper food-related behaviors—through "hard" measures such as economics, law, and administration, as well as "soft" measures such as education, culture, and historical lessons. The goal is to transmit proper food behaviors, rectify improper ones, and build a food-system order that safeguards the interests of all humanity. The construction of this discipline requires interdisciplinary support from economics, law, administration, education, folklore, and history. As a secondary discipline of Shiology, Food-System Order Science consists of five tertiary disciplines: Food-System Administration, Food-System Law, Food-System Economics, Food-System Education, and Food-System History.

Together, these three branches (Eater Health, Food Acquisition, and Food-system Order) form the core disciplinary system of Shiology. The triadic architecture ensures that Shiology's knowledge base is truly comprehensive—spanning the biological and individual level, the technical and production level, and the socio-political level of food systems—and equips it to analyze and solve how the Five Eater Needs (5E) can be met across the system. Put simply, it answers three core questions: (1) How does food affect the person? (2) How do people obtain food? (3) How do we organize and govern food affairs? This is described as the "3-15" system: 3 primary domains as above, 15 tertiary-level disciplines (the major subfields under each branch); and several quaternary-level specialized subjects that further detail specific topics (down to very granular studies, such as, for instance, food storage science or food customs). The extensive sub-division underscores that Shiology is not a single monolithic field, but a structured disciplinary system – effectively an interdisciplinary consortium unified under an eater-centric paradigm. This structure allows Shiology to engage with nine existing disciplines, most centrally agricultural science, as well as the biomedicine, ecology, engineering, management, law, economics, education, and history within a bigger picture, filling gaps between them and providing connective tissue. As a result, Shiology functions as a "meta-discipline", where insights from different fields of food-related research are synthesized and new subfields are created to address previously overlooked questions.

2-4 Principles of Shiology

The principles of Shiology are concise statements of objective regularities in food-system affairs. They ground the discipline's knowledge architecture and guide practical governance. Unlike the principles commonly found in physics, chemistry, mathematics, or economics, Shiology's principles exhibit three salient characteristics: (1) Accessibility—they require no abstruse formulas or arcane terminology; they arise from everyday life, often "hidden in plain sight." (2) Practicality—they operate at two levels: at the individual level, they clarify the dual nature of food ("food can both cause and cure disease"), enabling people to eat for health and longevity; at the societal level, they illuminate the essential linkage between food affairs and civilization, supporting social harmony and development. (3) Survival relevance—they concern both each person's survival and health and the continuity of the human species. Violating these principles endangers individual wellbeing and species persistence; using them well improves individual life quality and supports sustainable human development. In this sense, the principles of Shiology constitute an important scientific discovery in the trajectory of human civilization.

2-4.1 Principles in the realm of Eater Health

"Eater Health" view the eater through the lens of eating behavior (the act and outcome of ingesting food). Eating is foundational to human survival and health; it determines the quality of life and, to a large extent, healthy lifespan. History and daily experience repeatedly show that conforming to the objective regularities of eating promotes health and longevity, whereas violating them disrupts internal balance and precipitates illness—even mortality. Individual variability and fragmented experience have long obscured general laws, leaving people to "see them every day without recognizing them." The principles below bring those regularities into clear relief, placing agency back in the hands of each eater:

1. "Body as Food-Transformed" Principle

The human body is formed from food. Bones, blood, organs, muscles, brain, skin, and hair all derive from the intake, digestion, absorption, and resynthesis of what we eat. This is a highly complex and intelligent biotransformation system. In short, without food there is no body; without food there is no life.

2. "Body–Food Coupling" Principle

Human bodies differ across individuals and vary over time. Only by recognizing individual heterogeneity and time-varying needs, and by selecting foods and eating methods that match one's current physiological state, can one achieve optimal coupling between food and body, thereby securing health and homeostasis. Violations of this coupling tend to induce imbalance and disease.

3. "Food as Cause of Disease" Principle

Eating (the act and outcome of ingesting, processing, and utilizing food) is a significant source of disease. Inappropriate food choices or eating methods can trigger physiological imbalance and illness. Consequently, improper eating must be identified and avoided to reduce disease risk.

4. "Food as Cure of Disease" Principle

Eating is also a key modality of intervention. By leveraging the digestive–absorptive system to deliver nutritional and functional corrections to an imbalanced body, diet can play a therapeutic role—an ancient practice still advancing today. Appropriate eating can correct diet-induced disorders and support treatment of conditions arising from other causes.

5. "Five-Senses Eating Aesthetic" Principle

Eating is a multisensory aesthetic process—primarily olfactory, gustatory, and oral tactile, aided by visual and auditory inputs. Its responses are dual—both psychological (e.g., pleasure, satisfaction) and physiological (post-eating effects). Hence the insistence on the unity of palatability and health.

Health is a permanent human aspiration. These principles in the realm of eater health bear directly on the wellbeing of 8 billion people and their families. By acknowledging the dual nature of eating and mastering its objective regularities—so that quantity, quality, and eating method together achieve robust body–food coupling—each person can genuinely reclaim agency over their own health.

2-4.2 Principles in the realm of food-system order

Food systems are a fundamental component of human society, shaping both individual survival and the trajectory of social prosperity or decline. History shows that aligning with the objective laws of food-system order yields peace and prosperity, while

violating them breeds conflict and instability. These laws have long lacked systematic articulation. The five principles below make them visible and operational—offering a clear framework for a world food-system order that serves all 8 billion people and endures across generations.

1. "Food Nurtures Civilization" Principle

Food system affairs (shiance) long predate organized civilization and continuously seed its emergence and growth. They supply the material base on which societies endure; conversely, persistent mismanagement or harmful food system affairs undermine that base and jeopardize civilizational continuity.

2. "Food-System Triangle" Principle

All food system affairs unfold within an integrated triad: the food ecosystem, the eater behavior system, and the food converting system (physiological conversion and the ultimate ecological return). This triangular circulation delineates the functional bounds of food system.

3. "Food-System Priority" Principle

Because food system concern survival, they must be prioritized above other public affairs. Failures in provisioning, access, or distribution cascade through society—prices spike, entitlements collapse, and food-system order destabilizes. Prioritizing food-system secures national tranquillity; reversing priorities invites contestation and disorder.

4. "Dual Compliance Laws of Food Systems" Principle

Human activities must simultaneously respect two fundamental laws: the ecological production laws of the food ecosystem, and the transformation laws of the food-converting system. Only by aligning with both can humanity achieve health, longevity, and sustainable development. Ignoring either law leads to disease, imbalance, and ultimately the breakdown of sustainability.

5. "Food-System as the Basis of Order" Principle

Social order originates in how food is allocated and how food resources are held. Food-system order is the order of survival—it precedes and underpins broader social order. When food-system order collapses, other institutional orders rapidly unravel and civilization itself is shaken.

Taken together, these five principles provide an actionable framework to surface, assess, and correct the elements and behaviors that constitute food-system order. Through

transparency and systematization, societies can optimize resource allocation, reduce structural conflict, and raise efficiency and resilience. The goal is a fair, transparent, and durable food-system order for all humanity—freeing both present and future generations from food insecurity and enabling civilization to advance with greater stability and endurance.

2-5 Eater-Centered Food-system Issue Framework

In Shiology, the Five Eater Needs are not slogans but operational dimensions for research, monitoring, and policy. Once the "ends" are clarified—what must be achieved for people—the next question is where and why the system fails. To answer this, Shiology adopts an eater-centered framework that locates each issue by the primary eater need that is not being met. Any problem in food systems can be located by the need it primarily fails to meet—quantity (eating enough), diversity (eating with variety), hazards&fraud (food-safe eating), diet-related disease/suboptimal eating methods (Eating for Health and Longevity), or social–ecological overshoot (sustainable eating). Organizing the five needs into three tiers—the Survival Tier (Needs 1–3), the Eater Health Tier (Need 4), and the Eater Sustainability Tier (Need 5)—provides a coherent top-level structure for classification and governance, enabling clear and exhaustive mapping for analysis and policy while avoiding department- or discipline-based silos.

2-5.1 Hierarchical Structure (Six Levels)

The food-system issue framework is organized into six levels of hierarchy for clarity and thoroughness. At the **highest level (Level 1)** is the entirety of "food system issues" as one broad domain. This then splits into **Level 2: three overarching categories of issues**, defined exactly by the eater-centric logic. These three Level-2 categories are:

1. Eater Survival Issues

Here, "survival" is defined in a comprehensive way – it means every person's secure access to sufficient, diverse, and high-quality food necessary to live an active, healthy life. In other words, this category addresses the fundamental question: Do people have enough food, of the right kinds, to sustain themselves? It encompasses issues of **quantity**, **variety**, and **quality**.

2. Eater Health and Longevity Issues

Once the survival precondition is satisfied (quantity–variety–quality), the next

category addresses whether people are using that food in ways that maximize health and lifespan. These are problems of **food–body coupling and proper eating practices**. Essentially, given adequate food, are people eating in a healthy manner? This includes issues like incomplete understanding of food constituents, limited knowledge of individual physiology, unbalanced diets leading to obesity or diet-related diseases, harmful eating habits or cultural practices, and the general realm of "how to eat" correctly for long-term wellness. These issues are about utilization of food (behavior, knowledge, lifestyle) rather than availability of food.

3. Eater Sustainability Issues

These comprise food-system problems that manifest at the **population or global level**, beyond the scale of individual eaters, particularly those affecting the long-term viability and fairness of the food system. Sustainability issues are further understood in two sub-dimensions – reflecting internal vs. external conflicts in the food system.

- **Intra-human (internal) conflict**—failures of social order and economic operation (e.g., weak governance coordination, gaps in laws and standards, limited education and research capacity, imbalanced economic structures).
- **Human–environment (external) conflict**—damage from sustained pressure on ecosystems, including structural disruption of ecological space and patterns (occupation, conversion, fragmentation) and non-structural pollution of environmental media such as air, water, and soil.

This three-part ontology covers the spectrum of "Five Eater Needs" in a structured way. Below the Level-2 categories, the **framework further breaks issues down into Level 3, 4, 5, and 6 sub-categories**, increasing in specificity. For example, under Eater Survival, Level 3 might include specific domains like "food quantity issues" (yield shortfalls, etc.), "food variety issues" (lack of food species), and "food safety/quality issues" (contamination, adulteration problems). Each of those can further split – e.g. "food quality issues" might branch into "food contamination", "food spoilage", etc., all the way to particular hazards at Level 6.

2-5.2 Classification Principles

1. MECE design and lifecycle coverage.

The taxonomy is deliberately **mutually exclusive and collectively exhaustive (MECE)**: each concrete problem should fit **in one and only one** place, avoiding omissions

and double counting. It spans the **full food-system lifecycle**—production, processing, distribution, consumption, and waste management—so both **individual** and **population** perspectives are coherently captured.

2. Individual vs collective levels.

Shiology draws a clear line between **individual-oriented** categories—the **Survival Tier** (Needs 1–3) and the **Eater Health Tier** (Need 4)—and the **collective-oriented Eater Sustainability Tier** (Need 5). Thus, **obesity** is an eater-health issue, whereas **agricultural greenhouse-gas emissions** fall under sustainability. This separation enables targeted focus while preserving a system view, since both ultimately feed back to eater wellbeing.

Applying these principles keeps categories **conceptually distinct** yet **collectively complete**, enabling consistent measurement, comparability across contexts, and focused interventions. This systematic, eater-centred structure improves on list-based or discipline-siloed approaches and is a core strength of Shiology's problem-identification method.

2-5.3 Hierarchical Coding System

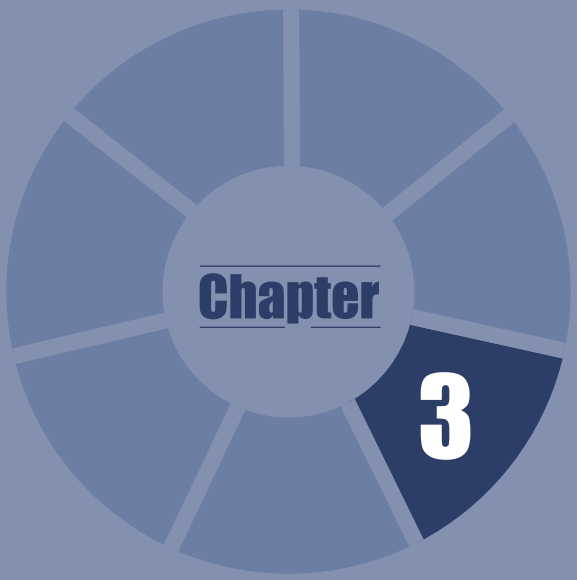
As part of this effort, Shiology even introduced a coding scheme to tag each issue uniquely. In the framework used by this report, codes of the form **"SI-xxxxxxx"** (where "SI" stands for Shi (eat+food) Issue) are assigned to every node in the issue tree. The first digit of the code indicates the Level-1 domain (the overall food system issues ontology), the second digit indicates the Level-2 category (1 = survival, 2 = health/longevity, 3 = sustainability), and subsequent digits encode lower levels down to Level 6. For example, SI-1100000 denotes the broad category of eater survival issues; SI-1120000 might denote a Level-3 subcategory under survival (say, food variety issues). Trailing zeros indicate higher-level aggregate categories, whereas fully specified codes (no trailing zeros) indicate the most granular issues. This kind of coding, reminiscent of library classification or medical coding, greatly aids **information management**: researchers and policymakers can reference issues by code, sort and compare data, and ensure comprehensive coverage.

2-5.4 Application – Structural Presentation of Issues

Using this eater-centered classification, we can structurally present and analyze food system issues in a way that highlights relationships and priorities. For instance, consider

a country facing multiple food challenges: high child stunting, an obesity rise in adults, periodic food price spikes, and soil erosion in farmlands. In an unstructured list, these problems might seem disparate. But through Shiology's lens: child stunting falls under survival issues (quantity/quality deficiency), obesity is an eater health issue, food price spikes relate to social order sustainability issues (economic coordination failure in the food system), and soil erosion is an environmental sustainability issue. By classifying them, we see that the country has challenges spanning all three main categories – indicating a need for a multipronged strategy. We also see sub-linkages: price spikes (sustainability problem) could worsen child stunting (survival problem) by making food unaffordable. Shiology's structure helps to systematically identify such linkages because the hierarchy is not just a filing system but a representation of how issues logically connect via the food system's flow from production to consumption. Policymakers using this framework can ensure they address root causes at each level: e.g. improving agricultural resilience (to tackle the soil erosion, a sustainability cause of price volatility) while also launching nutrition programs (to tackle stunting directly at the survival level) and public health campaigns (to address obesity at the health level). The hierarchical view thereby encourages **systemic responses** that cover all bases – precisely the kind of comprehensive approach that Shiology advocates.

In summary, Shiology's eater-centered issue identification system is a powerful tool that brings order to the complexity of food systems. By categorizing every problem under survival, health/longevity, or sustainability (and further sub-classifications) with the eater as the focal point, it provides a structural representation of the entire landscape of food system challenges. This enables more strategic thinking: stakeholders can pinpoint where a problem lies in the big picture and trace how it might interact with other issues. It also improves communication – experts and decision-makers can refer to standardized categories and codes, reducing ambiguity. Ultimately, this framework exemplifies Shiology's strengths: it is **comprehensive, logically organized, and action-oriented**, designed not just to understand food systems but to guide effective governance of them. As the food systems community increasingly embraces holistic approaches, the Shiology framework offers a ready blueprint for ensuring that no issue is left behind and that solutions are devised with the whole system – and the eater's welfare – in mind.



Food-System Issues:

Eater Survival — The Civilizational Baseline

Eater survival issues [SI-1100000] constitute a second-level category within the food system issue framework, corresponding to the Five Eater Needs (5E) of Eating Enough, Eating with Variety, and Food-Safe Eating. The imperative of human survival, anchored in the fundamental need for food, is the absolute bedrock upon which all other aspects of civilization are built. Without secure access to sufficient, diverse, and safe food, ambitions for health, education, productivity, and social stability cannot take hold.

As established in Chapter 1, progress has stalled—and in some contexts reversed: 713–757 million people were undernourished in 2023, while about 2 billion people face micronutrient deficiencies that erode health and human capital. At the other end of malnutrition, adult obesity has more than doubled since 1990, and roughly one-third of food produced is lost or wasted each year—evidence of deep inefficiencies coexisting with unmet basic need [FAO/IFAD/UNICEF/WFP/WHO, 2024; Lowe, 2021; WHO, 2025; FAO, 2011; UNEP, 2024]. Beyond adequacy, dietary variety remains constrained at critical life stages. Over two in three children aged 6–23 months (68 per cent) were not fed foods from at least five of the eight recommended food groups – the indicator referred to as minimum dietary diversity. [UNICEF, 2024]. On food safety and integrity, the burden is likewise substantial: about 600 million people fall ill and 420,000 die each year from unsafe food, with an estimated 33 million DALYs lost; children under five bear a disproportionate share [WHO, 2015].

Within the survival tier, three interlocking fronts determine whether populations reliably meet basic needs:

- **Food quantity.** Shortfalls arise not only from production limits but also from loss and waste, supply-chain fragility (shocks that disrupt flows in time and space), and demand pressures (dietary transitions and competing non-food uses).
- **Food variety.** Survival is not secured by calories alone. Because humans are omnivorous, the range of food types available to a population—shaped by geography and trade—governs dietary assembly and resilience. When the palette narrows, nutrition sources become singular, adaptive options shrink, and micronutrient gaps widen.

Table 3-1. Eater Survival Issues

Level 2	Level 3	Level 4	Level 5
Eater Survival Issues [SI-1100000]	1 Food Quantity Issues [SI-1110000]	1 Food Production Inadequacy [SI-1111000]	1 Food Production Inadequacy Driven by Climate Volatility and Extreme Weather Events [SI-1111100]
			2 Food Production Inadequacy Driven by Natural Resource Constraints [SI-1111200]
			3 Food Production Inadequacy Driven by Biological Threats [SI-1111300]
			4 Food Production Inadequacy Driven by Technological and Infrastructure Constraints [SI-1111400]
		2 Food Loss and Waste [SI-1112000]	1 Food Loss [SI-1112100]
			2 Food Waste [SI-1112200]
		3 Supply Chain Vulnerability [SI-1113000]	1 Supply Chain Susceptibility [SI-1113100]
			2 Supply Chain Cascade Vulnerability [SI-1113200]
			3 Supply Chain Resilience Deficiencies [SI-1113300]
		4 Increased Food Demand [SI-1114000]	1 Increased Food Demand Driven by Population Growth [SI-1114100]
			2 Increased Food Demand Driven by Dietary Structure Change [SI-1114200]
			3 Increased Food Demand Driven by Increased Industrial Use of Food [SI-1114300]
	2 Food Variety Issues [SI-1120000]	1 Insufficient Native Species [SI-1121000]	1 Scarcity of Local Traditional Food Varieties [SI-1121100]
			2 Underutilization of Potential Food Ingredients [SI-1121200]
		2 Insufficient Introduction of Food Species [SI-1122000]	1 Insufficient Introduction of Locally-Adapted Food Species [SI-1122100]
			2 Insufficient Introduction of Food Species through Trade [SI-1122200]
	3 Food Quality Issues [SI-1130000]	1 Food Contamination [SI-1131000]	1 Food Biological Contamination [SI-1131100]
			2 Food Chemical Contamination [SI-1131200]
			3 Food Physical Contamination [SI-1131300]
		2 Food Spoilage [SI-1132000]	1 Food Microbial Spoilage [SI-1132100]
			2 Food Enzymatic Spoilage [SI-1132200]
			3 Food Chemical Spoilage [SI-1132300]
		3 Improper Use of Synthetic Chemicals [SI-1133000]	1 Excessive Use of Chemical Additives [SI-1133100]
			2 Illegal Chemical Additives [SI-1133200]
		4 Toxic Food Issues [SI-1134000]	1 Toxic Substances Confused with Food [SI-1134100]
			2 Improper Detoxification Processing [SI-1134200]

- **Food quality (safety and integrity).** When contamination, spoilage, or misuse of inputs compromises food—whether via biological, chemical, or physical hazards—edibility and reliability decline; in severe cases food becomes inedible, directly threatening survival. Guarding end-to-end integrity is intrinsic to the survival tier, not a discretionary add-on.

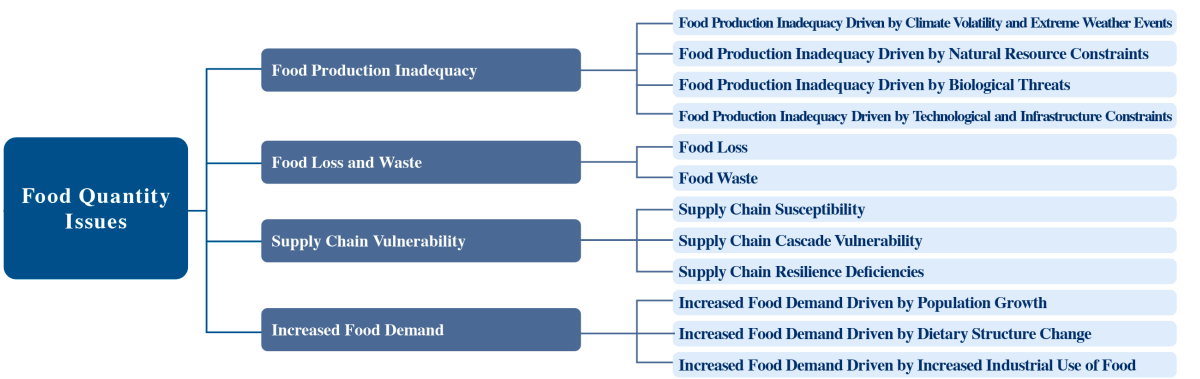
This chapter examines eater survival through Phenomenon, Cause, Hazard, and Response to clarify what is observed, why it occurs, what risks it creates, and which levers can stabilize the foundation on which all higher-order aims rest.

The framework of Eater Survival issues is summarized in Table 3-1.

3.1 Food Quantity Issues

Food Quantity Issues [SI-1110000] represent a critical third-level category within the food system issue framework, situated directly under the second-level domain of eater survival issues. This category addresses the total volume of food available to humanity through production and processing systems. The food quantity issues are illustrated below (Figure 3-1):

Figure 3-1. Food Quantity Issues



As defined by the 1996 World Food Summit, food security exists only when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food. Food quantity is the essential prerequisite that underpins this definition, specifically the element of "sufficient" food.

These issues encompass four primary drivers, i.e. food production inadequacy, food loss and waste, supply chain vulnerabilities, and increased food demand. Collectively, these drivers precipitate severe supply-demand shortfalls, which in turn manifest as multifaceted risks. These include elevated famine risks, structural market imbalances, localized food shortages, volatile price spikes, ecological resource depletion, and profound threats to social and political stability. Addressing these interconnected challenges requires integrated and strategic interventions across four key pillars: enhancing agricultural productivity, mitigating loss and waste, fortifying supply chain resilience, and restructuring dietary demand towards sustainable consumption.

The quadrant analysis table for food quantity issues is shown below (see Table 3-2):

Table 3-2. Quadrant Analysis Table of Food Quantity Issues

Category	Content
Phenomenon	Food shortages and malnutrition.
Cause	Insufficient food production, food loss and waste, vulnerable supply chain and increased food demand result in insufficient food quantity.
Hazard	Threatening human survival and triggering conflicts and crises.
Response	Building a food security guarantee system.

3-1.1 Food Production Inadequacy

Food Production Inadequacy [SI-1111000] is a fourth-level issue within the food system issue framework, categorized as a direct sub-issue of food quantity issues. It is defined as a systemic failure in agricultural output where production is insufficient to meet fundamental human consumption requirements.

Food production inadequacy primarily stems from four interconnected constraints: climate volatility and extreme weather events, natural resource depletion, biological threats to crops and livestock, and technological and infrastructural limitations. The repercussions of this inadequacy are severe: it critically undermines global supply chain resilience, directly jeopardizes subsistence security for vulnerable and low-income populations, and potentially triggers cascading systemic risks across economic and political spheres. Addressing this challenge and achieving sustainable food systems necessitates a multi-faceted approach. Key solutions include scaling up climate-resilient agricultural practices, deploying resource-efficient technologies, and mitigating

humanity's negative impact on the natural world.

The quadrant analysis table for food production inadequacy is shown below (see Table 3-3):

Table 3-3. Quadrant Analysis Table of Food Production Inadequacy

Category	Content
Phenomenon	Large populations suffering from hunger.
Cause	Extreme weather events, natural resource limitations, biological threats, and technological and infrastructure constraints lead to hunger.
Hazard	Threatening human survival.
Response	Increasing food quantity by expanding arable and breeding areas, improving agricultural technology, and mitigating humanity's negative impact on the natural world.

3-1.1.1 Food Production Inadequacy Driven by Climate Volatility and Extreme Weather Events

Food production inadequacy driven by climate volatility and extreme weather events [SI-1111100] is a fifth-level issue within the food system issue framework and a direct sub-issue of food production inadequacy.

Food production inadequacy driven by climate volatility and extreme weather events refers to systemic disruptions in agricultural output and food security resulting from increasing climate instability. These challenges are triggered by the rising frequency and intensity of meteorological disasters—including extreme heatwaves, prolonged droughts, heavy rainfall, flooding, frosts, hailstorms, and abnormal seasonal shifts—against the broader backdrop of global climate change.

This inadequacy stems primarily from five disaster types, including extreme heat and drought, heavy rainfall and floods, freezing damage, hailstorms, abnormal seasonal and climatic fluctuations. The core drivers behind these phenomena are the accumulation of greenhouse gases in the atmosphere and widespread ecosystem degradation. The consequences of such production failures extend beyond individual malnutrition to include large-scale famine, economic instability, and ultimately, threats to global civilization itself.

To address these risks, a comprehensive response is essential. Key strategies include climate-resilient agricultural practices, early warning and monitoring systems,

technological innovation and adoption, policy and institutional interventions. This integrated approach emphasizes prevention, adaptation, and international cooperation to safeguard food systems under increasing climate stress.

The quadrant analysis table for food production inadequacy driven by climate volatility and extreme weather events is shown below (see Table 3-4):

Table 3-4. Quadrant Analysis Table of Food Production Inadequacy Driven by Climate Volatility and Extreme Weather Events

Category	Content
Phenomenon	Poor or complete crop failure.
Cause	Abnormal atmospheric, geological, or biological conditions in nature.
Hazard	Reduction in food quantity, exacerbating hunger problems
Response	Climate-resilient agricultural practices, early warning and monitoring systems, technological innovation and adoption, policy and institutional interventions to reduce human-induced natural disasters.

3-1.1.2 Food Production Inadequacy Driven by Natural Resource Constraints

Food production inadequacy driven by natural resource constraints [SI-1111200] is a fifth-level issue within the food system issue framework and a sub-issue of food production inadequacy. It refers to limitations in agricultural output and sustainable development caused by scarce or degraded natural resources essential to farming—particularly arable land and water.

Key constraints include insufficient cultivated land area, poor soil quality, water scarcity, limited natural aquatic or aquaculture zones, and inadequate natural pastureland. These are primarily driven by geographical limitations, geological conditions, and ecological thresholds, which collectively suppress agricultural potential, reduce food output, and endanger food security.

Addressing this crisis requires systematic interventions such as implementing crop rotation and fallow systems to restore soil health, adopting precision irrigation technology, and establishing ecological compensation mechanisms to overcome these resource barriers.

The quadrant analysis table for food production inadequacy driven by natural resource constraints is shown below (see Table 3-5):

Table 3-5. Quadrant Analysis Table of Food Production Inadequacy Driven by Natural Resource Constraints

Category	Content
Phenomenon	Arable land depletion, water deficit.
Cause	Natural endowment limitation.
Hazard	Reduction in food quantity, exacerbating hunger problems.
Response	Deployment of high-efficiency technologies and remediation engineering.

3-1.1.3 Food Production Inadequacy Driven by Biological Threats

Food production inadequacy driven by biological threats [SI-1111300] is a fifth-level issue within the food system issue framework and a sub-issue of food production inadequacy. It refers to the destructive impacts of pests, diseases, and invasive species on agricultural systems, directly reducing food output.

These threats arise from two main sources: crop diseases and pests, and competition from weeds or invasive species. Typical manifestations include widespread crop infections, pest outbreaks, and the proliferation of noxious weeds, resulting from ecological imbalances, inadequate quarantine protocols, and evolving pesticide resistance. Such events cause significant yield losses and may escalate into regional food crises.

Effective response requires a structured "prevention-monitoring-governance" system, emphasizing disease-resistant crop breeding, biological control technologies, and enhanced cross-border quarantine cooperation to systematically mitigate biological risks and ensure production stability.

The quadrant analysis table for food production inadequacy driven by biological threats is shown below (see Table 3-6):

Table 3-6. Quadrant Analysis Table of Food Production Inadequacy Driven by Biological Threats

Category	Content
Phenomenon	Enhanced pest resistance, invasion of alien species, reduced biodiversity.
Cause	Homogenized cropping patterns, indiscriminate pesticide use, cross-border trade dissemination.
Hazard	Large-scale crop yield reduction, ecosystem disruption, and exacerbated food security risks.
Response	Establishing genetic resource banks, promoting biodiversity-based cultivation, and developing green pest control technologies.

3-1.1.4 Food Production Inadequacy Driven by Technological and Infrastructure Constraints

Food production inadequacy driven by technological and infrastructure constraints [SI-1111400] is a fifth-level issue within the food system issue framework and a sub-issue of food production inadequacy. It refers to the systemic limitation where actual agricultural output falls below regional potential due to underdeveloped technologies and inadequate infrastructure.

Key constraints include limited mechanization, outdated farming techniques, and deficient infrastructure, manifesting as low adoption of modern machinery, slow technological innovation, and insufficient storage and cold chain systems. These stem from inadequate investment, disjointed technology transfer, and poor infrastructural planning. Such shortcomings exacerbate post-harvest losses and impede agricultural modernization.

Addressing this issue requires accelerating the deployment of smart farming equipment, improving technology dissemination mechanisms, and expanding investment in modern infrastructure to systematically overcome productivity barriers and ensure a stable food supply.

The quadrant analysis table for food production inadequacy driven by technological and infrastructure constraints (see Table 3-7):

Table 3-7. Quadrant Analysis Table of Food Production Inadequacy Driven by Technological and Infrastructure Constraints

Category	Content
Phenomenon	Suboptimal mechanization adoption, severe agricultural labor shortage, and lagging agro-technological R&D
Cause	Agricultural underinvestment, disjointed technology transfer, and delayed infrastructure planning
Hazard	Elevated post-harvest losses and escalating regional food insecurity
Response	Diffusion of intelligent agricultural equipment, bridging of the R&D application gap, deploying digital agro-infrastructure

3-1.2 Food Loss and Waste

Food Loss and Waste [SI-1112000] is a fourth-level issue within the food system issue framework and a sub-issue under food quantity issues. It refers to the systemic

inefficiency wherein edible food is not fully utilized across the supply chain, from production to consumption, due to technical limitations (e.g., spoilage from inadequate cold chains), management failures (e.g., over-purchasing and discarding), or institutional gaps (e.g., overly strict standards).

This issue comprises two components: food loss (primarily in production and distribution) and food waste (largely at retail and consumption). Typical manifestations include harvest losses, spoilage during storage and transport, and consumer-level discards. Root causes involve technological deficits, governance shortcomings, and unsustainable consumption patterns. Globally, about one-third of all food produced is lost or wasted—enough to feed the world's population and eliminate hunger if prevented.

Addressing this challenge requires an integrated approach: advancing technical solutions like intelligent warehousing and improved preservation; implementing institutional measures such as standardized food labeling and redistribution systems; and fostering behavioral change through consumer education and initiatives like the "Clean Plate Campaign."

The quadrant analysis table for food loss and waste is shown below (see Table 3-8):

Table 3-8. Quadrant Analysis Table of Food Loss and Waste

Category	Content
Phenomenon	Food loss and waste occur extensively throughout the food supply chain, including during production, harvesting, transportation, and wholesale distribution
Cause	The issue is often perceived as ethical or moral concerns, rather than being recognized as critical systemic issues directly linked to global food security and human survival
Hazard	Threatening individual human survival and overall sustainability
Response	A holistic recognition of the harms caused by food loss and waste is essential, necessitating integrated interventions through legal measures combined with sustained educational efforts to shift public behavior and industry practices.

3-1.2.1 Food Loss

Food loss [SI-1112100] is a fifth-level issue within the food system issue framework and a sub-issue under food loss and waste issues. It refers to the systemic challenge of excessive food reduction from production to distribution—including post-harvest handling, storage, processing, and transportation—due to technical, infrastructural, or

managerial deficiencies. This leads to resource waste, economic losses, food security risks, and ecological pressure.

Food loss occurs across five key stages: production, post-harvest handling, processing, storage and transportation, and wholesale. Typical manifestations include harvest losses from outdated techniques, spoilage due to inadequate storage or transport facilities, and discard of edible portions under overly strict processing standards. Root causes involve limited technology adoption among smallholders, underinvestment in infrastructure (e.g., cold chains), and weak commercial value-adding capacity. These not only degrade natural resources and disrupt food systems but also reduce effective food output, hindering sustainable development.

Addressing this requires an integrated approach: promoting damage-reducing harvesting tools and on-site precooling technology; establishing agricultural product green channels and distributed cloud storage; and enhancing processing subsidies and rationalizing commercial standards through policy intervention.

The quadrant analysis table for food loss is shown below (see Table 3-9):

Table 3-9. Quadrant Analysis Table of Food Loss

Category	Content
Phenomenon	Food loss occurs extensively across key stages of the food supply chain, including production, harvesting, transportation, and wholesale distribution.
Cause	Outdated technology and inadequate storage infrastructure
Hazard	Reduction in available food quantity and unnecessary waste of land and water resources
Response	Addressing these challenges requires enhanced technology adoption, modernized infrastructure, and evidence-based policy interventions

3-1.2.2 Food Waste

Food waste [SI-1112200] is a fifth-level issue within the food system issue framework and a sub-issue under food loss and waste issues. It refers to the discard or underuse of edible food across processing, retail, and consumption stages due to multifactorial inefficiencies.

Key manifestations include processing losses from over-refinement and byproduct disposal, retail waste from aesthetic rejections based on cosmetic standards, and consumer waste from over-purchasing and plate discard. Root causes involve rigid processing specifications, inefficient procurement practices, and cultural norms

promoting excessive consumption. This crisis accelerates economic losses and arable land depletion, accounts for 8–10% of global greenhouse gas emissions, and intensifies food insecurity for over 800 million people.

Addressing food waste requires integrated interventions such as developing value-added technologies for byproducts, implementing dynamic pricing for near-expiry foods, promoting portion-aware kitchen tools, and legislating standardized food recovery protocols to establish a comprehensive waste reduction system.

The quadrant analysis table for food waste is shown below (see Table 3-10):

Table 3-10. Quadrant Analysis Table of Food Waste

Category	Content
Phenomenon	Food waste occurs extensively across multiple stages of the food system, including production, wholesale, and consumption.
Cause	Food waste is often perceived as a moral or ethical failing, rather than being recognized as a critical systemic issue with direct implications for global food security, resource sustainability, and human survival.
Hazard	Food waste directly threatens both individual survival and planetary sustainability
Response	A holistic recognition of the harms of food loss and waste is essential, requiring integrated action through legal measures combined with sustained educational efforts to shift public behavior and industry practices

3-1.3 Supply Chain Vulnerability

Supply chain vulnerability [SI-1113000] is a fourth-level issue within the food system issue framework and a sub-issue under food quantity issues. It refers to systemic risks across the entire supply chain—from production to consumption—where its ability to withstand disruptions, maintain stable supply, and ensure food security becomes critically compromised under multiple risk factors. This degradation can trigger cross-regional shortages, severe price volatility, and food safety crises.

This vulnerability exhibits three core characteristics: high interruptibility, strong cascade effects, and weak restorative capacity. These stem from structural flaws—such as over-centralization, excessive globalization, and rigid connectivity—coupled with systemic deficiencies like inadequate backup capacity and weak emergency mechanisms. Consequences include regional humanitarian crises from hub failures, global food catastrophes from systemic collapse, and long-term threats to civilizational stability due

to slow recovery.

Mitigation requires a tripartite strategy: constructing multi-hub networks to limit risk spread, implementing cross-process smart coordination for real-time adaptation, and strengthening strategic reserves with digital twin technology to enhance systemic resilience.

The quadrant analysis table for supply chain vulnerability is shown below (see Table 3-11):

Table 3-11. Quadrant Analysis Table of Supply Chain Vulnerability

Category	Content
Phenomenon	Regional food shortages, price volatility, transportation corridor disruptions, and excessively high grain loss rates
Cause	Structural flaws and systemic deficiencies
Hazard	Deterioration of food security, impediments to achieving SDG targets, and heightened socio-economic instability
Response	Spatial restructuring, enhanced process governance, and technology-enabled resilience strengthening

3-1.3.1 Supply Chain Susceptibility

Supply chain susceptibility [SI-1113100] is a fifth-level issue within the food system issue framework and a sub-issue of supply chain vulnerability. It denotes the risk from over-reliance on critical single nodes—such as specific ports, regions, or facilities—where sudden disruptions like transport blockages or storage failures trigger short-term supply gaps and systemic instability.

This susceptibility stems from two core elements: high exposure to natural hazards and inadequate infrastructure. These can directly cause transportation halts, storage facility closures, localized food stagnation, and empty retail shelves, worsening food access crises. Resulting ripple effects include inflated regional food prices, disproportionate impacts on low-income populations, and broader threats to food security and social stability.

Countermeasures require establishing diversified node networks, developing multi-corridor transport routes, and deploying distributed storage hubs to reduce single-point dependencies. Simultaneously, implementing node-level risk monitoring and early-warning systems is critical for proactive disruption management.

The quadrant analysis table for supply chain susceptibility is shown below (see Table 3-12):

Table 3-12. Quadrant Analysis Table of Supply Chain Susceptibility

Category	Content
Phenomenon	Sudden disruption or failure of critical nodes within food supply chains
Cause	High exposure to natural disasters and critical infrastructure deficiencies
Hazard	Undermining food security and threatening social stability.
Response	Establishing a diversified node network and implementing node-level risk monitoring mechanisms

3-1.3.2 Supply Chain Cascade Vulnerability

Supply chain cascade vulnerability [SI-1113200] is a fifth-level issue within the food system issue framework and a sub-issue of supply chain vulnerability. It arises from the coupling of rigid transmission chains—stemming from node hyperconnectivity—and amplification effects at capacity-constrained bottlenecks. This creates a risk-conduction amplifier that triggers a self-reinforcing cycle, enabling localized disruptions to escalate into system-wide collapse.

This vulnerability has two core aspects: hyper-connected node dependencies and pronounced capacity bottlenecks. Triggered by monolithic node distribution and excessive inter-node connectivity—compounded by critical capacity constraints—these factors form a risk propagation amplifier under external shocks. Resulting cascading effects exacerbate supply disruptions, paralyze food logistics, inflate regional grain prices, and may precipitate shortage risks. Critical mitigation requires dependency decoupling and dynamic bottleneck mitigation to reduce interruption risks.

The quadrant analysis table for supply chain cascade vulnerability is shown below (see Table 3-13):

Table 3-13. Quadrant Analysis Table of Supply Chain Cascade Vulnerability

Category	Content
Phenomenon	Critical hubs operating beyond capacity
Cause	Elevated node dependency density, pronounced capcaity bottlenecks
Hazard	Accelerated spread of food inflation, significant economic losses.
Response	Building a diversified node-level network and establishing a node risk monitoring mechanism

3-1.3.3 Supply Chain Resilience Deficiencies

Supply chain resilience deficiencies [SI-1113300] is a fifth-level issue within the food system issue framework and a sub-issue of supply chain vulnerability. It refers to a system's inability to quickly and effectively resume operations after shocks such as natural disasters, epidemics, geopolitical conflicts, or infrastructure failures.

This deficiency manifests in two core ways: the absence of backup supply channels and a lack of emergency inventory systems. Typical symptoms include delayed post-disruption recovery, failures in reactivating production and logistics assets, slow restoration of critical node functionality, and breakdowns in cross-link coordination. Root causes stem from hyper-concentrated supplier dependencies coupled with insufficient contingency production capacity, reserve inventories, and flexible transport resources. Economically, this triggers price inflation and potential supply chain offshoring; socially, it threatens basic livelihoods, exacerbates public anxiety, and undermines social order. Enhancing resilience requires implementing diversified structures, establishing emergency inventory and backup production systems, and constructing full-chain digital platforms to optimize resource allocation efficiency.

The quadrant analysis table for supply chain resilience deficiencies is shown below (see Table 3-14):

Table 3-14. Quadrant Analysis Table of Supply Chain Resilience Deficiencies

Category	Content
Phenomenon	Material flow disruptions and protracted end-point shortages
Cause	Monolithic supply network structures and failure to implement emergency inventory buffers
Hazard	Accelerating price inflation, deepening livelihood burdens, and disrupting social order
Response	Pursuing supply channel diversification and establishing emergency inventory systems

3-1.4 Increased Food Demand

Increased food demand [SI-1114000] is a fourth-level issue within the food system issue framework and a sub-issue of food quantity issues. It refers to the systemic pressure from persistent, inelastic expansion in total consumption volume, compounded by

structural imbalances within the system's sustainable provisioning capacity.

This demand is driven by three primary forces: population growth, dietary structure changes, and rising industrial consumption. Their combined effect causes rigid growth in total demand, which continuously outpaces supply capacity, triggering widespread food price increases and mounting food security pressures. Chain reactions include regional supply imbalances, elevated shortage risks for low-income groups, and the overloading of ecological resources. Addressing this challenge requires multidimensional measures: regulating population structure, guiding rational diets, optimizing industrial grain use, developing alternative raw materials, and enhancing comprehensive food supply capacity.

The quadrant analysis table for increased food demand is shown below (see Table 3-15):

Table 3-15. Quadrant Analysis Table of Increased Food Demand

Category	Content
Phenomenon	Persistent growth in food demand contributes to systemic shortage risks.
Cause	Population growth, dietary structure shifts, and increased industrial use of food resources.
Hazard	Threatening sustainable development
Response	Controlling population growth, moderating excessive food demand, and regulating non-essential industrial use of food resources.

3-1.4.1 Increased Food Demand Driven by Population Growth

Increased food demand driven by population growth [SI-1114100] is a fifth-level issue within the food system issue framework and a sub-issue of increased food demand. It refers to the deepening structural contradiction between persistently inelastic consumption growth—driven by continuous demographic expansion—and the capacity to enhance food production outputs.

Demographic growth encompasses two dimensions: aggregate population expansion and intensified regional density. Their convergence strains agricultural output growth rates beyond demand-matching capacities, rooted in persistently rapid and unmoderated population inflation. This unchecked expansion exacerbates structural food supply-demand contradictions, elevates security risks, and may instigate territorial conflicts.

Effective countermeasures necessitate evidence-based demographic governance frameworks, particularly in high-stress regions, to realign consumption trajectories with sustainable production pathways.

The quadrant analysis table for increased food demand driven by population growth is shown below (see Table 3-16):

Table 3-16. Quadrant Analysis Table of Increased Food Demand Driven by Population Growth

Category	Content
Phenomenon	Food output growth fails to match the pace of population expansion.
Cause	Ineffective population governance
Hazard	Food shortages, ecological degradation, and heightened social conflicts
Response	Managing population growth

3-1.4.2 Increased Food Demand Driven by Dietary Structure Change

Increased food demand driven by dietary structure change [SI-1114200] is a fifth-level issue within the food system issue framework and a sub-issue of increased food demand. Dietary structure refers to the quantities of various food categories and their proportional representation within the diet. The issue of increased food demand driven by changes in dietary structure pertains to the challenges arising from the growth in quantitative food requirements resulting from shifts in food consumption patterns.

Changes in dietary structures are intensifying global food demand, manifesting as both increased overall consumption and distortions in dietary transition directions. While national dietary patterns remain relatively stable under economic and cultural influences, emerging economies are undergoing profound transformations: expanding meat consumption, rising popularity of processed and high-value foods, and growing reliance on refined grains. This persistent trend escalates pressure on global food supply chains and threatens ecological carrying capacity. Addressing these challenges requires promoting sustainable diets, developing national dietary guidelines, and transforming agri-food systems.

The quadrant analysis table for Increased food demand driven by dietary structure change is shown below (see Table 3-17):

Table 3-17. Quadrant Analysis Table of Increased Food Demand Driven by Dietary Structure Change

Category	Content
Phenomenon	Rising consumption of animal-source foods
Cause	Dietary structure changes.
Hazard	Increasing pressure on food supply
Response	Promoting balanced dietary structures

3-1.4.3 Increased Food Demand Driven by Increased Industrial Use of Food

Increased food demand driven by industrial use of food [SI-1114300] is a fifth-level issue within the food system issue framework and a sub-issue of increased food demand. It refers to resource conflicts arising from the systematic redirection of edible commodities toward industrial applications, exemplified by biofuel production, which exacerbates competition between nutritional and industrial demand streams.

This issue manifests as a tripartite challenge: escalating industrial demands, bioenergy-driven food-to-fuel conversion, and non-food industrial utilization. Significant proportions of global staple crops are diverted toward biofuel applications and industrial sectors, intensifying human-machine grain competition. Core drivers include mandatory blending policies, fossil energy price incentives, and path dependency of first-generation biotechnologies on food-grade feedstocks. This trajectory triggers severe repercussions: displacement of dietary grain supplies, amplification of market price volatility, and induction of ecological risks. Urgent priorities encompass scaling non-food alternative feedstocks, establishing binding thresholds for industrial grain use, and integrating measures within global governance frameworks to rebalance energy and food security imperatives.

The quadrant analysis table for Increased food demand driven by increased industrial use of food is shown below (see Table 3-18):

Table 3-18. Quadrant Analysis Table of Increased Food Demand Driven by Increased Industrial Use of Food

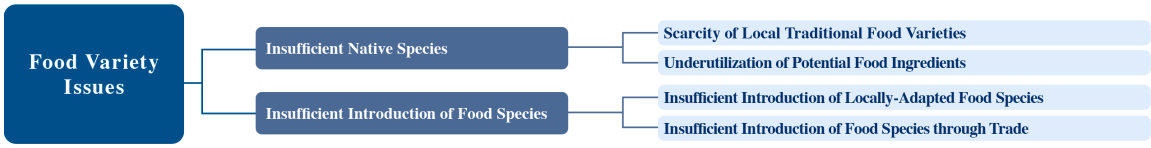
Category	Content
Phenomenon	Industrial appropriation of food resources.
Cause	Disregarding the scarcity of food resources.
Hazard	Reduced proportion of food available for human consumption, diversion of food production inputs, and exacerbated food shortages.
Response	Establishing the principle of prioritizing food for human consumption.

3-2 Food Variety Issues

Food variety issues [SI-1120000] represent a critical third-level category within the food system issue framework, situated under the second-level domain of survival issues. These issues are illustrated shown below (See Figure 3-2).

Food variety denotes the range of different food categories, varieties, and sources available for human consumption. This diversity directly influences nutritional intake, dietary culture, and ecological adaptability. These issues refer to the challenges humanity faces regarding food diversity and encompass two primary aspects: insufficient native species and inadequate introduction of food species issues.Beyond natural causes, these problems largely result from imbalanced regional development and improper allocation of food resources due to market mechanisms. This not only diminishes dietary diversity but also threatens regional food security and ecological sustainability. Addressing these issues requires strengthening the development and cultivation of local species, improving market trade systems, and employing policy guidance to promote greater food variety.

Figure 3-2. Food Variety Issues



The quadrant analysis table for food variety issues is shown below (see Table 3-19):

Table 3-19. Quadrant Analysis Table of Food Variety Issues

Category	Content
Phenomenon	Limited food variety leads to nutritional imbalances
Cause	Geography and market allocation mechanisms
Hazard	Threatening human survival, and causing conflicts and crises
Response	Developing local species, introducing suitable non-native species, and promoting both domestic and international trade

3-2.1 Insufficient Native Species

Insufficient native species [SI-1121000] is a fourth-level issue within the food system issue framework and a sub-issue of food variety issues. It refers to the inability of

a region's native edible resources to meet the population's basic nutritional and dietary diversity needs due to natural or human factors.

This issue involves the scarcity of local traditional food varieties and the underutilization of existing ingredients. It stems from environmental constraints and human activities like over-exploitation, monoculture dependence, and dietary habits. Consequences include nutritional imbalances, reduced ecosystem stability, and increased vulnerability of the food supply. Solutions require systematic collection and protection of native species, applying modern technology to develop their value, and enhancing public dietary education to raise awareness of local foods—thereby improving nutrition and ecosystem resilience.

The quadrant analysis table for insufficient native species is shown below (see Table 3-20):

Table 3-20. Quadrant Analysis Table of Insufficient Native Species

Category	Content
Phenomenon	Limited variety of local foods; traditional ingredients are often underutilized.
Cause	Climate change, ecological degradation, monoculture farming, lack of awareness, and inadequate processing technology, etc.
Hazard	Reliance on single-source nutrition poses a significant threat to human survival
Response	Breeding and promoting high-quality varieties, as well as exploring and utilizing traditional food ingredients.

3-2.1.1 Scarcity of Local Traditional Food Varieties

Scarcity of local traditional food varieties [SI-1121100] is a fifth-level issue within the food system issue framework and a sub-issue of insufficient native species. It refers to the limited availability or gradual loss of culturally significant local ingredients due to modernization, industrialization, and urbanization.

This issue encompasses scarcity of local grain crops, disappearance of wild food sources, and failure to develop adapted new varieties. Causes include natural constraints—such as topography, climate, and soil—as well as urbanization and industrial influences. Consequences involve reduced dietary, cultural, and nutritional diversity, alongside weakened ecological adaptability. Solutions require protecting and restoring traditional crops, breeding and promoting locally adapted varieties, and developing regionally tailored agricultural models to optimize food production environments.

The quadrant analysis table for scarcity of local traditional food varieties is shown below (see Table 3-21):

Table 3-21. Quadrant Analysis Table of Scarcity of Local Traditional Food Varieties

Category	Content
Phenomenon	A narrow and monotonous range of local traditional food varieties
Cause	Influences from geology, terrain, landform, hydrology, climate, soil, vegetation, fauna, and natural disasters
Hazard	Limiting dietary choices and reducing nutritional diversity
Response	Protecting and restoring traditional crops, as well as breeding and promoting new food species adapted to local conditions

3-2.1.2 Underutilization of Potential Food Ingredients

Underutilization of potential food ingredients [SI-1121200] is a fifth-level issue within the food system issue framework and a sub-issue of insufficient native species. It refers to the underdevelopment or neglect of locally available edible resources due to lack of awareness, outdated technology, inefficient distribution, or low market demand.

This issue encompasses the neglect of non-mainstream crops and the non-consumption of traditional ingredients. Constraints are primarily technical, cognitive, and market-related. Inadequate processing, low awareness, and insufficient demand result in wasted resources, loss of dietary knowledge, reduced food variety, and heightened food security risks. Solutions require overcoming technical barriers, improving processing and storage methods, streamlining the supply chain, and raising public awareness through dietary education—thereby enhancing food variety and sustainability.

The quadrant analysis table for Underutilization of Potential Food Ingredients is shown below (see Table 3-22):

Table 3-22. Quadrant Analysis Table of Scarcity of Underutilization of Potential Food Ingredients

Category	Content
Phenomenon	Potential food ingredients remain underutilized
Cause	Technical limitations, lack of awareness and low market demand
Hazard	This leads to a waste of biological resources and increases the vulnerability of the food system.
Response	Advancing processing technology and strengthening dietary culture education

3-2.2 Insufficient Introduction of Food Species

Insufficient introduction of food species [SI-1122000] is a fourth-level issue within the food system issue framework and a sub-issue under food variety issues. It refers to a region's failure to effectively increase edible species diversity through new varieties or trade, resulting in a monotonous dietary structure.

This issue includes insufficient introduction of locally-adapted species and limited introduction through trade. It is influenced by policy restrictions, technical barriers, market preferences, and logistics costs. These limitations exacerbate regional nutritional imbalances, hinder dietary cultural innovation, and reduce resilience to local crop failures. Addressing this requires establishing a scientific species introduction evaluation system, improving cross-border trade networks, and promoting adaptive cultivation technologies alongside consumer education.

The quadrant analysis table for insufficient introduction of food species is shown below (see Table 3-23):

Table 3-23. Quadrant Analysis Table of Insufficient Introduction of Food Species

Category	Content
Phenomenon	There is a low introduction rate of non-native foods and limited variety in international food trade.
Cause	Restrictive trade policies, a lack of adaptive cultivation technologies, and conservative consumer preferences
Hazard	Narrow nutritional supplementation channels and limited vitality for dietary culture innovation
Response	Optimizing species introduction approval processes and developing international food trade platform

3-2.2.1 Insufficient Introduction of Locally-Adapted Food Species

Insufficient introduction of locally-adapted food species [SI-1122100] is a fifth-level issue within the food system issue framework and a sub-issue of insufficient introduction of food species. It refers to a region's failure to introduce and promote foreign edible species suitable for local conditions, limiting the enhancement of food diversity.

This issue involves a lack of locally-adapted varieties and insufficient introduction of new species. Causes include inadequate adaptability research, policy barriers, and low market acceptance. Consequences include simplified local food structures, reduced

agricultural resilience, and limited nutritional diversity for residents. Addressing this requires strengthening adaptive variety selection and cultivation, improving introduction policies, advancing agricultural technology, and increasing market and consumer acceptance of new varieties.

The quadrant analysis table for insufficient introduction of locally-adapted food species is shown below (see Table 3-24):

Table 3-24. Quadrant Analysis Table of Insufficient Introduction of Locally-Adapted Food Species

Category	Content
Phenomenon	Insufficient introduction of new varieties suitable for local agricultural production
Cause	Inadequate research on variety adaptability, strict policy approvals and delayed technology promotion
Hazard	A simplified food structure, weak agricultural risk resilience and limited nutritional sources
Response	Strengthening variety adaptability trials and optimizing introduction policies

3-2.2.2 Insufficient Introduction of Food Species through Trade

Insufficient introduction of food species through trade [SI-1122200] is a fifth-level issue within the food system issue framework and a sub-issue of insufficient introduction of food species. It refers to trade restrictions, supply chain gaps, or market barriers limiting the availability of imported food raw materials and processed products, thereby hindering local dietary diversity and nutritional optimization.

This issue involves insufficient introduction of both food raw materials and processed foods via trade. Contributing factors include shifts in international trade policies, logistical disruptions, and geopolitical tensions. Consequences encompass reduced food diversity, constrained consumer choice, nutritional imbalances, and public health risks. Addressing this requires strengthening international trade cooperation, optimizing policies, ensuring diversified and stable imports, modernizing supply chains, and promoting diverse dietary practices.

The quadrant analysis table for insufficient introduction of food species through trade is shown below (see Table 3-25):

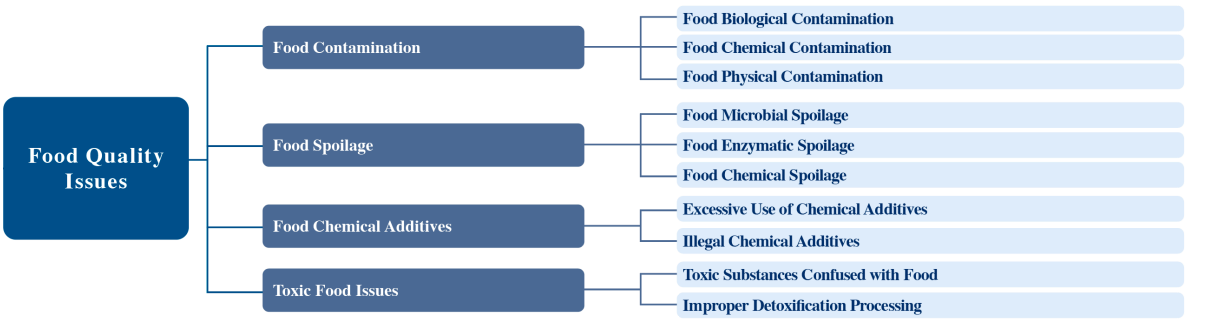
Table 3-25. Quadrant Analysis Table of Insufficient Introduction of Food Species through Trade

Category	Content
Phenomenon	A limited variety of imported food raw materials and processed foods
Cause	Trade policy restrictions, tariff barriers, supply chain disruptions, high logistics costs and international market fluctuations
Hazard	Insufficient food diversity, and a monotonous nutritional structure
Response	Optimizing trade policies, improving supply chain efficiency, and fostering diversified market demand

3-3 Food Quality Issues

Food quality issues [SI-1130000] represent a critical third-level category within the food system issue framework, situated under the second-level domain of survival issues. Food quality issues are illustrated shown below (See Figure 3-3).

Figure 3-3. Food Quality Issues



Food quality refers to the overall standard of food, directly impacting human health and safety. High-quality food enhances dietary well-being, while poor quality can cause harm—from mild tissue damage to life-threatening conditions. These issues encompass food contamination, spoilage, chemical additives, and toxic substances. They typically stem from inadequate production controls, environmental pollution, improper storage, insufficient regulation, and limited consumer awareness. Consequences include food-borne illnesses, chronic disease risks, resource waste, increased medical costs, and eroded public trust. Addressing them requires strengthening full-chain quality control,

enhancing regulations and traceability, and improving public food safety education.

The quadrant analysis table for food quality Issues is shown below (see Table 3-26):

Table 3-26. Quadrant Analysis Table of Food Quality Issues

Category	Content
Phenomenon	Quality deterioration leads to food-borne diseases
Cause	Contamination, spoilage, excessive additives and hidden risks of new technologies
Hazard	Significant risks to human health
Response	Implementing scientific and rational prevention measures

3-3.1 Food Contamination

Food Contamination [SI-1131000] is a fourth-level issue within the food system issue framework and a sub-issue under food quality issues. It refers to the decline in food quality due to the introduction of harmful substances or pathogens during production, processing, transportation, storage, or sales.

This issue includes biological, chemical, and physical contamination. Primary causes include substandard production hygiene, environmental pollution, unqualified raw materials, inadequate storage and transport protection, insufficient equipment cleaning, and weak regulatory enforcement. Consequences encompass food poisoning, chronic diseases, increased public health risks, resource waste, and eroded consumer trust. Addressing this requires establishing a full-chain hygiene and quality control system, strengthening testing and pollution control, improving regulatory enforcement, and raising public food safety awareness.

The quadrant analysis table for food contamination is shown below (see Table 3-27):

Table 3-27. Quadrant Analysis Table of Food Contamination

Category	Content
Phenomenon	Contaminated food leads to quality deterioration and causes food-borne illnesses
Cause	Inadequate protection during food production and utilization processes
Hazard	It poses a serious threat to human health and life.
Response	Strengthen preventive and protective measures across all stages of the food system

3-3.1.1 Food Biological Contamination

Food biological contamination [SI-1131100] is a fifth-level issue within the food system issue framework and a sub-issue under food contamination. It refers primarily to the contamination of food by pathogens.

This issue includes microbial, parasitic, insect, and viral contamination. Causes involve poor production and processing hygiene, unclean raw materials, improper storage temperature and humidity, and inadequate pest control. Consequences range from food poisoning and parasitic diseases to broader public health threats and increased medical burdens. Prevention requires strengthening hygiene management, establishing raw material traceability, optimizing storage and transport conditions, improving pest control, and raising public health awareness.

The quadrant analysis table for food biological contamination is shown below (see Table 3-28):

Table 3-28. Quadrant Analysis Table of Food Biological Contamination

Category	Content
Phenomenon	Contamination leads to a decline in food quality.
Cause	Biological contamination occurs during raw material handling, processing, storage, transportation, or sales
Hazard	It poses a serious threat to human health and life.
Response	Strengthening prevention of biological contamination across all stages, including production, processing, storage, transportation, and sales

3-3.1.2 Food Chemical Contamination

Food chemical contamination [SI-1131200] is a fifth-level issue within the food system issue framework and a sub-issue under food contamination. It refers to the pollution of food by harmful chemical substances.

This issue includes pesticide, fertilizer, herbicide, hormone, and toxic metal contamination, as well as pollution from chemical containers, packaging materials, storage, transport, and processing. Causes involve inadequate hygiene, environmental pollution, and excessive agrochemical use. Consequences range from acute poisoning to chronic health hazards. Prevention requires strengthening full-chain hygiene management, improving testing standards and traceability, promoting green agricultural practices, and raising public food safety awareness.

The quadrant analysis table for food chemical contamination is shown below (see Table 3-29):

Table 3-29. Quadrant Analysis Table of Food Chemical Contamination

Category	Content
Phenomenon	Chemical contamination occurs through both active and passive means.
Cause	Cognitive bias
Hazard	It threatens human health and life, and endangers the ecological environment.
Response	Enhancing public awareness, strengthening regulatory oversight, and preventing chemical contamination

3-3.1.3 Food Physical Contamination

Food physical contamination [SI-1131300] is a fifth-level issue within the food system issue framework and a sub-issue under food contamination. It refers to food safety problems caused by excessive impurities or the absorption of external radioactive nuclides.

This issue includes physical contamination during circulation, food adulteration and counterfeiting, and radioactive contamination. Causes range from inadequate equipment maintenance and operational violations to damaged packaging, poor environmental control, illegal practices, and nuclear accidents. Consequences include physical injuries, radioactive health risks, reduced food value, and eroded consumer trust. Effective measures involve strengthening equipment maintenance and foreign object detection, improving raw material inspection and environmental controls, enhancing packaging and transport protection, and enforcing anti-adulteration regulations and traceability systems.

The quadrant analysis table for food physical contamination is shown below (see Table 3-30):

Table 3-30. Quadrant Analysis Table of Food Physical Contamination

Category	Content
Phenomenon	Contamination of food by foreign materials
Cause	Outdated equipment, environmental pollution and improper commercial practices
Hazard	It threatens human health and compromises the sensory qualities or nutritional value of food.
Response	Strengthening the prevention of all forms of physical contamination

3-3.2 Food Spoilage

Food spoilage [SI-1132000] is a fourth-level issue within the food system issue framework and a sub-issue under food quality issues. It refers to physical, chemical, or microbiological changes during production, processing, storage, transport, or sales that reduce or eliminate a food's edibility. Consumption can cause illness or life-threatening conditions.

This issue includes microbial, enzymatic, and chemical spoilage. Causes involve improper temperature or humidity control, poor packaging, inadequate processing, suboptimal transport conditions, and environmental contamination. Consequences encompass food-borne diseases, loss of nutritional and sensory quality, food waste, and economic losses. Prevention requires optimizing storage and transport conditions, enforcing strict temperature control, using advanced preservation techniques, strengthening processing quality control, improving testing and traceability systems, and enhancing public food safety education.

The quadrant analysis table for food spoilage is shown below (see Table 3-31):

Table 3-31. Quadrant Analysis Table of Food Spoilage

Category	Content
Phenomenon	Internal spoilage of food
Cause	Improper storage environments and methods
Hazard	Threatens human health and life; reduces nutritional value
Response	Scientific storage and processing of food; increase consumer awareness

3-3.2.1 Food Microbial Spoilage

Food microbial spoilage [SI-1132100] is a fifth-level issue within the food system issue framework and a sub-issue under food spoilage. It refers to physical, chemical, or microbiological changes during production, processing, storage, transport, or sales that reduce or eliminate a food's edibility. Consumption can cause illness or life-threatening conditions.

This issue includes microbial, enzymatic, and chemical spoilage. Causes involve improper temperature or humidity control, poor packaging, inadequate processing, suboptimal transport conditions, and environmental contamination. Consequences encompass food-borne diseases, loss of nutritional and sensory quality, food waste,

and economic losses. Prevention requires optimizing storage and transport conditions, enforcing strict temperature control, using advanced preservation techniques, strengthening processing quality control, improving testing and traceability systems, and enhancing public food safety education.

The quadrant analysis table for food microbial spoilage is shown below (see Table 3-32):

Table 3-32. Quadrant Analysis Table of Food Microbial Spoilage

Category	Content
Phenomenon	Deterioration in the appearance or form of food
Cause	Proliferation of harmful microorganisms in food
Hazard	It results in loss of food usability and poses threats to health and life.
Response	Minimizing the impact of microorganisms on food throughout all stages—production, processing, storage, transportation, and sales

3-3.2.2 Food Enzymatic Spoilage

Food enzymatic spoilage [SI-1132200] is a fifth-level issue within the food system issue framework and a sub-issue under food spoilage. It refers to spoilage caused by enzymatic activity, reducing food quality or edibility and potentially harming eaters.

This issue includes enzyme-induced rancidity and fruit rot. Causes involve improper raw material maturity, delayed post-harvest handling, poor processing or storage conditions, and inadequate packaging. It commonly affects grains, nuts, dairy, fruits, and vegetables. Consequences include reduced quality, economic losses, food waste, and supply chain disruptions. Mitigation requires timely harvesting, low-temperature storage, blanching for enzyme inactivation, optimized processing and storage, and enhanced quality monitoring.

The quadrant analysis table for food enzymatic spoilage is shown below (see Table 3-33):

Table 3-33. Quadrant Analysis Table of Food Enzymatic Spoilage

Category	Content
Phenomenon	Deterioration in the form and quality of food
Cause	Enzymatic degradation of nutrients into lower-quality compound
Hazard	This leads to loss of food usability and poses a threat to health and life.
Response	Food preservation should utilize scientifically validated methods, including pH modification or thermal processing.

3-3.2.3 Food Chemical Spoilage

Food chemical spoilage [SI-1132300] is a fifth-level issue within the food system issue framework and a sub-issue under food spoilage. It refers to the degradation of food quality and safety due to chemical reactions—such as oxidation, or non-microbial decomposition—leading to nutrient loss, organoleptic deterioration, and potential health risks.

This issue manifests as a tripartite challenge: escalating industrial demands, bioenergy-driven food-to-fuel conversion, and non-food industrial utilization. Significant proportions of global staple crops are diverted toward biofuel applications and industrial sectors, intensifying human-machine grain competition. Core drivers include mandatory blending policies, fossil energy price incentives, and path dependency of first-generation biotechnologies on food-grade feedstocks. This trajectory triggers severe repercussions: displacement of dietary grain supplies, amplification of market price volatility, and induction of ecological risks. Urgent priorities encompass scaling non-food alternative feedstocks, establishing binding thresholds for industrial grain use, and integrating measures within global governance frameworks to rebalance energy and food security imperatives.

The quadrant analysis table for food chemical spoilage is shown below (see Table 3-34):

Table 3-34. Quadrant Analysis Table of Food Chemical Spoilage

Category	Content
Phenomenon	Deterioration of food appearance or quality
Cause	Food oxidation
Hazard	Reducing or eliminating food usability, and posing risks to health and life
Response	Inhibiting conditions for chemical reactions and applying scientific preservation methods

3-3.3 Improper Use of Synthetic Chemicals

Improper use of synthetic chemicals [SI-1133000] are a fourth-level issue within the food system issue framework and a sub-issue of food quality. They refer to chemical substances added during production and processing to improve color, aroma, taste, texture, or extend shelf life.

This issue encompasses challenges and conflicts regarding the safety, compliance, ethics, and eater awareness of chemical additive use. It covers two main aspects: excessive use and illegal additives, primarily caused by corporate misuse and inadequate supervision. Such practices pose health risks, disrupt market order, and erode eater trust, commonly found in processed meats, condiments, baked goods, and snacks. Countermeasures include improving laws and standards, strengthening oversight, establishing risk assessment, promoting natural alternatives, enhancing corporate responsibility, conducting consumer education, and fostering industry research.

The quadrant analysis table for the improper use of synthetic chemicals is shown below (see Table 3-35):

Table 3-35. Quadrant Analysis Table of Improper Use of Synthetic Chemicals

Category	Content
Phenomenon	Exceeding legal limits for chemical additives or employing illegal additives
Cause	Reducing production costs or enhancing taste, incomplete regulatory frameworks, and insufficient enforcement
Hazard	Health risks (e.g., allergic reactions, poisoning, carcinogenic potential) and disruption of food market order
Response	Improving laws and standards, strengthening supervision and testing, and enhancing public education

3-3.3.1 Excessive Use of Chemical Additives

Excessive use of chemical additives [SI-1133100] is a fifth-level issue within the food system issue framework and a sub-issue of improper use of synthetic chemicals. It refers to the use of a single chemical additive exceeding the maximum permissible level set by regulations, or the combined use of multiple additives in the same food resulting in a total amount surpassing legal limits.

This issue encompasses two aspects: exceeding the maximum limit for a single additive and exceeding the total limit for multiple additives. It primarily stems from enterprises using excessive additives to improve food quality, extend shelf life, or reduce production costs. Contributing factors include inadequate regulatory frameworks, insufficient enforcement, and a lack of risk assessment. Such overuse can cause acute allergic reactions, chronic poisoning, and carcinogenic risks, while also disrupting market order, eroding eater trust, and hindering sustainable industry development. Effective

responses include improving usage standards, strengthening production control and traceability, establishing scientific risk assessment mechanisms, and enhancing detection technology and enforcement.

The quadrant analysis table for excessive use of chemical additives is shown below (see Table 3-36):

Table 3-36. Quadrant Analysis Table of Excessive Use of Chemical Additives

Category	Content
Phenomenon	Food quality degradation
Cause	Proliferation of harmful microorganisms in food
Hazard	Loss of food usability and threats to health and life
Response	Addressing microbial hazards across production, processing, storage, transport, and sales stages

3-3.3.2 Illegal Chemical Additives

Illegal Chemical Additives [SI-1133200] are a fifth-level issue within the food system issue framework and a sub-issue of improper use of synthetic chemicals. They refer to the unlawful addition, during food production, processing, or storage, of non-edible substances prohibited by national regulations, the misuse of unassessed chemical substances, or the use of permitted additives beyond approved scope.

This issue is a major focus and challenge in current food safety regulation. It covers three main aspects: use of banned substances, use of unapproved new substances, and misuse of approved additives. The problem is common in processed meat, dairy, condiments, and other processed foods. It can lead to acute poisoning, chronic diseases, and other health risks, while disrupting market order and damaging industry reputation. Governance measures include improving laws and regulations, establishing dynamic regulatory lists, enhancing full-chain traceability and rapid detection systems, strengthening enforcement, and promoting multi-stakeholder co-governance to build preventive and control capacity from source to end product.

The quadrant analysis table for illegal chemical additives is shown below (see Table 3-37):

Table 3-37. Quadrant Analysis Table of Illegal Chemical Additives

Category	Content
Phenomenon	Food quality degradation
Cause	Profit-driven practices by enterprises, regulatory gaps, and outdated detection technologies
Hazard	Threats to consumer health, undermining market fairness, and damaging industry reputation
Response	Improving laws and standards, strengthening enforcement, and promoting social co-governance

3-3.4 Toxic Food Issues

Toxic food issues [SI-1134000] represent a critical fourth-level category within the food system issue framework, situated under the third-level domain of food quality issues. Toxic food refers to products that, during production, processing, storage, transport, or sale, contain or generate toxic and harmful substances due to human or natural causes, posing acute or chronic health hazards.

This issue arises when toxic components harmful to human health remain in food due to failures in identifying or removing naturally occurring toxins, or improper handling of ingredients containing potential toxic substances. It encompasses two main aspects: toxic substances being confused with food, and improper detoxification processing.

As a core challenge in food safety governance, it stems from source pollution due to lack of awareness, industrial emissions, pesticide overuse, profit-driven illegal additives, outdated regulatory standards, insufficient enforcement, and poor safety awareness among practitioners. Solutions require comprehensive governance: improving laws and standards, establishing intelligent monitoring and traceability systems, enhancing detection technologies, and promoting industry self-regulation and public oversight to build a long-term, multi-stakeholder governance mechanism.

The quadrant analysis table for toxic food issues is shown below (see Table 3-38):

Table 3-38. Quadrant Analysis Table of Toxic Food Issues

Category	Content
Phenomenon	Presence of toxic and harmful substances in food
Cause	Source pollution from industrial emissions and pesticide overuse; lack of awareness
Hazard	Causing acute poisoning and chronic diseases; undermining food supply chain safety
Response	Improving the food safety regulatory and standards system; strengthening dietary education.

3-3.4.1 Toxic Substances Confused with Food

Toxic substances confused with food [SI-1134100] is a fifth-level issue in the food system issue framework, and a sub-issue of toxic food issues. It refers to situations during food production, processing, or storage where toxic substances are accidentally mixed into food due to misidentification or operational errors.

It includes two aspects: mistaking naturally toxic plants or animals as edible ingredients and accidental mixing of toxic chemical substances. The issue mainly stems from inadequate professional knowledge among practitioners, lack of raw material identification systems, and chaotic production management. It often occurs during wild ingredient collection and food processing, and can lead to acute poisoning and public health incidents. Addressing these challenges requires establishing toxic substance databases, strengthening professional training, improving raw material acceptance procedures, implementing standardized production management, enhancing traceability systems, and reinforcing both targeted supervision and public education—thus building a full-chain prevention and control mechanism to safeguard food safety.

The quadrant analysis table for toxic substances confused with food is shown below (see Table 3-39):

Table 3-39. Quadrant Analysis Table of Toxic Substances Confused with Food

Category	Content
Phenomenon	Toxic plants or animals mistaken for edible ingredients
Cause	Insufficient professional knowledge among practitioners
Hazard	Causing acute food poisoning incidents and long-term health risks
Response	Establishing toxic substance databases and identification guidelines; strengthening targeted supervision of high-risk foods

3-3.4.2 Improper Detoxification Processing

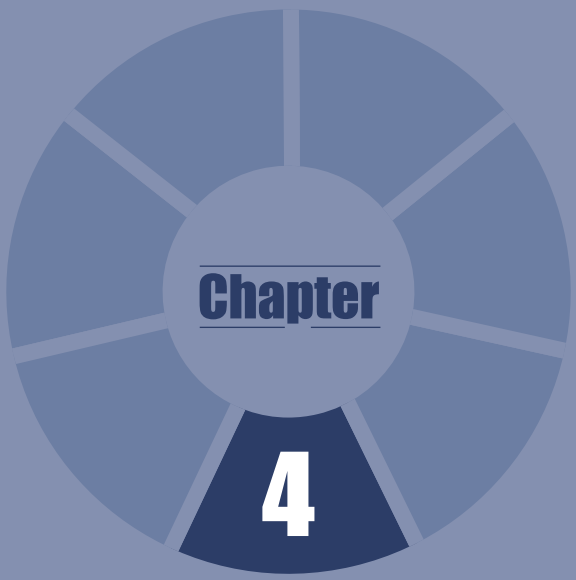
Improper detoxification processing [SI-1134200] is a fifth-level issue in the food system issue framework, and a sub-issue of toxic food issues. It refers to cases during food processing where no effective measures are taken to remove or degrade naturally occurring toxic substances in raw materials, or where detoxification processes fail to meet required standards.

It includes two aspects: incomplete detoxification in traditional processing and inadequate treatment in industrial processing. The issue is mainly caused by outdated processes, insufficient process control, and inadequate technology, potentially leading to health risks. Addressing it requires establishing standardized process systems, promoting new technologies, strengthening process control, improving detection methods, implementing raw material grading, and enhancing staff training—forming a "standards–technology–supervision" system to control toxin risks.

The quadrant analysis table for improper detoxification processing is shown below (see Table 3-40):

Table 3-40. Quadrant Analysis Table of Improper Detoxification Processing

Category	Content
Phenomenon	Failure to effectively remove natural toxins from raw materials during processing, or detoxification processes failing to meet required standards
Cause	Absence of standardized traditional detoxification protocols; inadequate quality control systems
Hazard	Reducing nutritional value of food and posing health risks for specific population groups
Response	Promoting advanced detoxification technologies; strengthening quality control during processing



Food-System Issues:

Eater Health and Longevity — A Shared Vision for Humanity

Eater health and longevity issues [SI-1200000] represent a second-level category within the food-system issue framework, focusing on the relationship between eating behaviors and health outcomes, and it corresponds primarily to the Five Eater Needs (5E) requirement of Eating for Health and Longevity. At the heart of these issues is the concept of food–body alignment—the degree to which eating practices meet the body's actual physiological needs.

The World Health Organization (WHO) emphasizes that a healthy diet can prevent malnutrition and reduce the risk of non-communicable diseases such as diabetes, cardiovascular disease, and stroke. Conversely, unhealthy dietary patterns—particularly those leading to obesity—greatly increase the risk of type 2 diabetes, cardiovascular disease, and certain cancers.

Globally, diet-related diseases have reached alarming levels. In industrialized nations, the health impacts of poor diets are especially acute. According to the latest WHO data, about 43% of adults worldwide are overweight and 16% are obese[1]. In the United States, roughly 42% of adults meet the criteria for obesity, which substantially raises the risk of hypertension, diabetes, and other metabolic disorders—major drivers of cardiovascular disease[2]. Cardiovascular disease has become the world's leading cause of death, claiming an estimated 17.9 million lives annually[3], with around 30% of these deaths directly linked to unhealthy dietary habits[4]. The prevalence of type 2 diabetes is

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1 World Health Organization. (2025, May 7). Obesity and overweight [Fact sheet]. Retrieved July 3, 2025, from https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

2 Centers for Disease Control and Prevention. (2024, May 14). Adult obesity facts. Retrieved July 3, 2025, from https://www.cdc.gov/obesity/adult-obesity-facts/index.html

3 World Health Organization. (n.d.). Cardiovascular diseases. Retrieved July 3, 2025, from https://www.who.int/health-topics/cardiovascular-diseases

4 Deschasaux-Tanguy, M., et al. (2024). Nutritional quality of diet characterized by the Nutri-Score profiling system and cardiovascular disease risk: A prospective study in 7 European countries. The Lancet Regional Health – Europe, 46, Article 101006. https://doi.org/10.1016/j.lanepe.2024.101006

also increasing rapidly. WHO notes that appropriate diet and weight management can prevent or delay the onset of type 2 diabetes[5]; indeed, a 2018 study estimated that over 70% of new type 2 diabetes cases in that year were closely tied to poor dietary choices[6]. These findings underscore the strong connection between eating habits and the global burden of chronic disease, representing a major public-health challenge.

In addition, growing evidence shows that dietary patterns directly affect life expectancy. Modeling studies have found that in the United States, adopting an optimal diet from age 20 (emphasizing whole grains, fruits, vegetables, and nuts, while reducing red meat, processed foods, and sugary drinks) can extend life expectancy by about 10.7 years for women and 13.0 years for men. Even making these changes at age 60 can lengthen lifespan by 8–9 years[7]. This demonstrates how profoundly unhealthy diets can shorten ten healthy life expectancy.

From a shiology perspective, the central issue is the lack of a comprehensive understanding of how individuals should eat. Every eater is unique and must identify the foods and dietary patterns most suitable for their own body and health condition. The extent to which food intake aligns with bodily needs directly determines both health outcomes and lifespan.

Eater health and longevity issues can be grouped into three interrelated areas:eating-related illnesses,eating methodology, and eating aesthetics.Among these, eating methodology forms the essential foundation of health and longevity, while eating aesthetics play a supportive role. Eating-related illnesses ultimately represent the consequences of deficiencies in the first two areas. The framework for eater health and longevity issues is shown in Table 4-1:

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5 World Health Organization. (2024, November 14). Diabetes [Fact sheet]. Retrieved July 3, 2025, from https://www.who.int/news-room/fact-sheets/detail/diabetes

6 O'Hearn, M., Lara-Castor, L., Cudhea, F., Miller, V., Reedy, J., Shi, P., ... Mozaffarian, D. (2023). Incident type 2 diabetes attributable to suboptimal diet in 184 countries. Nature Medicine, 29(4), 982–995. https://doi.org/10.1038/s41591-023-02278-8

7 Fadnes, L. T., ° kland, J.-M., Haaland, ° . A., & Johansson, K. A. (2022). Estimating impact of food choices on life expectancy: A modeling study. PLOS Medicine, 19(2), e1003889. https://doi.org/10.1371/journal.pmed.1003962

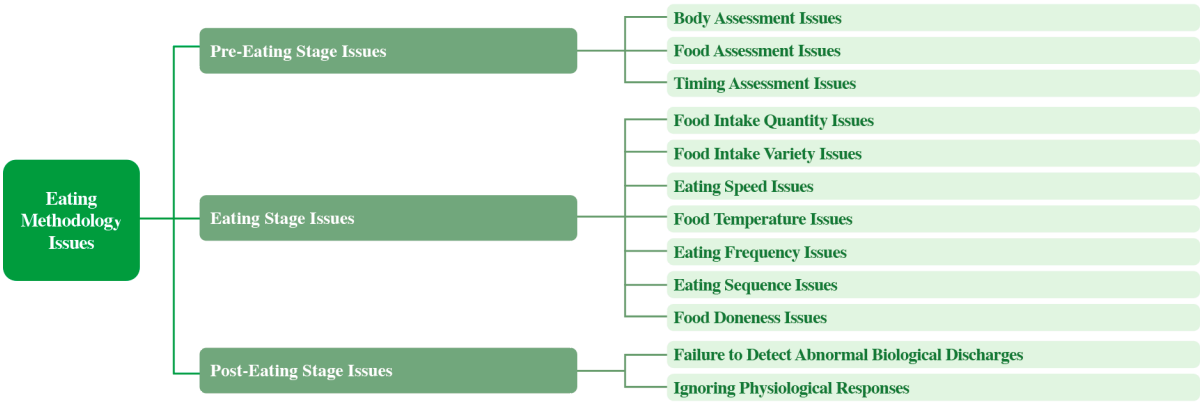
Table 4-1. Eater Health and Longevity Issues

Level 2	Level 3	Level 4	Level 5
Eater Health and Longevity Issues [SI-1200000]	1 Eating Methodology Issues [SI-1210000]	1 Pre-Eating Stage Issues [SI-1211000]	1 Body Assessment Issues [SI-1211100]
			2 Food Assessment Issues [SI-1211200]
			3 Timing Assessment Issues [SI-1211300]
		2 Eating Stage Issues [SI-1212000]	1 Food Intake Quantity Issues [SI-1212100]
			2 Food Intake Variety Issues [SI-1212200]
			3 Eating Speed Issues [SI-1212300]
			4 Food Temperature Issues [SI-1212400]
			5 Eating Frequency Issues [SI-1212500]
			6 Eating Sequence Issues [SI-1212600]
			7 Food Doneness Issues [SI-1212700]
		3 Post-Eating Stage Issues [SI-1213000]	1 Failure to Detect Abnormal Biological Discharges [SI-1213100]
			2 Ignoring Physiological Responses [SI-1213200]
	2 Prevalence of Eating-Related Illnesses [SI-1220000]	1 Prevalence of Under-Eating Diseases [SI-1221000]	1 Prevalence of Caloric Deficiency Diseases [SI-1221100]
			2 Prevalence of Deficiency Diseases [SI-1221200]
		2 Prevalence of Food-Borne Diseases [SI-1222000]	1 Prevalence of Pollutant-Driven Food-Borne Diseases [SI-1222100]
			2 Prevalence of Spoilage-Driven Food-Borne Diseases [SI-1222200]
			3 Prevalence of Food-Borne Toxicosis from Misidentified Sources [SI-1222300]
		3 Prevalence of Diseases from Dietary Imbalance [SI-1223000]	1 Prevalence of Dietary Imbalance Caused by Personal Preferences [SI-1223100]
			2 Prevalence of Culturally Influenced Dietary Imbalance [SI -1223200]
		4 Prevalence of Overeating Diseases [SI-1224000]	1 Prevalence of Over-Energy Diseases [SI-1224100]
			2 Prevalence of Selective Ingredient Hyperaccumulation [SI-1224200]
		5 Prevalence of Food Sensitivity Diseases [SI-1225000]	1 Prevalence of Cutaneous Food Allergy [SI-1225100]
			2 Prevalence of Respiratory Food Allergy [SI-1225200]
			3 Prevalence of Gastrointestinal Food Allergy [SI-1225300]
			4 Prevalence of Systemic Anaphylaxis [SI-1225400]
		6 Prevalence of Appetite Deficiency Diseases [SI-1226000]	1 Prevalence of Anorexia [SI-1226100]
			2 Prevalence of Degenerative Appetive Diseases [SI-1226200]
			3 Prevalence of Other Appetite Deficiency Diseases [SI-1226300]
	3 Eating Aesthetics Issues [SI-1230000]	1 Dual-Aesthetic Imbalance [SI-1231000]	1 One-Sided Pursuit of Sensory-Driven Eating Aesthetics [SI-1231100]
			2 Misconceptions regarding Gourmet Experts [SI-1231200]
		2 Five-Sense Aesthetic Bias [SI-1232000]	1 Sensory Bias [SI-1232100]
			2 Misweighting of Five-Sense Aesthetic Perception [SI-1232200]

4-1 Eating Methodology Issues

Eating methodology issues [SI-1210000] are a key part of the food system issue framework, falling under the broader category of eater health and longevity. (See Figure 4-1). Put simply, eating methodology refers to the way people approach eating, and it can be broken down into three stages: before eating (assessment), during eating (coupling food with the body's needs), and after eating (evaluation). At its heart, this is about how well food intake matches the body's actual requirements. When the methodology is fragmented or poorly understood, people often miss the bigger picture: they may overlook the importance of eating as both a science and an art, and they become more vulnerable to eating-related illnesses.

Figure 4-1. Eating Methodology Issues



Eating methodology issues can be broken down into three stages: before eating, during eating, and after eating. Yet in practice, the first and last stages are often ignored, and even in the act of eating itself, the crucial link between food and the body is frequently overlooked.

The deeper problem is the failure to recognize individual differences. Most people rely on one-size-fits-all habits, rather than a scientific system for managing diet. Without a clear grasp of the three-stage process of eating or the seven key dimensions of the eating stage, health inevitably suffers. The result is more diet-related diseases, shorter lifespans, and heavier healthcare burdens.The path forward lies in advancing *eatology*—the science of eating—and helping the public move toward personalized eating practices. This means

shifting from mindless consumption to thoughtful, evidence-based choices that align food with each person's unique needs.

The quadrant analysis of eating methodology issues is shown below (see Table 4-2):

Table 4-2. Quadrant Analysis Table of Eating Methodology Issues

Category	Content
Phenomenon	Neglect of individual differences; widespread prevalence of eating-related illnesses.
Cause	Eating is not approached as a scientific practice; comprehensive management of eating methodology is lacking.
Hazard	Threatening physical health, shortening lifespan and increasing healthcare costs.
Response	Promoting eatology.

4-1.1 Pre-Eating Stage Issues

Pre-eating stage issues [SI-1211000] are a fourth-level category within the food system issue framework and fall under eating methodology issues. This stage is all about preparation—assessing three interconnected dimensions: the body (the foundation), the food (the prerequisite), and the timing (the critical factor). Together, these form the system for truly scientific dietary preparation.

In practice, however, this step is often skipped. Few people pause to assess their body's actual needs, the quality and suitability of the food, or whether the timing is right. Modern eating habits rarely approach this with scientific rigor, and the gap comes down to one root cause: society still doesn't treat eating as a discipline in its own right. The consequences are serious. Mismatches between food and body needs lead directly to health problems. Nutritional gaps accelerate long-term decline. And preventable diet-related illnesses drive up healthcare costs worldwide.The solution is to advance *eatology*—to improve public food literacy, teach the skills for body, food, and timing assessments, and guide people to shift from arbitrary eating to evidence-based choices. Only then can eating become both personal and scientific.

The quadrant analysis for pre-eating stage issues is shown below (see Table 4-3):

Table 4-3. Quadrant Analysis Table of Pre-Eating Stage Issues

Category	Content
Phenomenon	Lack of awareness regarding this stage and its importance
Cause	Failure to identify eating practices as a scientific discipline
Hazard	compromised health, reduced lifespan, and increased healthcare costs
Response	Promoting eatology and prioritizing three pre-eating assessments

4-1.1.1 Body Assessment Issues

Body assessment issues [SI-1211100] are a fifth-level category within the food system issue framework, nested under pre-eating stage issues. This refers to evaluating one's physical condition and nutritional needs before eating—a critical practice that is too often ignored.

The root of the problem lies in two gaps: a limited understanding of the body's structure and functions, and frequent misjudgment of one's actual physiological state. This stems from society's failure to approach eating scientifically and the corresponding lack of awareness about personalized nutrition. Without this knowledge, most people fall into indiscriminate eating habits, disconnected from their body's real requirements. This neglect has serious consequences. Poor food-body alignment accelerates health decline, chronic nutritional imbalances shorten life expectancy, and preventable diet-related diseases drive up healthcare costs.The solution is to embed *eatology* into education and daily practice—raising public awareness of the importance of body assessment and promoting science-based eating habits tailored to each individual's physical condition, health status, and nutritional needs.

The quadrant analysis for body assessment issues is shown below (see Table 4-4):

Table 4-4. Quadrant Analysis Table of Body Assessment Issues

Category	Content
Phenomenon	Failure to recognize and assess the body's state before eating
Cause	Not approaching eating as a scientific practice
Hazard	Compromised physical health; reduced lifespan; increased healthcare costs
Response	Promoting eatology education; emphasizing body assessment and individual nutritional needs before eating

4-1.1.2 Food Assessment Issues

Food assessment issues [SI-1211200] represent a fifth-level category within the food system issue framework, falling under pre-eating stage issues. This concept refers to the practice of evaluating and selecting appropriate foods before consumption—a critical yet frequently overlooked step in modern eating habits.

The problem manifests through two key deficiencies: widespread misjudgment of nutritional components and inadequate understanding of fundamental food natures. Contemporary dietary patterns reveal a concerning "food assessment gap," where individuals often select foods based on preference rather than scientific evaluation of nutritional value, inherent natures, and individual compatibility. This stems from society's failure to approach eating as a scientific discipline. The consequences include significant health impacts: nutritional imbalances leading to metabolic disorders, accelerated physical decline reducing lifespan potential, and increased medical costs from preventable diet-related conditions. Addressing this requires implementing comprehensive eatology education to improve public food literacy and promote science-based food selection.

The quadrant analysis for food assessment issues is shown below (see Table 4-5):

Table 4-5. Quadrant Analysis Table of Food Assessment Issues

Category	Content
Phenomenon	Failure to recognize and assess food before eating
Cause	Not approaching eating as a scientific practice
Hazard	Compromised physical health; reduced lifespan; increased healthcare costs
Response	Promoting eatology education; emphasizing food choices before eating

4-1.1.3 Timing Assessment Issues

Timing assessment issues [SI-1211300] represents a fifth-level category within the food system issue framework, falling under pre-eating stage issues. This concept involves two essential assessments: evaluating seasonal contexts and determining optimal daily eating times.

The issues primarily manifest through two fundamental gaps: the failure to adjust food choices according to seasonal changes and the neglect of chrono-nutritional windows. Contemporary eating practices demonstrate a significant lack of chrono-

sensitive awareness, often overlooking seasonal dietary adaptations, missing optimal eating windows, and disregarding circadian-based meal structuring. This stems from viewing eating merely as a response to hunger rather than a scientifically-regulated physiological process.

The consequences accumulate progressively: disrupted biological rhythms impairing digestive function, missed seasonal nutrition leading to hidden deficiencies, and prolonged poor practices potentially triggering metabolic disorders—collectively compromising long-term health while increasing medical burdens. Addressing this requires implementing systematic eatology education to develop dual competencies: understanding seasonal ingredient cycles and identifying optimal digestion-absorption periods.

The quadrant analysis for timing assessment issues is shown below (see Table 4-6):

Table 4-6. Quadrant Analysis Table of Timing Assessment Issues

Category	Content
Phenomenon	Failure to recognize and assess temporal factors before eating
Cause	Not approaching eating as a scientific practice
Hazard	Compromised physical health; reduced lifespan; increased healthcare costs
Response	Promoting eatology education; emphasizing seasonal and chrono-nutritional awareness before eating

4-1.2 Eating Stage Issues

Eating stage issues [SI-1212000] constitute a fourth-level category under eating methodology issues in the food system issue framework. This phase is defined by a seven-dimensional coupling between the human body and food, encompassing quantity, variety, speed, temperature, frequency, sequence, and doneness. Consequently, these issues are subdivided into seven corresponding areas, from food intake quantity to doneness issues, which are consistently overlooked in modern dietary practices.

These aspects form an organically linked system where each is vital: quantity determines total intake, variety ensures nutritional completeness, speed affects digestion, temperature relates to physiological tolerance, frequency maintains metabolic stability, sequence optimizes absorption, and doneness impacts bioavailability and safety. Their coordinated interaction enables scientific eating for holistic health, but an imbalance in

any single dimension disrupts the entire network.

Current practices suffer from a severe eating stage cognitive blind spot, where a lack of awareness of these couplings leads to high rates of eating-related disease. This stems from structural flaws in dietary guidance, where national standards oversimplify dynamic processes and public understanding remains fragmented. The consequences are immediate health damage from metabolic disorders, accelerated aging from nutritional imbalances, and soaring medical costs for preventable conditions. The solution requires systematically promoting the seven food-body couplings theory through public education on these interactions, fostering precise eating regulation to transition from random consumption to precision-controlled dietary practices.

The quadrant analysis for eating stage issues is shown below (see Table 4-7):

Table 4-7. Quadrant Analysis Table of Eating Stage Issues

Category	Content
Phenomenon	A poor understanding of the critical coupling between food intake and physiological response during eating contributes directly to the high incidence of diet-related diseases
Cause	Deficient public awareness of the seven core food-body couplings; Inadequate national dietary guidelines.
Hazard	Compromised individual and public health status; Reduced healthy life expectancy; Elevated and preventable healthcare expenditures.
Response	Comprehensive public education on the seven essential food-body couplings

4-1.2.1 Food Intake Quantity Issues

Food intake quantity issues [SI-1212100] constitute a fifth-level category within the food system issue framework, classified under eating stage issues. This category pertains to deviations in the total amount of food consumed per meal, with energy content serving as the core quantitative determinant. The foundational physiological principle asserts that maintaining equilibrium between energy intake and expenditure represents the optimal state for health. Issues emerge when this balance is disrupted through either chronic overconsumption or underconsumption.

These imbalances manifest in two primary forms: excessive single-meal intake and insufficient single-meal intake. Contemporary dietary health is significantly impacted by

widespread food intake quantity imbalance, most visibly exemplified by behaviors such as binge eating or consistently inadequate meal consumption. These practices directly contribute to the development of eating-related disorders, including digestive impairment and metabolic dysfunction.

The origin of these issues lie in a pervasive public lack of understanding regarding quantity-body coupling—the physiological relationship between food volume, energy intake, and bodily response. This knowledge deficit results in both short-term consequences, such as gastrointestinal distress, and long-term health deterioration, including obesity, malnutrition, and associated comorbidities. These conditions not only compromise organ function and reduce healthy life expectancy but also generate substantial, preventable medical expenditures. The resolution necessitates systematic promotion of the quantity-body coupling concept, emphasizing mindful eating practices and advocating for the principle of consuming until approximately 80% full, tailored to individual physiological needs and activity levels.

The quadrant analysis for food intake quantity issues is shown below (see Table 4-8):

Table 4-8. Quadrant Analysis Table of Food Intake Quantity Issues

Category	Content
Phenomenon	Deviations in single-meal quantity—whether excessive or insufficient—commonly precipitate diet-related diseases.
Cause	Deficient comprehension of intake-volume homeostasis
Hazard	Health impairment, diminished healthy life expectancy, and elevated preventable healthcare expenditures
Response	Systematic public education on food intake quantity-body coupling

4-1.2.2 Food Intake Variety Issues

Food intake variety issues [SI-1212200] form a fifth-level category within the food system issue framework, situated under eating stage issues. This classification pertains to imbalances in the selection of diverse food categories during meals. As omnivorous organisms whose diets are primarily plant-based with supplementary animal products, humans exhibit complex dietary behaviors influenced by ethnic, regional, and individual factors. The core issue arises when food selection becomes skewed by sensory preference or cognitive bias.

These imbalances manifest through two primary pathways: sensory-driven

selection errors and cognition-based choice distortions. Contemporary eating patterns demonstrate significant intake variety mismatch, typified either by overconsumption of high-sugar or high-fat foods due to palatability, or unwarranted avoidance of essential nutrients stemming from dietary misconceptions. This discrepancy originates in insufficient public understanding of how dietary variety should systematically align with physiological requirements—particularly regarding nutritional properties and personalized food combination principles. The consequent knowledge gap generates progressive health implications: compromised nutritional status, reduced quality of life, and increased healthcare expenditures. Addressing this issue requires implementing food variety-body coupling education, instructing individuals to base food selection on three fundamental factors: physiological natures, physiological structure, and food natures, thereby enabling dietary choices that genuinely support individual health maintenance.

The quadrant analysis for food intake variety issues is shown below (see Table 4-9):

Table 4-9. Quadrant Analysis Table of Food Intake Variety Issues

Category	Content
Phenomenon	Sensory-driven and cognition-biased food selection errors contribute significantly to the development of diet-related diseases.
Cause	Deficient comprehension of food variety-body coupling
Hazard	Health deterioration, diminished healthy life expectancy, and elevated preventable healthcare expenditures
Response	Systematic public education on food variety-body coupling

4-1.2.3 Eating Speed Issues

Eating speed issues [SI-1212300] constitute a fifth-level category within the food system issue framework, classified under eating stage issues. This category pertains to deviations in meal duration—primarily governed by chewing and swallowing rates—which directly impact food breakdown and subsequent digestive efficiency. The fundamental concern arises when consumption occurs at physiologically suboptimal rates, whether excessively rapid or abnormally prolonged.

These dysregulations manifest through two distinct patterns: rushed ingestion and abnormally protracted consumption. Modern eating habits frequently exhibit such dysregulation, often characterized by either hurriedly consuming meals or extending eating duration beyond functional necessity—both extremes potentially precipitating

digestive dysfunction. This issue stems primarily from insufficient public awareness regarding eating speed-body dynamic coupling, including limited understanding of the relationship between mastication frequency and nutrient assimilation, as well as an inability to adapt eating pace to specific food properties. The resulting knowledge deficit contributes to compromised long-term health outcomes and increased healthcare burdens. Addressing this requires targeted education on speed-body coupling principles, emphasizing the physiological benefits of mindful chewing and contextually appropriate eating rates to support optimal digestion.

The quadrant analysis for eating speed issues is shown below (see Table 4-10):

Table 4-10. Quadrant Analysis Table of Eating Speed Issues

Category	Content
Phenomenon	Deviations from optimal eating pace—whether excessively rapid or abnormally prolonged—significantly contribute to the development of diet-related diseases.
Cause	Deficient comprehension of eating speed-body coupling
Hazard	Health deterioration, diminished healthy life expectancy, and elevated preventable healthcare expenditures
Response	Systematic public education on eating speed-body coupling

4-1.2.4 Food Temperature Issues

Food temperature issues [SI-1212400] constitute a fifth-level category within the food system issue framework, classified under eating stage issues. This category pertains to the thermal properties of consumed foods, where appropriate temperature ranges enhance palatability, reduce physiological irritation, and support digestive function. The core concern arises when foods are ingested at extremes of temperature, either excessively hot or cold.

These deviations manifest through two distinct forms: hyperthermic (>65°C) and hypothermic (<10°C) consumption. Contemporary dietary practices demonstrate significant thermal impropriety, frequently involving the intake of scalding or frigid substances, which directly causes oral mucosal lesions and gastrointestinal distress. The origin of this issue lies in a pervasive public unawareness of food temperature–digestive tolerance coupling, including insufficient knowledge of tissue thermal limits and adaptive ingestion practices. This deficiency yields compounded health consequences:

hyperthermic intake increases risks of esophageal damage, while hypothermic consumption disrupts enzymatic function and motility, potentially progressing to chronic gastroenterological disorders. These outcomes diminish long-term well-being and elevate healthcare burdens. Resolution necessitates structured education on temperature-body coupling principles, emphasizing alignment with physiological norms. Given the human body's stable core temperature of approximately 37°C, ideal food temperatures should generally remain within a moderate range, minimally deviating from oral baseline conditions to support systemic compatibility.

The quadrant analysis for food temperature issues is shown below (see Table 4-11):

Table 4-11. Quadrant Analysis Table of Food Temperature Issues

Category	Content
Phenomenon	Consumption of foods at extreme temperatures—either excessively hot or excessively cold—is a significant contributing factor to the development of diet-related diseases.
Cause	Deficient comprehension of food temperature-body coupling
Hazard	Health deterioration, diminished healthy life expectancy, and elevated preventable healthcare expenditures
Response	Systematic public education on food temperature-body coupling

4-1.2.5 Eating Frequency Issues

Eating frequency issues [SI-1212500] constitute a fifth-level category within the food system issue framework, classified under eating stage issues. This category pertains to irregularities in the number of meals consumed within a defined period and is intrinsically linked to both food quality and quantity. The core concern arises when consumption frequency deviates significantly from physiological needs, whether excessively high or insufficient.

These irregularities manifest through two distinct patterns: hyperfrequency (excessively frequent intake) and hypofrequency (insufficient meal frequency). Contemporary eating patterns frequently demonstrate such dysregulation, often characterized either by abbreviated intermeal intervals that overwhelm digestive capacity or prolonged fasting periods that provoke hypoglycemic responses. This discrepancy originates in limited public awareness of eating frequency–metabolic coupling, including inadequate understanding of digestive rhythms and insufficient adaptation of meal

timing to energy expenditure.

The resultant behavioral mismatch yields progressive health consequences: short-term manifestations include gastrointestinal discomfort or energy instability, while long-term effects may encompass metabolic dysregulation and chronic digestive dysfunction. These outcomes not only accelerate physiological decline but also elevate costs associated with managing preventable chronic conditions. Addressing this issue necessitates foundational education in frequency-body coupling principles. Under modern lifestyle conditions, a structured three-meal framework—comprising breakfast, lunch, and dinner—is generally advocated, with approximately 4–6 hours between breakfast and lunch, and 12–14 hours between dinner and the following breakfast, aligning with typical circadian metabolic variations.

The quadrant analysis for eating frequency issues is shown below (see Table 4-12):

Table 4-12. Quadrant Analysis Table of Eating Frequency Issues

Category	Content
Phenomenon	Deviation from physiologically appropriate eating frequency—whether excessively high or insufficient—significantly contributes to the development of diet-related diseases.
Cause	Deficient comprehension of eating frequency-body coupling
Hazard	Health deterioration, diminished healthy life expectancy, and elevated preventable healthcare expenditures
Response	Systematic public education on eating frequency-body coupling

4-1.2.6 Eating Sequence Issues

Eating sequence issues [SI-1212600] constitute a fifth-level category within the food system issue framework, classified under eating stage issues. This category pertains to the order in which different food types are consumed during a meal, where improper sequencing can impede nutrient absorption or disrupt gastrointestinal function.

These issues manifest through two primary dimensions: sequence errors that hinder nutrient assimilation and those that compromise digestive well-being. Modern dietary practices frequently exhibit eating sequence dysregulation, often characterized by consumption patterns that contradict physiological digestive processes. This stems from a pervasive lack of public awareness regarding eating sequence–body coupling—specifically, insufficient knowledge of food-specific digestion kinetics and the adaptation

of intake order to individual metabolic profiles. The resulting cognitive deficit adversely affects long-term health outcomes and increases healthcare costs. Addressing this issue requires structured education in sequence-body coupling principles, focusing on three core competencies: comprehending food-specific digestive timelines, implementing a foundational "fiber–protein–carbohydrate" consumption framework, and achieving precise synchronization between dietary sequencing and individual digestive physiology.

The quadrant analysis for eating frequency issues is shown below (see Table 4-13):

Table 4-13. Quadrant Analysis Table of Eating Frequency Issues

Category	Content
Phenomenon	Improper food consumption sequencing disrupts nutrient assimilation and compromises gastrointestinal function, thereby contributing to the development of diet-related diseases.
Cause	Deficient comprehension of eating sequence-body coupling
Hazard	Health deterioration, diminished healthy life expectancy, and elevated preventable healthcare expenditures
Response	Systematic public education on eating sequence-body coupling

4-1.2.7 Food Doneness Issues

Food doneness issues [SI-1212700] constitute a fifth-level category within the food system issue framework, classified under eating stage issues. This category pertains to the degree of heating applied during food preparation, where deviations—whether insufficient or excessive—compromise safety, nutrient integrity, or digestibility.

These issues manifest through two primary dimensions: health risks arising from inadequately prepared foods and nutrient degradation resulting from overcooking. Contemporary dietary practices exhibit significant doneness imbalance, frequently characterized by the consumption of unsafe raw or undercooked ingredients or the application of excessive heat that diminishes nutritional value. Such practices directly contribute to food-borne illnesses and dietary deficiencies. The underlying cause is a pervasive lack of public understanding regarding doneness–body coupling—specifically, insufficient knowledge of safety thresholds for diverse ingredients and optimized cooking techniques for preserving nutrients. The associated risks are twofold: underprepared foods may harbor pathogenic organisms, while overcooked foods can generate harmful compounds and reduce nutrient bioavailability. Prolonged exposure may lead to

chronic gastrointestinal impairment, systemic toxicity, and related health complications, ultimately diminishing quality of life and increasing healthcare costs. Addressing this issue requires comprehensive education on doneness–body coupling, emphasizing three critical competencies: mastering safety standards for various food types, understanding thermal impacts on nutritional quality, and adapting preparation methods to individual digestive tolerance. The ultimate objective is to achieve an optimal equilibrium among food safety, nutrient preservation, and physiological compatibility.

The quadrant analysis for food doneness issues is shown below (see Table 4-14):

Table 4-14. Quadrant Analysis Table of Food Doneness Issues

Category	Content
Phenomenon	Consumption of inadequately prepared foods—whether undercooked or overcooked—adversely affects health and contributes significantly to the development of diet-related diseases.
Cause	Deficient comprehension of doneness-body coupling
Hazard	Health deterioration, diminished healthy life expectancy, and elevated preventable healthcare expenditures
Response	Systematic public education on doneness-body coupling

4-1.3 Post-Eating Stage Issues

Post-eating stage issues [SI-1213000] constitute a fourth-level category within the food system issue framework, classified under eating methodology issues. This phase involves dual postprandial verification processes: monitoring biological discharges and physiological responses to assess digestive and metabolic outcomes.

These issues are subdivided into two distinct problem areas: failure to detect abnormal biological discharges and disregard for adverse physiological responses. The core concern lies in the neglect of these critical biofeedback mechanisms, which impedes the timely identification of diet-related health risks. Unobserved abnormalities in excretions—such as urine, stool, or sweat—represent missed objective biomarkers of internal dysfunction, while ignored physiological signals—like bloating, fatigue, or gastrointestinal discomfort—reflect a failure in somatic alert systems. Collectively, these gaps compromise opportunities for early intervention and undermine preventive health protection.

Contemporary society demonstrates limited awareness of this postprandial phase, largely due to cultural and perceptual models that reduce eating to mere consumption rather than recognizing it as an integrated biochemical and physiological process. In the absence of systematic understanding of digestion and metabolism, individuals frequently overlook the diagnostic value of monitoring biological outputs and somatic signals. This oversight contributes to elevated health risks, including undetected chronic inflammation, accelerated physiological decline, and avoidable healthcare expenditures. Addressing this deficiency requires the integration of comprehensive "eatology" education—encompassing the full cycle of food-body interactions—and the promotion of a dual-verification method: systematic assessment of both biological discharges and physiological reactions. This approach facilitates the establishment of an effective personal health monitoring system and enhances societal capacity for evidence-based, proactive dietary health management.

The quadrant analysis for post-eating stage issues is shown below (see Table 4-15):

Table 4-15. Quadrant Analysis Table of Post-Eating Stage Issues

Category	Content
Phenomenon	Neglect of the postprandial monitoring phase and its critical role in health maintenance
Cause	Failure to approach eating as a scientific practice
Hazard	Health impairment, diminished healthy life expectancy, and elevated preventable healthcare expenditures
Response	Promoting eatology education and implementing dual postprandial verification

4-1.3.1 Failure to Detect Abnormal Biological Discharges

Failure to detect abnormal biological discharges [SI-1213100] constitutes a fifth-level category within the food system issue framework, classified under post-eating stage issues. Biological discharges refer to substances eliminated from the body following metabolic and energy conversion processes, categorized by origin into eleven primary types: nasal (e.g., mucus), aural (e.g., cerumen), dermal (e.g., sweat), anal (e.g., feces, flatus), menstrual (e.g., vaginal discharge), oral (e.g., saliva), urinary (e.g., urine), umbilical (e.g., navel secretions), mammary (e.g., lactation), scalp (e.g., sebum, dandruff), and ocular (e.g., tears, rheum).

This issue manifests through four observational deficiencies: neglect of solid, liquid, gaseous, and thermal discharges. Individuals frequently overlook postprandial variations in discharge properties—such as color, odor, consistency, volume, or temperature—due to insufficient physiological literacy and absent monitoring protocols. Contributing factors include a lack of accessible diagnostic tools (e.g., rapid saliva test strips) and sociocultural stigmatization of bodily excretion topics. The consequences of this neglect include delayed pathological detection, reduced healthy lifespan, and increased healthcare expenditures, as late-stage interventions incur significantly higher costs than early prevention. Addressing this issue requires integrating eatology education that emphasizes discharge monitoring, supported by practical tools such as urine color charts, saliva self-assessment guides, and digital health journals for tracking discharge-diet correlations. Abnormal discharges function as critical, often overlooked, bioindicators—enhancing public awareness, developing accessible monitoring technologies, and implementing systematic observation protocols can substantially reduce associated health risks.

The quadrant analysis for failure to detect abnormal biological discharges is shown below (see Table 4-16):

Table 4-16. Quadrant Analysis Table of Failure to Detect Abnormal Biological Discharges

Category	Content
Phenomenon	Delayed or missed detection of abnormal biological discharges
Cause	Deficient knowledge of biological discharge indicators and inadequate monitoring practices
Hazard	Health impairment, diminished healthy life expectancy, and elevated preventable healthcare expenditures
Response	Systematic public education on biological discharge monitoring and interpretation

4-1.3.2 Ignoring Physiological Responses

Ignoring physiological responses [SI-1213200] constitutes a fifth-level category within the food system issue framework, classified under post-eating stage issues. This category pertains to the neglect or misinterpretation of the body's physiological reactions and mental state fluctuations following food consumption.

These issues manifest through two primary dimensions: disregard for physical changes and inattention to postprandial cognitive or affective states. Individuals

frequently dismiss bodily distress signals—such as bloating, nausea, fatigue, or dizziness—often misattributing them to benign causes (e.g., overeating) or normalizing discomfort due to cultural habituation. Underlying causes include insufficient public understanding of physiological signaling and decreased sensitivity to subtle, chronic symptoms. The consequences of such neglect include delayed diagnosis of dietary-related pathologies, potential progression to chronic conditions, reduced healthy lifespan, and increased healthcare burdens. Addressing this issue requires enhanced physiological literacy through structured health education, including the implementation of symptom severity response protocols to clarify indications for medical consultation. Strengthening individual health agency and reinforcing social support systems are essential to mitigating risks associated with unheeded physiological feedback.

The quadrant analysis for ignoring physiological responses is shown below (see Table 4-17):

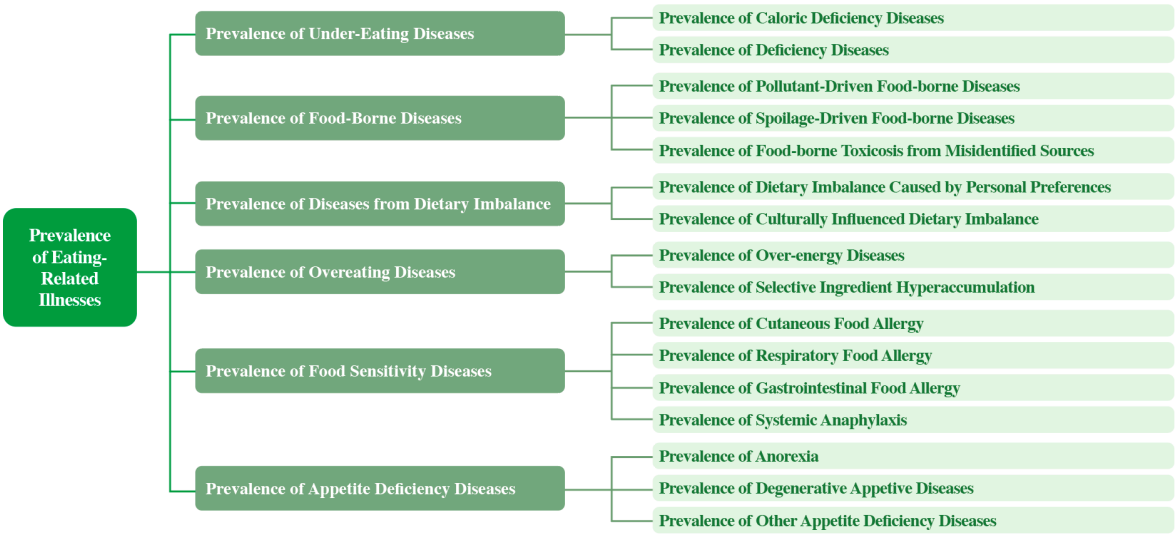
Table 4-17. Quadrant Analysis Table of Ignoring Physiological Responses

Category	Content
Phenomenon	Neglect of postprandial somatic and psychosomatic feedback
Cause	Deficient awareness of physiological feedback mechanisms and underestimation of symptom progression
Hazard	Health deterioration, diminished healthy life expectancy, and elevated preventable healthcare expenditures
Response	Systematic public education on postprandial physiological response recognition and interpretation

4-2 Prevalence of Eating-Related Illnesses

Prevalence of eating-related illnesses [SI-1220000] constitutes a third-level issue within the food system issue framework, classified under eater health and longevity issues. These conditions result from improper food selection and unhealthy eating practices, manifesting as six primary disease classifications: under-eating diseases, food-borne diseases, diseases from dietary imbalance, overeating diseases, food sensitivity diseases, and appetite deficiency diseases. The term "eating-related illnesses" collectively encompasses these six prevalent pathological categories. This category is shown below (See Figure 4-2):

Figure 4-2. Prevalence of Eating-Related Illnesses



This category is subdivided into six distinct areas of concern: the prevalence of under-eating diseases, food-borne diseases, diseases from dietary imbalance, overeating diseases, food sensitivity diseases, and appetite deficiency diseases. The classification system employs an etiology-based nomenclature in which each disease name directly references its causative factor, thereby facilitating immediate recognition of pathological origins while reinforcing scientific accuracy and preventive awareness.

These illnesses arise from both external factors—predominantly related to food quality and safety—and internal factors, such as improper eating methodologies. The widespread prevalence of eating-related diseases represents a significant threat to human health and survival, markedly reducing life expectancy and quality of life. Addressing these conditions requires a two-fold strategy: first, establishing the conceptual and taxonomic framework of eating-related illnesses to provide a theoretical foundation for systematic management; and second, emphasizing preventive measures through the adoption of scientifically sound eating practices to mitigate disease development before clinical manifestation.

The quadrant analysis for prevalence of eating-related illnesses is shown below (see Table 4-18):

Table 4-18. Quadrant Analysis Table of Prevalence of Eating-Related Illnesses

Category	Content
Phenomenon	Six pervasive eating-related diseases
Cause	Suboptimal eating practices
Hazard	Compromising eater survival and health integrity
Response	Advancing systemic awareness of eating-related illnesses and the optimal eating methodology

4-2.1 Prevalence of Under-Eating Diseases

Prevalence of under-eating diseases [SI-1221000] constitutes a fourth-level issue within the food system issue framework, classified under the prevalence of eating-related illnesses. It denotes pathological physiological states resulting from chronically insufficient food intake, representing one of the six major classes of dietary disorders.

This category manifests through two primary dimensions: diseases arising from total caloric deficiency and those resulting from insufficient intake of specific nutrient categories, reflecting deficits in both quantity and diversity of food. Characteristic physical manifestations include persistent hunger and clinically significant signs of nutritional deficiencies. Systemically, these diseases originate from macro-level factors such as food scarcity and inequitable distribution networks, while individual cases often stem from misconceptions regarding dietary practices. These conditions pose direct threats to survival and physiological well-being. Addressing this issue necessitates integrated systemic strategies: enhancing agricultural productivity and optimizing distribution mechanisms to ensure foundational food security, complemented by targeted education to rectify erroneous dietary beliefs and promote consumption adequacy.

The quadrant analysis for prevalence of under-eating diseases is shown below (see Table 4-19):

Table 4-19. Quadrant Analysis Table of Prevalence of Under-Eating Diseases

Category	Content
Phenomenon	Hunger, undernourishment
Cause	Systemic food insecurity and nutritionally inadequate dietary practices
Hazard	Endangering survival and compromising physiological well-being
Response	Ensuring food adequacy and rectifying dietary misconceptions

4-2.1.1 Prevalence of Caloric Deficiency Diseases

Prevalence of caloric deficiency diseases [SI-1221100] constitutes a fifth-level issue within the food system issue framework, classified under the prevalence of under-eating diseases. It encompasses disorders resulting from chronically insufficient total caloric intake.

This category manifests through four primary clinical dimensions: emaciation, physical debilitation, compromised immune function, and generalized malnutrition. Characteristic symptoms include persistent hunger, progressive weight loss, and multisystem nutrient deficiency indicators.

Etiologically, these conditions arise from systemic drivers—such as food scarcity and inequitable distribution—coupled with individual factors, including erroneous dietary beliefs and practices. Caloric deficiency poses a direct threat to survival and physiological integrity. Addressing this issue necessitates dual-pathway interventions: strengthening agricultural output and optimizing food distribution networks to ensure caloric availability, complemented by targeted educational initiatives to correct misconceptions regarding dietary adequacy and energy requirements.

The quadrant analysis for prevalence of caloric deficiency diseases is shown below (see Table 4-20):

Table 4-20. Quadrant Analysis Table of Prevalence of Caloric Deficiency Diseases

Category	Content
Phenomenon	Hunger, undernourishment
Cause	Insufficient food availability and nutritionally inadequate dietary pattern
Hazard	Endangering survival and compromising physiological well-being
Response	Ensuring sufficient food and correcting nutritional misconceptions

4-2.1.2 Prevalence of Deficiency Diseases

Prevalence of deficiency diseases [SI-1221200] constitutes a fifth-level issue within the food system issue framework, classified under the prevalence of under-eating diseases. It refers to pathological conditions resulting from insufficient intake of specific nutrient categories.

This category manifests through five principal forms of malnutrition: protein, essential fatty acid, vitamin, mineral, and trace element deficiencies. Characteristic

clinical presentations include edema, muscle wasting, dermatological abnormalities, growth impairment, and immune dysfunction.

Etiologically, these deficiencies stem from systemic drivers such as constrained food diversity and inequitable access to nutrient-rich foods. Category-specific nutritional shortages directly compromise metabolic and physiological integrity. Addressing these conditions requires systemic interventions focused on enhancing agricultural diversity and optimizing distribution mechanisms to ensure consistent availability of nutritionally complete foods.

The quadrant analysis for prevalence of deficiency diseases is shown below (see Table 4-21):

Table 4-21. Quadrant Analysis Table of Prevalence of Deficiency Diseases

Category	Content
Phenomenon	Undernourishment
Cause	Insufficient dietary diversity
Hazard	Endangering survival and compromising physiological well-being
Response	Ensuring dietary diversity

4-2.2 Prevalence of Food-Borne Diseases

Prevalence of food-borne diseases [SI-1222000] constitutes a fourth-level issue within the food system issue framework, classified under the prevalence of eating-related illnesses. It encompasses pathological conditions resulting from the consumption of contaminated, spoiled, or toxic foods, representing one of the six principal classes of dietary disorders.

This category manifests through three primary etiologies: diseases caused by environmental or industrial pollutants, diseases resulting from microbial spoilage, and toxicoses arising from misidentified or inherently toxic biological sources. These issues frequently coexist, particularly in regions with underdeveloped food safety infrastructure.

The scope of food-borne diseases extends beyond spoilage-related morbidity to include conditions caused by natural contaminants and chemical contaminants introduced during agricultural production, processing, or distribution. Contamination risks permeate the entire supply chain, from primary production to final consumption.

These hazards pose significant threats to human health and survival. Effective mitigation requires a preventive framework encompassing: first, the capacity to sensorily and contextually identify contaminated or spoiled foods to eliminate risks prior to consumption; second, strict adherence to culinary and personal hygiene protocols; and third, systematic public education on food safety principles, including recognition of toxic species and hazardous preparation practices to prevent accidental exposure.

The quadrant analysis for prevalence of food-borne diseases is shown below (see Table 4-22):

Table 4-22. Quadrant Analysis Table of Prevalence of Food-Borne Diseases

Category	Content
Phenomenon	Food-borne illnesses resulting from spoilage, contamination, and toxins
Cause	Consumption of spoiled commodities; exposure to contaminated foodstuffs or food-contact surfaces; ingestion of toxic substances
Hazard	Endangering survival and compromising physiological integrity
Response	Systematic elimination of contamination vectors and spoilage pathways; implementation of public safety education on toxic substance identification and avoidance

4-2.2.1 Prevalence of Pollutant-Driven Food-Borne Diseases

Prevalence of pollutant-driven food-borne diseases [SI-1222100] constitutes a fifth-level issue within the food system issue framework, classified under the prevalence of food-borne diseases. It encompasses disorders resulting from the ingestion of foods contaminated during production or processing by harmful natural or synthetic substances.

This category manifests through three primary contamination pathways: chemical (e.g., pesticide residues, heavy metals), physical (e.g., foreign materials), and microbial (e.g., pathogenic bacteria, viruses). Consumption may result in acute gastroenteritis, neurotoxic effects, or systemic infections due to factors such as improper handling, inadequate storage, excessive agrochemical application, or contaminated equipment and water. Short-term health consequences include dehydration, hypovolemic shock, and acute organ failure, while chronic exposure elevates risks of carcinogenic, mutagenic, and teratogenic outcomes, collectively endangering both health and survival. Mitigation necessitates rigorous source control measures, including the implementation of Hazard Analysis and Critical Control Point (HACCP) systems, enhanced monitoring of pesticide

and pollutant residues, and strengthened enforcement of food safety protocols across the supply chain.

The quadrant analysis for prevalence of pollutant-driven food-borne diseases is shown below (see Table 4-23):

Table 4-23. Quadrant Analysis Table of Prevalence of Pollutant-Driven food-borne diseases

Category	Content
Phenomenon	Food-borne diseases resulting from chemical, physical, or biological contamination
Cause	Exposure to contaminated foodstuffs or unsanitary food-contact surfaces
Hazard	Endangering survival and compromising physiological integrity
Response	Systematic eradication of contamination vectors and pathways

4-2.2.2 Prevalence of Spoilage-Driven Food-Borne Diseases

Prevalence of spoilage-driven food-borne diseases [SI-1222200] constitutes a fifth-level issue within the food system issue framework, classified under the prevalence of food-borne diseases. It encompasses pathological conditions resulting from the ingestion of decomposed, moldy, or rancid foods.

This category manifests through three primary deterioration mechanisms: chemical oxidation, enzymatic degradation, and microbial proliferation. Consumption elicits acute or chronic symptoms, including gastrointestinal distress, allergic responses, and neurotoxic effects, arising from factors such as microbial toxin production, lipid peroxidation, and inadequate storage conditions. Health implications range from immediate manifestations—such as septic shock or respiratory paralysis—to long-term sequelae including hepatic carcinoma and gastric malignancies, collectively endangering physiological integrity and survival. Effective prevention requires a multi-faceted approach: eradicating spoilage sources through technological innovations (e.g., intelligent packaging with time-temperature integrators); behavioral interventions such as adherence to the "2-hour rule" for perishable food handling; and regulatory advancements including standardized rapid detection protocols for microbial and chemical spoilage indicators.

The quadrant analysis for prevalence of spoilage-driven food-borne diseases is shown below (see Table 4-24):

Table 4-24. Quadrant Analysis Table of Prevalence of Spoilage-Driven Food-borne Diseases

Category	Content
Phenomenon	Food-borne diseases resulting from biological or chemical spoilage
Cause	Consumption of organoleptically degraded or microbiologically compromised foodstuffs
Hazard	Endangering survival and compromising physiological integrity
Response	Identification and elimination of sources of spoilage

4-2.2.3 Prevalence of Food-Borne Toxicosis from Misidentified Sources

Prevalence of food-borne toxicosis from misidentified sources [SI-1222300] constitutes a fifth-level issue in the food system issue framework, classified under the prevalence of food-borne diseases. This category refers to illnesses caused by the consumption of foods that are naturally toxic, improperly processed to remove toxins, or contaminated due to misidentification of species. Such incidents often result in severe and sometimes fatal health outcomes.

The issue manifests through two distinct reaction patterns: immediate and delayed responses. Ingestion can trigger severe symptoms such as lip numbness and neurotoxicity, multi-organ failure—as observed in amanitin poisoning—or hemolytic reactions, including favism. These effects originate from exposure to natural toxins such as ciguatoxin or solanine, inadequate detoxification during processing (for instance, insufficient cassava soaking), or species misidentification, such as confusing hemlock with parsley. Acute cases may be fatal within hours or result in permanent neurological impairment. Effective solutions necessitate source elimination via technological innovations like AI-assisted mushroom identification and strengthened regulatory measures, such as Japan's stringent fugu chef licensing system.

The quadrant analysis for prevalence of food-borne toxicosis from misidentified sources is shown below (see Table 4-25):

Table 4-25. Quadrant Analysis Table of Prevalence of Food-Borne Toxicosis from Misidentified Sources

Category	Content
Phenomenon	Food-borne diseases from toxins
Cause	Toxic substances in food
Hazard	Endangering survival and compromising physiological integrity
Response	Elimination of toxin sources in the food supply

4-2.3 Prevalence of Diseases from Dietary Imbalance

Prevalence of diseases from dietary imbalance [SI-1223000] is a fourth-level issue within the food system issue framework, classified under prevalence of eating-related illnesses. It occurs when deliberate excessive or insufficient consumption of certain foods leads to an unhealthy physiological state, making it one of the six major eating-related diseases.

This issue manifests through two primary pathways: dietary imbalance resulting from personal preferences and dietary imbalance influenced by cultural traditions. These drivers interact to form and sustain unbalanced dietary patterns over time. The condition arises from long-term monotonous eating behaviors that cause nutritional disorders, characterized by simultaneous overconsumption of some nutrients and deficiencies in others. Personal preferences, often shaped by early-life experiences and psychological factors, lead to deeply ingrained taste habits. Cultural traditions systematically reinforce certain food choices through regional customs and shared identity, while limiting diversity in nutritional intake. Such imbalances can weaken immune function, provoke digestive disorders, and contribute to the development of chronic diseases that may reduce overall lifespan. Addressing this problem requires multidimensional strategies, including modifying individual dietary awareness to encourage balanced eating, integrating psychological support where needed, promoting cultural shifts in food perception, and providing necessary nutrient supplementation. These efforts collectively aim to establish sustainable and health-conscious dietary practices.

The quadrant analysis for prevalence of diseases from dietary imbalance is shown below (see Table 4-26):

Table 4-26. Quadrant Analysis Table of Prevalence of Diseases from Dietary Imbalance

Category	Content
Phenomenon	Nutritional imbalance
Cause	Personal preferences and cultural traditions
Hazard	Endangering survival and compromising physiological integrity
Response	Fostering proper nutritional awareness, implementing psychological interventions, reforming cultural dietary perceptions, and strategically supplementing essential nutrients

4-2.3.1 Prevalence of Dietary Imbalance Caused by Personal Preferences

Prevalence of dietary imbalance caused by personal preferences [SI-1223100] is classified as a fifth-level issue within the food system issue framework, falling under prevalence of diseases from dietary imbalance. It refers to disorders resulting from individuals' long-term avoidance of essential food groups—such as vegetables or grains—and excessive intake of preferred items, often high in sugar or fat, due to psychological dependence, entrenched taste habits, or cognitive biases. These behaviors lead to a nutritionally imbalanced dietary structure.

The issue manifests through three primary forms: sensory-dependent dietary imbalance, cognitive-biased eating behaviors, and habitualized eating patterns. Each contributes to nutrition-related disorders. These preferences, frequently influenced by early-life experiences and psychological conditioning, become deeply ingrained over time. Prolonged imbalance can increase the risk of chronic diseases and adversely affect longevity. Addressing this condition requires a multidisciplinary approach, incorporating individualized dietary education to foster balanced nutritional awareness, integrated psychological support, and targeted nutrient supplementation to correct specific deficiencies.

The quadrant analysis for prevalence of dietary imbalance caused by personal preferences is shown below (see Table 4-27):

Table 4-27. Quadrant Analysis Table of Prevalence of Dietary Imbalance Caused by Personal Preferences

Category	Content
Phenomenon	Nutritional imbalance
Cause	Personal preferences
Hazard	Compromising health and lifespan
Response	Fostering proper nutritional awareness, implementing psychological interventions, and strategically supplementing essential nutrients

4-2.3.2 Prevalence of Culturally Influenced Dietary Imbalance

Prevalence of culturally influenced dietary imbalance [SI -1223200] is a fifth-level issue within the food system issue framework, classified under prevalence of diseases from dietary imbalance. It refers to disorders arising from nutritional imbalance due to collective dietary patterns shaped by intergenerationally transmitted regional or ethnic

eating customs, such as religious dietary prohibitions or festival-specific foods.

This condition manifests through three primary forms: religious or faith-based dietary restrictions, regionally rigidified eating patterns, and ceremonial or festive food consumption—all contributing to nutritionally unbalanced intake. Cultural traditions systematically reinforce certain food preferences through geographical customs and collective memory, while indirectly marginalizing other nutritionally valuable sources. Such sustained imbalance can increase the risk of chronic disease and reduce longevity. Addressing this issue requires a coordinated intervention strategy that integrates individualized dietary awareness education to foster balanced eating habits, cultural-level dietary paradigm reform to encourage nutritional diversity, and targeted nutrient supplementation to address specific deficiencies.

The quadrant analysis for prevalence of culturally influenced dietary imbalance is shown below (see Table 4-28):

Table 4-28. Quadrant Analysis Table of Prevalence of Culturally Influenced Dietary Imbalance

Category	Content
Phenomenon	Nutritional imbalance
Cause	Cultural traditions
Hazard	Compromising health and lifespan
Response	Fostering proper nutritional awareness, reforming cultural dietary perceptions, and strategically supplementing essential nutrients

4-2.4 Prevalence of Overeating Diseases

Prevalence of overeating diseases [SI-1224000] is a fourth-level issue within the food system issue framework, classified under the broader prevalence of eating-related illnesses. As one of the six major eating-related diseases, it encompasses disorders resulting from the habitual consumption of food in quantities exceeding physiological needs.

This issue manifests in two primary forms: diseases arising from an overall caloric surplus and those resulting from the excessive intake of specific dietary components. Both forms involve consumption beyond the body's requirements for health maintenance and optimal function, warranting active mitigation.

Prolonged overconsumption contributes to obesity and related metabolic dysfunctions, marked by abnormal weight gain and systemic dysregulation. Root causes include poorly regulated eating behaviors, psychological dependence on energy-dense foods, and disrupted appetite control mechanisms. Without intervention, this condition substantially increases the risk of diabetes, cardiovascular disorders, and reduced life expectancy. Effective management relies on a multifaceted strategy: delivering dietary education to promote mindful eating; implementing behavioral and environmental modifications such as portion control tools and structured meal pacing; and, in clinically indicated cases, supplementing with pharmacological or surgical treatments to support sustained health improvement.

The quadrant analysis for prevalence of overeating diseases is shown below (see Table 4-29):

Table 4-29. Quadrant Analysis Table of Prevalence of Overeating Diseases

Category	Content
Phenomenon	Overweight, metabolic dysfunctions, and related health implications
Cause	Overeating
Hazard	Compromising health and lifespan
Response	Correcting understanding, regulating food quantities, and implementing medical and surgical interventions

4-2.4.1 Prevalence of Over-Energy Diseases

Prevalence of over-energy diseases [SI-1224100] is a fifth-level issue within the food system issue framework, classified under prevalence of overeating diseases. It arises when prolonged energy intake consistently exceeds expenditure, leading to fat accumulation and subsequent metabolic dysregulation, as well as increased mechanical stress on bodily systems.

This condition manifests through four key systemic dimensions: metabolic disturbances, cardiovascular symptoms, endocrine and reproductive effects, and respiratory and motor impairments. Chronic energy surplus results in overweight or obesity, often accompanied by metabolic disorders such as insulin resistance and fatty liver disease, along with cardiovascular conditions including hypertension and atherosclerosis. Root causes involve sustained hyperphagia, especially diets high in fats

and sugars, which promote energy storage. Associated health risks include reduced life expectancy, higher susceptibility to chronic diseases, and impaired quality of life. Effective management requires a comprehensive strategy: improving education about eating-related illnesses, implementing caloric deficit approaches—such as reducing daily intake by 500–750 kcal—and emphasizing low-glycemic, high-fiber foods. In cases of moderate to severe obesity, adjunct treatments such as GLP-1 receptor agonists or bariatric procedures like sleeve gastrectomy may be necessary. Regular monitoring of body mass index, waist circumference, and metabolic biomarkers is essential within this intervention framework.

The quadrant analysis for prevalence of over-energy diseases is shown below (see Table 4-30):

Table 4-30. Quadrant Analysis Table of Prevalence of Over-Energy Diseases

Category	Content
Phenomenon	Overweight, metabolic dysfunctions and cardiovascular disorder
Cause	Overeating in total quantity
Hazard	Compromising health and lifespan
Response	Correcting understanding, regulating food quantities, and implementing medical and surgical interventions

4-2.4.2 Prevalence of Selective Ingredient Hyperaccumulation

Prevalence of selective ingredient hyperaccumulation [SI-1224200] is a fifth-level category within the food system issue framework, classified under prevalence of overeating diseases. It refers to disorders resulting from the excessive intake of specific dietary components—such as macronutrients, minerals, vitamins, or contaminants—leading to physiological abnormalities including fat deposition, metabolic dysregulation, or organ damage.

This issue manifests in four primary forms: macronutrient overload, mineral excess, vitamin toxicity, and accumulation of other harmful substances. Clinically, it may present as overweight, metabolic disturbances (e.g., hyperuricemia, hypervitaminosis), or hepatorenal toxicity due to disproportionate consumption of certain foods or contaminated products. Common causes include chronic overconsumption of refined sugars, saturated fats, sodium, or exposure to heavy metals in foods. Associated risks

range from exacerbated obesity and chronic diseases to acute poisoning (e.g., vitamin A hepatotoxicity) or cancer (e.g., nitrite-related gastric cancer). Effective management requires targeted interventions: improving education on eating-related illnesses, restricting high-risk components through dietary monitoring, implementing regular biomarker screenings (e.g., serum uric acid, renal and hepatic panels), and applying precision therapeutics when indicated.

The quadrant analysis for prevalence of selective ingredient hyperaccumulation is shown below (see Table 4-31):

Table 4-31. Quadrant Analysis Table of Prevalence of Selective Ingredient Hyperaccumulation

Category	Content
Phenomenon	Overweight, metabolic dysfunctions, and related comorbidities
Cause	Overconsumption of specific foods
Hazard	Compromising health and lifespan
Response	Correcting understanding, regulating intake of specific foods, and implementing medical and surgical interventions

4-2.5 Prevalence of Food Sensitivity Diseases

Prevalence of food sensitivity diseases [SI-1225000] is a fourth-level issue within the food system issue framework, classified under prevalence of eating-related illnesses. It refers to abnormal physiological conditions resulting from exaggerated immune responses to specific food categories, representing one of the six major eating-related diseases.

This issue manifests through four clinical dimensions: cutaneous, respiratory, gastrointestinal, and systemic food allergies. These categories reflect a progression from localized to multisystem involvement, with increasing severity. Respiratory, digestive, and systemic reactions can be life-threatening, and no form of food hypersensitivity should be considered minor. Common clinical presentations include pruritus, vomiting, diarrhea, dyspnea, and anaphylactic shock. The underlying cause involves immune hyperreactivity to specific food components. Risks range from impaired quality of life in mild cases to potential fatality due to asphyxiation or circulatory collapse in severe episodes. The most effective management strategy combines allergen testing with strict dietary avoidance—

eliminating identified triggers such as peanuts or dairy—supplemented by emergency protocols for accidental exposure.

The quadrant analysis for prevalence of food sensitivity diseases is shown below (see Table 4-32):

Table 4-32. Quadrant Analysis Table of Prevalence of Food Sensitivity Diseases

Category	Content
Phenomenon	Allergic reaction following food consumption
Cause	Physiological hypersensitivity to specific foods
Hazard	Threatening health and survival
Response	Allergen avoidance

4-2.5.1 Prevalence of Cutaneous Food Allergy

Prevalence of cutaneous food allergy [SI-1225100] is a fifth-level category within the food system issue framework, classified under prevalence of food sensitivity diseases. It refers to inflammatory skin conditions resulting from exaggerated immune responses to specific food components.

This disorder manifests through two distinct clinical pathways: immediate-onset and delayed-onset reactions. Immediate reactions, occurring within minutes to two hours after ingestion, include urticaria (characterized by wheals and pruritus) and angioedema (involving swelling of the lips, eyelids, or other areas). Delayed reactions, emerging hours to days after exposure, encompass conditions such as atopic dermatitis and contact dermatitis. The underlying mechanism involves allergen proteins—such as β-lactoglobulin in milk or ovomucoid in eggs—activating immune cells and prompting the release of histamine and cytokines, which disrupt skin barrier function and promote inflammation. Diagnosis typically requires skin prick testing or serum IgE analysis to identify specific triggers. Management centers on strict allergen avoidance complemented by topical anti-inflammatory treatments, such as corticosteroid creams, to alleviate symptoms and restore skin health.

The quadrant analysis for prevalence of cutaneous food allergy is shown below (see Table 4-33):

Table 4-33. Quadrant Analysis Table of Prevalence of Cutaneous Food Allergy

Category	Content
Phenomenon	Skin reactions—including hives (wheals), itching, red rashes, and facial swelling—may occur following food ingestion.
Cause	Adverse physiological responses to specific food components
Hazard	Poising a risk to health
Response	Allergen avoidance

4-2.5.2 Prevalence of Respiratory Food Allergy

Prevalence of respiratory food allergy [SI-1225200] is a fifth-level category within the food system issue framework, classified under prevalence of food sensitivity diseases. It occurs when ingested food allergens trigger IgE-mediated airway hyperresponsiveness, leading to acute or chronic inflammation, obstruction, and impaired respiratory function.

This condition manifests through upper airway symptoms—such as nasal congestion, rhinorrhea, and dysphonia—or lower airway involvement, including expiratory dyspnea and chest tightness, which may progress to respiratory failure. The underlying mechanism is an IgE-mediated type I hypersensitivity reaction. Primary risks include acute upper airway obstruction and bronchospasm, which can be life-threatening. Management requires strict allergen avoidance, accessible epinephrine auto-injectors, and consideration of component-resolved diagnostics or immunotherapy for high-risk cases. Daily precautions include medical alert identification and availability of bronchodilators for emergency use.

The quadrant analysis for prevalence of respiratory food allergy is shown below (see Table 4-34):

Table 4-34. Quadrant Analysis Table of Prevalence of Respiratory Food Allergy

Category	Content
Phenomenon	Respiratory symptoms—including nasal congestion, rhinorrhea, coughing, wheezing, throat tightness, and dyspnea—may develop following food ingestion.
Cause	Adverse physiological reactions to specific food components.
Hazard	Posing a risk to health and survival
Response	Allergen avoidance

4-2.5.3 Prevalence of Gastrointestinal Food Allergy

Prevalence of gastrointestinal food allergy [SI-1225300] is a fifth-level category within the food system issue framework, classified under prevalence of food sensitivity diseases. It refers to pathological digestive tract reactions triggered by specific food components, particularly proteins, which may cause localized or systemic symptoms.

This disorder presents through two immunological pathways: immediate-onset (IgE-mediated) and delayed-onset (non-IgE-mediated) reactions. Immediate reactions produce symptoms such as nausea, vomiting, abdominal pain, and diarrhea within two hours of ingestion, often accompanied by cutaneous manifestations. Delayed reactions may result in chronic diarrhea, bloody stools, growth retardation, or feeding difficulties. Underlying mechanisms differ: IgE-mediated responses involve mast cell activation and histamine release, while non-IgE-mediated conditions like celiac disease involve T-cell driven damage to intestinal villi. Risks include dehydration, electrolyte imbalance, and developmental impairment, with severe cases posing life-threatening complications. Management requires strict elimination of triggers, confirmed through serum sIgE testing or food challenges. Chronic conditions necessitate lifelong dietary adherence and regular nutritional monitoring to maintain mucosal and systemic health.

The quadrant analysis for prevalence of gastrointestinal food allergy is shown below (see Table 4-35):

Table 4-35. Quadrant Analysis Table of Prevalence of Gastrointestinal Food Allergy

Category	Content
Phenomenon	Gastrointestinal symptoms—including nausea, vomiting, abdominal pain, diarrhea, bloody stools, and growth retardation—may develop following food ingestion.
Cause	Adverse physiological reactions to specific food components
Hazard	Posing a risk to health and survival
Response	Allergen avoidance

4-2.5.4 Prevalence of Systemic Anaphylaxis

Prevalence of systemic anaphylaxis [SI-1225400] is a fifth-level category within the food system issue framework, classified under prevalence of food sensitivity diseases. It represents a severe, life-threatening condition in which food allergens trigger an IgE-mediated systemic reaction, resulting in rapid multi-organ dysfunction.

This condition manifests through two temporal patterns: immediate systemic reactions, occurring within 30 minutes and featuring anaphylactic shock and laryngeal edema, and delayed biphasic reactions, in which symptoms recur hours after initial exposure. The mechanism involves food-specific IgE antibodies initiating a cascade of physiological overreactions. Critical risks include complete airway obstruction due to laryngeal swelling and sustained hypotension leading to cerebral or cardiac hypoperfusion and irreversible organ damage. Some patients may experience symptom recurrence hours after initial resolution. Management requires rigorous allergen avoidance through careful label scrutiny and prevention of cross-contamination, along with comprehensive emergency preparedness. This includes carrying epinephrine auto-injectors and understanding proper intramuscular administration in the mid-outer thigh, wearing medical alert identifiers, and maintaining personalized allergy action plans that emphasize administering epinephrine before contacting emergency services to ensure timely intervention.

The quadrant analysis for prevalence of systemic anaphylaxis is shown below (see Table 4-36):

Table 4-36. Quadrant Analysis Table of Prevalence of Systemic Anaphylaxis

Category	Content
Phenomenon	Life-threatening systemic symptoms—including anaphylactic shock, laryngeal edema, and potential irreversible organ damage—may occur following food ingestion.
Cause	Hypersensitivity to specific food components
Hazard	Posing a risk to health and survival
Response	Allergen avoidance

4-2.6 Prevalence of Appetite Deficiency Diseases

Prevalence of appetite deficiency diseases [SI-1226000] is a fourth-level category within the food system issue framework, classified under prevalence of eating-related illnesses. It refers to abnormal physiological states resulting from appetite suppression and represents one of the six major eating-related diseases.

This condition manifests through three dimensions: neurologically or psychologically driven suppression, functional degeneration of appetite regulation, and

disease-mediated reduction. These span a continuum from active refusal to passive incapacity, often resulting in a vicious cycle that culminates in malnutrition syndrome. Clinically, it presents primarily as nutritional deficiency, with persistent appetite dysregulation severely compromising physical and mental health. Prolonged cases may progress to organ failure and life-threatening conditions. Management requires multidimensional interventions: public health initiatives to disseminate scientific nutritional knowledge, combined with individualized psychological therapies and clinical nutritional rehabilitation. This integrated approach establishes a tripartite solution involving education, psychological support, and medical care to break the disorder's self-perpetuating cycle.

The quadrant analysis for prevalence of appetite deficiency diseases is shown below (see Table 4-37):

Table 4-37. Quadrant Analysis Table of Prevalence of Appetite Deficiency Diseases

Category	Content
Phenomenon	Nutritional deficiency
Cause	Appetite suppression
Hazard	Posing a risk to health and survival
Response	Promoting education on eating-related illnesses supported by psychological and physiological interventions

4-2.6.1 Prevalence of Anorexia

Prevalence of anorexia [SI-1226100] is a fifth-level category within the food system issue framework, classified under prevalence of appetite deficiency diseases. This condition results from psychological factors or neurochemical imbalances, leading to prolonged food restriction that causes malnutrition and potential organ failure.

The disorder manifests as anorexia nervosa or avoidant/restrictive food intake disorder (ARFID), characterized by severe caloric restriction, voluntary refusal of nourishment, and distorted body image. Etiology involves psychological drivers such as perfectionism and control needs, alongside neurobiological abnormalities like serotonin dysregulation. Associated risks are severe: when body mass index falls below 15, multi-organ failure may occur, with mortality rates reaching 10%. Management

requires cognitive behavioral therapy, family-based treatment for adolescents, pharmacological support such as olanzapine, and emergency nutritional rehabilitation in critical cases.

The quadrant analysis for prevalence of anorexia is shown below (see Table 4-38):

Table 4-38. Quadrant Analysis Table of Prevalence of Anorexia

Category	Content
Phenomenon	Voluntary food refusal or extreme caloric restriction resulting in malnutrition
Cause	Neurologically or psychologically induced appetite suppression
Hazard	Posing a risk to health and survival
Response	Promoting education on eating-related illnesses, supported by psychological and physiological interventions

4-2.6.2 Prevalence of Degenerative Appetive Diseases

Prevalence of degenerative appetive diseases [SI-1226200] is a fifth-level category within the food system issue framework, classified under appetite deficiency diseases. This condition arises from age-related or disease-induced physiological decline—such as diminished chewing or swallowing capacity and impaired nutrient absorption—leading to inadequate nutritional intake despite maintained desire to eat.

The disorder manifests through two primary pathways: chemosensory impairment causing appetite loss, and mastication or deglutition dysfunction. It primarily affects elderly or chronically ill individuals, presenting as persistent appetite reduction and insufficient food consumption without intentional avoidance. The pathophysiology involves multisystem functional decline, including gustatory and olfactory receptor depletion, slowed gastrointestinal motility, and reduced secretion of orexigenic hormones like ghrelin. Associated risks include severe sarcopenia, pressure ulcer formation, and increased infection susceptibility due to hypoalbuminemia. Management requires multimodal rehabilitation: nutrient-dense supplementation to address deficits, oropharyngeal muscle training to improve swallowing function, and cautious use of appetite-stimulating medications that may also alleviate comorbid depressive symptoms.

The quadrant analysis for prevalence of degenerative appetive diseases is shown below (see Table 4-39):

Table 4-39. Quadrant Analysis Table of Prevalence of Degenerative Appetive Diseases

Category	Content
Phenomenon	Reduced food intake due to eating difficulties resulting in malnutrition
Cause	Physiological functional decline leading to appetite suppression
Hazard	Posing a risk to health
Response	Physical training and therapeutic interventions

4-2.6.3 Prevalence of Other Appetite Deficiency Diseases

Prevalence of other appetite deficiency diseases [SI-1226300] is a fifth-level category within the food system issue framework, classified under appetite deficiency diseases. This condition arises from organic diseases or pathological states—such as infections, malignancies, or endocrine disorders—that directly disrupt normal feeding patterns.

The disorder manifests through three primary etiologies: infection-mediated appetite decline, neoplasm-induced anorexia, and chronic disease or chemotherapy-related eating dysfunction. It presents as appetite loss secondary to underlying pathologies, including tumors, systemic infections, or endocrine abnormalities like hyperthyroidism. Pathophysiology involves inflammatory cytokines suppressing hypothalamic feeding centers, combined with hypermetabolic states such as cancer cachexia, creating a cycle that accelerates disease progression and reduces survival. Management requires a three-tiered approach: treating the underlying condition, using appetite stimulants such as megestrol acetate, and providing enteral nutrition support via methods like percutaneous endoscopic gastrostomy for severe malnutrition.

The quadrant analysis for prevalence of other appetite deficiency diseases is shown below (see Table 4-40):

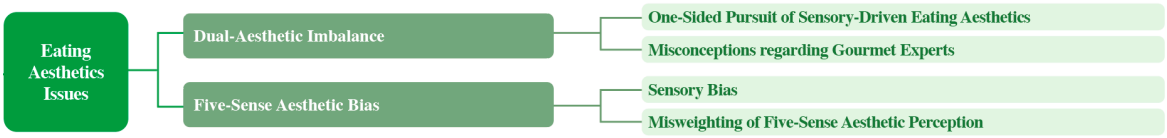
Table 4-40. Quadrant Analysis Table of Prevalence of Other Appetite Deficiency Diseases

Category	Content
Phenomenon	Reduced food intake due to infections, malignancies, chronic illnesses, or chemotherapy resulting in malnutrition
Cause	Organic diseases or pathological conditions causing appetite suppression
Hazard	Posing a risk to health and survival
Response	Physical therapy

4-3 Eating Aesthetics Issues

Eating aesthetics issues [SI-1230000] constitute a third-level category within the food system issue framework, situated beneath the broader category of eater health and longevity issues. Food aesthetics fundamentally refers to an individual's appreciation and judgment of food, wherein issues emerge specifically from one-sided or imbalanced perceptions of this appreciation. The structural relationship of this category is shown below (See Figure 4-3):

Figure 4-3. Prevalence of Eating Aesthetics Illnesses



These eating aesthetics issues are defined by two principal dimensions: the dual-aesthetic imbalance and the five-sense aesthetic bias. Together, these dimensions underscore the inherent complexity involved in evaluating eating aesthetics, a process which necessitates the careful harmonization of psychological responses with physiological health imperatives. Authentic food appreciation is a multisensory art that engages the full spectrum of human perception—specifically taste, smell, touch (with particular emphasis on oral texture), vision, and hearing. A truly balanced aesthetic experience neglects none of these sensory channels.

Nevertheless, contemporary dietary culture demonstrates a pronounced tendency to overemphasize the psychological pursuit of pleasure, frequently to the direct detriment of physiological health. Concurrently, it often prioritizes certain sensory experiences, such as visual appeal, while systematically neglecting others. This prevailing bias originates from a critical deficiency: the lack of a systematic integration of eating aesthetics into modern scientific frameworks, which has resulted in the establishment of skewed standards and norms. Such imbalanced standards not only significantly distort individual and collective food choices but also pose substantial health risks, a concerning reality evidenced by the widespread proliferation of hyper-palatable, high-sugar, and high-fat "aestheticized" food products. Effectively addressing this multifaceted problem requires a dedicated effort toward promoting a balanced dual-aspect aesthetic that gives equal weight to psychological

and physiological considerations, while also fostering a holistic five-sense synergy. The ultimate objective is the establishment of a more robust, coherent, and scientifically grounded framework for understanding and applying the principles of eating aesthetics.

The quadrant analysis for eating aesthetics issues is shown below (see Table 4-41):

Table 4-41. Quadrant Analysis Table of Eating Aesthetics Issues

Category	Content
Phenomenon	Dual-aesthetic imbalance, five-sense aesthetic bias
Cause	Eating aesthetics has not been systematically integrated into modern scientific frameworks
Hazard	Compromising physiological well-being
Response	Promoting public education on dual aesthetics and five-sense aesthetics

4-3.1 Dual-aesthetic Imbalance

Dual-aesthetic imbalance [SI-1231000] is a fourth-tier issue within the food system issue framework, classified under eating aesthetics issues. It denotes the failure to acknowledge that eating aesthetics constitutes a unified integration of psychological response and physiological well-being. This issue manifests through two primary dimensions: the one-sided pursuit of sensory-driven eating aesthetics and misconceptions regarding gourmet experts. Collectively, these represent a systemic cognitive distortion within aesthetic food appreciation.

In practical terms, dual-aesthetic imbalance leads individuals to either excessively pursue sensory and psychological gratification—such as consuming high-sugar, high-fat comfort foods—or to misunderstand the professional standards of gourmet experts, thereby reducing food appreciation to subjective preference. This discrepancy arises from the inadequate integration of eating aesthetics science into contemporary scientific frameworks, creating a disjunction between psychological satisfaction and physiological requirements. Such imbalance can result in either overconsumption or nutritional deficiency, ultimately compromising health and longevity. Addressing this issue necessitates the promotion of dual-aspect eating aesthetics, which emphasizes harmonious balance between palatable enjoyment and nutritional adequacy, ensuring that dietary practices fulfill both emotional and bodily needs.

The quadrant analysis for dual-aesthetics imbalance is shown below (see Table 4-42):

Table 4-42. Quadrant Analysis Table of Dual-Aesthetics Imbalance

Category	Content
Phenomenon	An excessive emphasis on sensory stimulation during eating, or a deficient comprehension of gourmet expertise
Cause	The absence of eating aesthetics within a modern scientific framework has resulted in a fundamental misalignment between psychological gratification and physiological well-being.
Hazard	Compromising physiological well-being
Response	Promoting public education on dual aesthetics

4-3.1.1 One-Sided Pursuit of Sensory-Driven Eating Aesthetics

One-sided pursuit of sensory-driven eating aesthetics [SI-1231100] constitutes a fifth-level category within the food system issue framework, subordinate to dual-aesthetic imbalance. This phenomenon describes the excessive prioritization of immediate sensory stimulation and emotional gratification during eating, concurrently neglecting nutritional value and the body's genuine physiological requirements.

The issue manifests through two principal dimensions: an overemphasis on flavor appeal at the expense of health considerations, and the failure of contemporary aesthetic frameworks to acknowledge physiological dimensions in food appreciation. A notable paradox characterizes modern dietary culture: while visual and gustatory stimulation, alongside psychological pleasure, receive increasing emphasis during meals, the critical impact of food on physical well-being is routinely disregarded.

This discrepancy originates in the absence of eating aesthetics within modern scientific systems. Because sensory enjoyment (psychological response) and nutrient absorption (physiological response) operate on divergent timelines, individuals are predisposed to prioritize immediate sensory gratification. This imbalanced approach to dietary aesthetics consequently undermines population health and longevity. Addressing this challenge necessitates promoting the concept of dual-aspect eating aesthetics, thereby cultivating public aesthetic sensibilities that equally value sensory pleasure and physiological health. Achieving this dynamic equilibrium between palatability and nourishment in dietary choices is fundamental to realizing sustainable development in food culture.

The quadrant analysis for one-sided pursuit of sensory-driven eating aesthetics is shown below (see Table 4-43):

Table 4-43. Quadrant Analysis Table of One-sided Pursuit of Sensory-Driven Eating Aesthetics

Category	Content
Phenomenon	The prioritization of sensory stimulation and psychological gratification at the expense of physiological health during eating
Cause	The absence of eating aesthetics within a modern scientific framework has resulted in a fundamental misalignment between psychological gratification and physiological well-being.
Hazard	Compromising physiological well-being
Response	Promoting public education on dual aesthetics

4-3.1.2 Misconceptions Regarding Gourmet Experts

Misconceptions regarding gourmet experts [SI-1231200] constitute a fifth-level issue within the food system issue framework, categorized under dual-aesthetic imbalance. Gourmet experts are defined as professionals proficient in both culinary creation and appreciation, classified into five distinct types: culinary gourmets (cooking artists), fermentation gourmets (fermentation artists), traditional gourmets (tasting experts), modern gourmets (health-oriented experts), and holistic gourmets. The central misconception lies in the failure to recognize the full diversity of these roles, particularly the critical contributions of fermentation gourmets, modern gourmets, and holistic gourmets beyond the more widely acknowledged culinary and traditional experts.

This issue manifests through two primary dimensions: the absence of health-oriented gourmet experts as mainstream role models, and the disproportionate emphasis on tasting expertise. The reduction of gourmet experts merely to "flavor judges" has resulted in the celebration of professionals skilled primarily in palatability while disregarding nutritional wisdom. This stems from the broader absence of eating aesthetics within modern scientific systems, which confines public understanding to sensory evaluation alone. Such skewed perceptions risk promoting uncritical adherence to transient food trends, ultimately compromising public health and longevity. Addressing this issue requires redefining the image of gourmet experts by enhancing public recognition of those who harmonize deliciousness with well-being. This involves emphasizing their multifaceted roles as both "champions of five-sensory appreciation" and "advocates of physiological health," while fostering a modern dietary aesthetic that equally prioritizes flavor and nourishment.

The quadrant analysis for misconceptions regarding gourmet experts is shown below

(see Table 4-44):

Table 4-44. Quadrant Analysis Table of Misconceptions regarding gourmet experts

Category	Content
Phenomenon	A deficient public comprehension of the multifaceted roles and expertise of gourmet professionals
Cause	The absence of eating aesthetics within a modern scientific framework
Hazard	Compromising physiological well-being
Response	Promoting public education on the comprehensive roles and contributions of gourmet experts

4-3.2 Five-Sense Aesthetic Bias

Five-sense aesthetic bias [SI-1232000] constitutes a fourth-level issue within the food system issue framework, subordinate to eating aesthetics issues. This bias refers to the tendency in food appreciation to emphasize certain sensory dimensions while neglecting the integrated nature of eating aesthetics, which arises from the combined effect of olfactory, visual, gustatory, tactile, and auditory perceptions. Alternatively, it may involve a misjudgment regarding the relative importance of these five senses.

The issue encompasses two primary aspects: sensory bias and the misweighting of five-sense aesthetic perception. This reveals a dual imbalance in the eating experience. Firstly, it manifests as a judgmental bias resulting from the dominance of a single sense and insufficient awareness of sensory synergy. Secondly, even when all five senses are engaged, there is frequent misidentification of the core sensory experiences. This phenomenon originates in the limitations of traditional aesthetic concepts, which fail to recognize eating as a holistic aesthetic activity integrating all five senses or to accurately assess the relative significance of visual and gustatory dimensions. Such a one-sided aesthetic approach diminishes the capacity for full culinary appreciation and shifts the focus of the eating experience away from its fundamental sensory foundations. Addressing this issue requires the systematic promotion of five-sense aesthetic theory, facilitating the establishment of a comprehensive cognitive framework for eating aesthetics and the correct identification of core sensory priorities, thereby enhancing holistic appreciation capabilities.

The quadrant analysis for five-sense aesthetic bias is shown below (see Table 4-45):

Table 4-45. Quadrant Analysis Table of Five-Sense Aesthetic Bias

Category	Content
Phenomenon	An imbalanced focus on selective sensory dimensions during eating, or an erroneous valuation of the aesthetic contributions among the five senses.
Cause	Constrained by traditional aesthetic paradigms, resulting in the neglect of holistic five-sense eating aesthetics or the misidentification of core sensory appreciation
Hazard	Undermining the capacity for comprehensive appreciation of food's multidimensional aesthetic qualities
Response	The systematic promotion and integration of five-sense eating aesthetic theory

4-3.2.1 Sensory Bias

Sensory bias [SI-1232100] constitutes a fifth-level issue within the food system issue framework, classified under five-sense aesthetic bias. It refers to situations where eaters, due to excessive reliance on a single sensory experience, neglect other sensory dimensions, resulting in imbalanced judgments about food.

This bias encompasses five aspects: taste bias (overemphasis on flavor), olfactory misguidance (smell substituting for quality assessment), visual bias (prioritizing appearance over nutrition), oral tactile bias (equating mouthfeel with overall quality), and auditory bias (misleading sensory marketing). Over-reliance on one sensory dimension—such as pursuing visual appeal or taste stimulation while ignoring aroma, texture, or sound—fragments the eating experience, reducing multidimensional appreciation to single-sense stimulation. This phenomenon originates from traditional aesthetic concepts that fail to recognize eating as a holistic multisensory activity. Addressing this requires promoting five-sense aesthetic theory, clarifying complementary sensory relationships—such as how aroma enhances taste or sound enriches texture—to rebuild a comprehensive framework for food appreciation.

The quadrant analysis for sensory bias is shown below (see Table 4-46):

Table 4-46. Quadrant Analysis Table of Sensory Bias

Category	Content
Phenomenon	An overreliance on a singular sensory modality during eating
Cause	Constrained by traditional aesthetic paradigms, resulting in the neglect of holistic five-sense eating aesthetics
Hazard	Undermining the capacity for comprehensive appreciation of food's multidimensional aesthetic qualities
Response	The advancement and dissemination of five-sense eating aesthetic theory

4-3.2.2 Misweighting of Five-Sense Aesthetic Perception

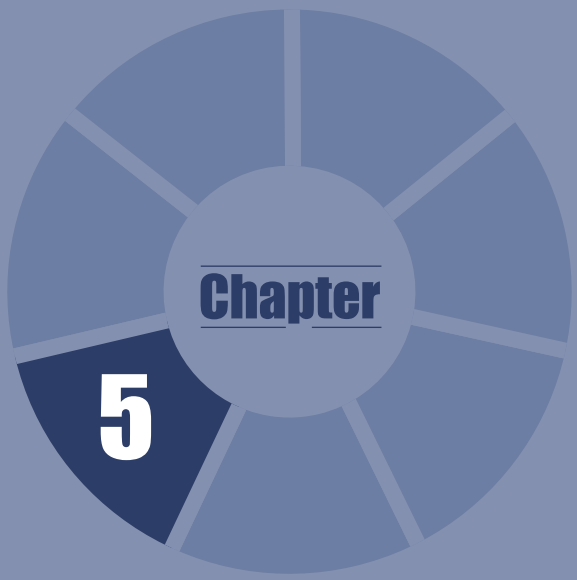
Misweighting of five-sense aesthetic perception [SI-1232200] constitutes a fifth-level issue within the food system issue framework, falling under five-sense aesthetic bias. It refers to eaters' disproportionate emphasis on visual aesthetics during consumption, failing to prioritize taste as the central sensory dimension.

This issue comprises two aspects: the overvaluation of visual aesthetics and the failure to recognize taste as the core aesthetic modality. Many mistakenly prioritize visual appeal as the primary experience, neglecting taste and smell—the senses most fundamentally linked to flavor perception. This cognitive distortion originates from traditional aesthetic hierarchies that mechanically rank "color, aroma, and taste," resulting in excessive focus on appearance at the expense of taste complexity and olfactory nuance. The bias diminishes capacity to appreciate food's core dimensions, superficializing the eating experience. Examples include pursuing meticulously plated but flavor-deficient dishes, or selecting visually trendy foods without regard for actual taste. Correction requires promoting five-sense aesthetic theory to establish scientific sensory weighting. While preserving visual appreciation, emphasis must return to taste-centric dietary evaluation, thereby enhancing both the quality and depth of eating experiences.

The quadrant analysis for misweighting of five-sense aesthetic perception is shown below (see Table 4-47):

Table 4-47. Quadrant Analysis Table of Misweighting of Five-Sense Aesthetic Perception

Category	Content
Phenomenon	An excessive prioritization of visual aesthetics at the expense of gustatory appreciation.
Cause	Constrained by traditional aesthetic paradigms, resulting in the misidentification of core sensory appreciation
Hazard	Undermining the capacity for comprehensive appreciation of food's core-dimensional qualities.
Response	The advancement and integration of five-sense eating aesthetic theory



Food-System Issues:

Eater Sustainability — Intergenerational Equity and Long-Term Supply

"Sustainable development" was defined by the Brundtland Commission as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [World Commission on Environment and Development, 1987]. It was further institutionalized as three interdependent and indivisible pillars—economic development, social development, and environmental protection—in the 2005 World Summit Outcome [UNGA, 2005], and operationalized within the overarching frame of People–Planet–Prosperity–Peace–Partnership in the 2030 Agenda adopted in 2015 [UNGA, 2015]. In this report, **eater sustainability** denotes whether the **aggregate population**, across generations, can obtain and use food in **stable, affordable, and predictable** ways under **institutional and structural guarantees**. Unlike the preceding chapters on **Eater Survival** and **Eater Health & Longevity**, the focus here is whether the **population as a whole** can sustain an institutionally and structurally supported **average condition** under recurrent fluctuations and episodic shocks, corresponding to the Five Eater Needs (5E) requirement of Sustainable Eating.

Against this benchmark, Eater Sustainability Issues constitute a Level-2 domain in our framework [SI-1300000]. They refer to population-level drivers and patterns that degrade the above condition. From an eater-centred perspective, we group these issues into **two overarching categories** and examine their **drivers, mechanisms, and hazards**: (i) intra-human (internal) conflict; and (ii) human–environment (external) conflicts.

- **Intra-human (internal) conflict:** failures of social order and economic functioning—insufficient governance coordination; gaps or uneven enforcement in laws and standards; weak education and research capacity; and distorted market structures. Acting primarily through the **social** and **economic** pillars, these problems reshape affordability, information and choice conditions, and the alignment between prices and incomes at the population level.
- **Human–environment (external) conflict:** persistent anthropogenic pressures that cause **structural degradation** of ecological space and configuration (conversion, encroachment, fragmentation) and **non-structural pollution** of environmental media (air, water, soil). Operating through availability and quality, connectivity, and volatility, these pressures alter the **environmental** pillar's support to population-average access and usability over the long term.

Table 5-1. Eater Sustainability Issues

Level 2	Level 3	Level 4	Level 5
Eater Sustainability Issues [SI-1300000]	1 Intra-Human (Internal) Conflict [SI-1310000]	1 Public Administration Issues in the Food System [SI-1311000]	1 Administrative Management Gaps [SI-1311100]
			2 Fragmented Administrative Mandates [SI-1311200]
			3 Insufficient Enforcement Capacity and Resources [SI-1311300]
			4 Population Management Issues [SI-1311400]
		2 Gaps in Laws and Standards for the Food System [SI-1312000]	1 Incomplete Coverage of Laws and Standards [SI-1312100]
			2 Lagging Updates of Laws and Standards [SI-1312200]
			3 Lack of Harmonized National Food Laws [SI-1312300]
			4 Absence of a Globally Applicable Food-System Convention [SI-1312400]
		3 The Failure of Education, Science, and Culture to Address Food System Unsustainability [SI-1313000]	1 Weak Public Food and Eating Education [SI-1313100]
			2 Insufficient Training Pipeline for Food-System Workers [SI-1313200]
			3 Missing Research Domains and Underinvestment [SI-1313300]
			4 Insufficient Protection and Dissemination of Exemplary Food Culture [SI-1313400]
			5 Cultural Norm Deviations or Conflicts [SI-1313500]
		4 External Shocks and Geopolitical Risks to the Food System [SI-1314000]	1 Geopolitical and Trade Shocks [SI-1314100]
			2 Major Epidemic/Pandemic Shocks [SI-1314200]
		5 Economically Unsustainable Development of the Food System [SI-1315000]	1 Insufficient Recognition of Food's Dual Nature (Commodity and Survival Necessity) [SI-1315100]
			2 Market Structure and Competition Imbalances [SI-1315200]
			3 Fragile Business Models [SI-1315300]
			4 Inequitable Income Distribution [SI-1315400]
			5 Failures of Price Mechanisms and Risk Management [SI-1315500]
			6 Insufficient Incentives and Safety-Net Mechanisms [SI-1315600]
			7 Externalized Environmental and Health Costs (Unpriced Externalities) [SI-1315700]
	2 Human–Environment (External) Conflict [SI-1320000]	1 Structural Ecosystem Degradation (Caused by Food-System Activities) [SI-1321000]	1 Occupation and Conversion of Natural Areas [SI-1321100]
			2 Fragmentation of Natural Landscape Patterns [SI-1321200]
			3 Alteration of Hydrological Processes and River–Lake Morphology [SI-1321300]
			4 Degradation of Soil Structure and Functions [SI-1321400]
			5 Coastal and Seabed Ecological Disturbance [SI-1321500]
			6 Biodiversity Decline and Biotic Imbalance [SI-1321600]
		2 Non-structural Ecosystem Degradation (Driven by Food-System Emissions and Loads) [SI-1322000]	1 Air Pollution [SI-1322100]
			2 Water Pollution [SI-1322200]
			3 Soil Pollution [SI-1322300]

The former corresponds primarily to the social and economic dimensions of sustainable development, while the latter pertains chiefly to the environmental dimension; together, they constitute the essential elements of sustainability. Intertwined, these two categories erode the carrying capacity and resilience of food systems, leaving a substantial gap from the target of eater sustainability. Accordingly, this chapter conducts a layered stocktake of eater sustainability issues and, using a quadrant schema (Phenomenon–Cause–Hazard–Response), proceeds top-down to the 3rd/4th/5th levels to delineate the problem landscape, salient phenomena, core drivers, and response modes, thereby establishing benchmarks for comparative assessment and country mapping in subsequent chapters.

5-1 Intra-Human (Internal) Conflict

Intra-Human (Internal) Conflict [SI-1310000] is a Level-3 issue within the food-system issue framework and falls under Eater Sustainability Issues.

This category refers to conflicts that arise within the food system—either between different population groups or between people and the institutional systems constructed and operated by humans (e.g., administration, law, education, science and technology)—due to divergent interests, rules, and cognitions. These conflicts occur primarily on the **social** and **economic** planes. They weaken food-system order and system resilience, increase governance costs and uncertainty, and thereby undermine the sustainable development of food systems.

The issue comprises five sub-items: Public Administration Issues; Gaps in Laws and Standards; The Failure of Education, Science, and Culture; External Shocks and Geopolitical Risks; and Economically Unsustainable Development. Distributed across the economic and social dimensions of the food system, these problems often interweave and amplify one another. Principal drivers include insufficient governance provision and fragmented mandates, gaps in the legal and standards system, and weak support in food education and research. On this basis, external shocks transmit through price, employment, and supply-chain channels and further magnify tensions, while distorted incentives and distribution deepen structural imbalances. As a result, the affordability and accessibility of healthy diets decline, nutritional inequality widens, and the order and resilience of the food system are weakened.

Figure 5-1. Framework of Intra-Human (Internal) Conflict



A response to such issues should take order-centred stewardship as the throughline: strengthening governance and the rule-of-law framework; improving cross-sectoral coordination and food education; establishing price-stabilization and strategic-reserve risk buffers; optimizing competition and distribution structures; and enhancing rules-based openness and international cooperation. The quadrant table for Intra-Human (Internal) Conflict is shown below (see Table 5-2).

Table 5-2. Quadrant Analysis of Intra-Human (Internal) Conflict

Category	Content
Phenomenon	Ongoing internal conflicts among eaters
Cause	Inadequate governance and support for food system order
Hazard	Rights of some eaters are impaired; system resilience and social trust decline
Response	Emphasize that food right is a basic human right; Take order as the hub, aligning institutional constraints with social cultivation

5-1.1 Public Administration Issues in the Food System

Public Administration Issues in the Food System [SI-1311000] is a Level-4 issue within the food-system issue framework, under Intra-Human (Internal) Conflict. It refers to institutional and capacity shortfalls in policy design, allocation of powers and responsibilities, cross-sectoral coordination, and public-service delivery, which result in incomplete governance coverage, constrained implementation, and inefficient collaboration. A central bottleneck is the absence of a unified food-governance lead agency or an effective coordinating mechanism—producing multi-headed management, overlapping mandates, and regulatory blind spots.

The issue comprises four sub-items: Administrative Management Gaps; Fragmented Administrative Mandates; Insufficient Enforcement Capacity and Resources; and Population Management Issues. Taken together, these sub-items exhibit structural features of unclear lines of authority and accountability, as well as under-provision of resources and personnel. Consequences include delayed decision-making and response, low efficiency in regulation and public services, uneven coverage of assistance, and erosion of social trust.

Governance should take the maintenance of food-system order as the guiding thread: establish (or clearly designate) a unified lead agency; clarify powers, responsibilities, and accountability; unblock information-sharing and coordination chains; strengthen frontline capacity and resource provision; improve population and data management; and build risk-buffer tools such as price-stabilization and strategic reserves. The quadrant analysis for Public Administration Issues in the Food System is as follows (see Table 5-3).

Table 5-3. Quadrant Analysis for Public Administration Issues in the Food System

Category	Content
Phenomenon	Dispersed management, inconsistent standards, and elongated implementation chains
Cause	Lack of unified leadership and coordination; fragmented powers and responsibilities; weak capacity and data foundations
Hazard	Delayed response; inefficient regulation and services; unstable supply and prices with episodic runs; declining order and resilience
Response	Establish (or strengthen) a unified lead; clarify powers, responsibilities, and accountability; enhance coordination and information-sharing; close frontline capacity and resource gaps

5-1.1.1 Administrative Management Gaps

Administrative Management Gaps [SI-1311100] is a Level-5 issue within the food-system issue framework, under Public Administration Issues in the Food System.

It refers to situations where, in the food-system domain, management functions or institutional arrangements have not been established, not been effectively empowered, or lack routinized operating mechanisms, creating vacancies and breakpoints along the governance chain—in plain terms, "no responsible agency, no mechanism, and no safeguard."

Typical manifestations include the absence or long-term non-operation of foundational mechanisms such as monitoring/early warning and strategic reserves; incomplete data indicators and information-disclosure regimes; missing performance evaluation and accountability chains; and lack of "last-mile" coverage in frontline public services. These gaps directly lead to delayed policy and emergency responses, failure of supply/price-stabilization tools, and inaccessibility of public services. Addressing this issue should focus on expanding the scope of food-system governance, refining responsibility lists, strengthening data and indicator regimes, and standardizing procedures and accountability mechanisms. The quadrant table for Administrative Management Gaps is as follows (see Table 5-4).

Table 5-4. Quadrant Analysis of Administrative Management Gaps

Category	Content
Phenomenon	Foundational mechanisms are missing; data and information regimes are incomplete; service chains exhibit breakpoints
Cause	Institutions not established or not empowered; insufficient routinized mechanisms; weak resource and data foundations.
Hazard	Delayed responses; failure of stabilization tools; insufficient coverage.
Response	Expand the scope of food-system governance; refine responsibilities, procedures, and associated regimes; standardize accountability mechanisms.

5-1.1.2 Fragmented Administrative Mandates

Fragmented Administrative Mandates [SI-1311200] is a Level-5 issue within the food-system issue framework, under Public Administration Issues in the Food System.

It refers to situations in which management and enforcement powers in the food-system domain are dispersed across multiple departments and tiers, without a

unified food-governance lead agency or a clearly designated and binding coordinating mechanism. Unlike Administrative Management Gaps, which highlight the absence of agencies or mechanisms, this issue emphasizes fragmentation of powers and responsibilities despite the existence of institutions—i.e., multi-headed arrangements that result in mandate splintering.

Typical manifestations include: agriculture, fisheries, and livestock supervised by different authorities; production–processing–distribution–food service managed in siloed stages; standard-setting separated from inspection/testing, licensing/certification, and market enforcement; and inconsistent scales and definitions across agencies. Direct consequences include multi-headed management and duplicative approvals, inconsistent enforcement and buck-passing, and misalignment between decision-making and execution, all of which reduce policy timeliness and governance efficiency. Addressing this problem requires establishing a unified food-governance lead agency or clearly designating a binding lead and coordinating mechanism, while simultaneously clarifying powers, responsibilities, and procedures in law, and advancing integration of standards and data.

The quadrant table for Fragmented Administrative Mandates is as follows (see Table 5-5):

Table 5-5. Quadrant Analysis of Fragmented Administrative Mandates

Category	Content
Phenomenon	Administrative powers are fragmented across different industries within the food system
Cause	Lack of a unified food-governance lead agency or a clearly designated, binding coordinating mechanism.
Hazard	Low policy timeliness and governance efficiency.
Response	Shift from fragmented to centralized management; refine responsibilities and procedures; strengthen information-sharing.

5-1.1.3 Insufficient Enforcement Capacity and Resources

Insufficient Enforcement Capacity and Resources [SI-1311300] is a Level-5 issue within the food-system issue framework, under Public Administration Issues in the Food System.

It refers to shortages of personnel, funding, equipment, and skills—as well as incomplete processes and tools—along the governmental implementation chain in key functions such as policy rollout, regulatory enforcement, monitoring and early warning, price/strategic-reserve adjustment, and emergency relief.

Typical manifestations include: weak frontline inspection and sampling capacity; insufficient or delayed budgets and earmarked funds; inadequate information systems and data capabilities; bottlenecks in mobilizing emergency supplies and reserves; and limited on-site cross-departmental coordination. Root causes typically involve chronic underinvestment and budget misallocation, shortages of specialized personnel and on-the-job training, weak digitalization, incomplete standard operating procedures and performance accountability, and deficits in field coordination and basic infrastructure. Consequences include sluggish policy response, reduced regulatory coverage and quality, and weakened effectiveness of price and supply-stabilization tools, which in turn impair eaters' rights and erode food-system order. Governance priorities should include aligning people and finance with responsibilities, strengthening capacity building and in-service training, closing gaps in testing and inspection infrastructure, improving data systems and digital platforms, and establishing flexible contingency funding, emergency posts, and mechanisms for cross-departmental information-sharing and coordination.

The quadrant table for Insufficient Enforcement Capacity and Resources is as follows (see Table 5-6):

Table 5-6. Quadrant Analysis of Insufficient Enforcement Capacity and Resources

Category	Content
Phenomenon	Insufficient frontline personnel, funding, equipment, and skills; incomplete processes and tools.
Cause	Underinvestment and budget misallocation; shortages in talent and training; weak digitalization; gaps in accountability.
Hazard	Low policy timeliness and governance efficiency.
Response	Under food-system administration: align people and finance with responsibilities; strengthen capacity building; provide in-service training.

5-1.1.4 Population Management Issues

Population Management Issues [SI-1311400] is a Level-5 issue within the food-system issue framework, under Public Administration Issues in the Food System.

It refers to the long-standing decoupling between population policy and food-system governance, whereby key population variables—size, structure, and migration—are not brought under unified coordination with grain and oil supply, prices and strategic reserves, nutrition, and public services. Root causes include the absence of a unified

lead and binding coordination mechanism, weak monitoring/early-warning and data foundations for population–food balance, and mismatches between spatial/industrial/public-service carrying capacity and demographic change. As a result, demand growth becomes decoupled from supply capacity; the people–grain co-increase dynamic approaches critical thresholds; and the affordability and accessibility of healthy diets are further undermined—widening nutritional inequality and weakening eaters' rights.

In terms of orientation, population management should be mainstreamed into food-system governance: designate a unified lead and coordination mechanism; build population–food balance monitoring, early-warning, and data platforms; and adjust fertility policy, migration and spatial planning, public services, and strategic reserves in a timely manner in line with population dynamics.

The quadrant table for Population Management Issues is as follows (see Table 5-7):

Table 5-7. Quadrant Analysis of Population Management Issues

Category	Content
Phenomenon	Population management and food-system governance operate in isolation from each other.
Cause	Lack of a unified coordination and data-monitoring system; mismatches between planning and carrying capacity.
Hazard	The people–grain co-increase approaches critical thresholds; affordability and accessibility are impaired.
Response	Mainstream population management into integrated governance and build monitoring/early-warning for population–food balance.

5-1.2 Gaps in Laws and Standards for the Food System

Gaps in Laws and Standards for the Food System [SI-1312000] is a Level-4 issue within the food-system issue framework, under Intra-Human (Internal) Conflict.

It refers to systemic shortfalls in the coverage, timeliness, and consistency of food-system laws and technical standards. This issue comprises four sub-items: Incomplete Coverage of Laws and Standards; Lagging Updates of Laws and Standards; Lack of Harmonized National Food Laws; and Absence of a Globally Applicable Food-System Convention. Overall features include insufficient rule supply, slow update mechanisms, domestic inconsistencies across levels and sectors, and limited cross-border mutual recognition.

Root causes, beyond limited legislative and standard-setting capacity, include weak cross-sectoral coordination, rapid technological and risk evolution outpacing regulatory response, and insufficient alignment with international rules. They also reflect incomplete system-level understanding of the food system and weak academic evidence bases, which together undermine risk assessment, indicator systems, and policy appraisal. Consequences include regulatory blind spots and rising risks, market fragmentation and greater trade frictions, and adverse impacts on the affordability and accessibility of healthy diets. Addressing this issue calls for completing and unifying the law–standard framework, establishing an evidence- and risk-based dynamic update mechanism, strengthening the relevant academic system and evidence generation, and enhancing alignment and mutual recognition with international rules.

The quadrant Analysis for Gaps in Laws and Standards for the Food System is as follows (see Table 5-8):

Table 5-8. Quadrant Analysis Table of Gaps in Laws and Standards

Category	Content
Phenomenon	Insufficient rule supply and slow update mechanisms.
Cause	Limited legislative and standard-setting capacity; incomplete system-level understanding of the food system; weak academic support.
Hazard	Regulatory blind spots and elevated risks; uneven enforcement and rising compliance costs.
Response	Complete and unify the law–standard framework; establish dynamic, evidence- and risk-based updating; strengthen academic system building.

5-1.2.1 Incomplete Coverage of Laws and Standards

Incomplete Coverage of Laws and Standards [SI-1312100] is a Level-5 issue within the food-system issue framework, under Gaps in Laws and Standards for the Food System.

It refers to legal vacuums or breaks in technical standards across several critical nodes of the food system, which makes it difficult to provide a complete, executable, and supervisable normative basis for governance and for market actors.

Typical manifestations include: lack of legal recognition and remedies for eaters' rights; incomplete objectives and tiered pathways for anti–food waste; gaps in labelling and traceability rules; and absence of minimum nutrition requirements for meals served in schools and institutions. The main causes lie in three aspects:

1. Missing system-level understanding — laws and standards remain framed around the "food product or a single stage," rather than placing production, use, and system order within one integrated framework, leading to omitted boundaries and intersections;
2. Missing integrated architecture — long-standing siloed (by department or by stage) rulemaking leaves domains operating in isolation and out of sync, creating "no one accountable" grey areas and coverage breakpoints;
3. Unstandardized key concepts and definitions, which hampers standard-setting, alignment, and mutual recognition.

The harm is a deficient regulatory foundation: at multiple critical nodes, governance and market actors lack a rule set that is enforceable and auditable, making it hard to form stable expectations and consistent practices. As mechanisms falter, food-system order and public trust are weakened. In orientation, efforts should adopt an eater-centred and holistic principle to carry out "coverage repair + system reconstruction": use a Shiology-based food-system framework to place acquisition–utilization–order under one coherent set of rules, and conduct a coverage audit of relevant laws and standards.

The quadrant analysis for Incomplete Coverage of Laws and Standards is as follows (see Table 5-9):

Table 5-9. Quadrant Analysis Table of Incomplete Coverage of Laws and Standards

Category	Content
Phenomenon	Legal vacuums or breaks in technical standards at several critical nodes of the food system.
Cause	Missing system-level understanding and corresponding architecture; lack of unified key concepts and definitions.
Hazard	Operational frictions at key nodes; difficulty forming stable expectations and consistent practices.
Response	Based on a Shiology-led food-system framework, implement "coverage repair + system reconstruction."

5-1.2.2 Lagging Updates of Laws and Standards

Lagging Updates of Laws and Standards [SI-1312200] is a Level-5 issue within the food-system issue framework, under Gaps in Laws and Standards for the Food System.

It refers to situations in which revisions to food-system laws and technical standards fall behind changes in technology, risk, and business models—creating a mismatch where

"old rules govern new problems."

The principal causes include: insufficient "food-system first" prioritization, which lengthens update cycles and leaves no forward-scanning or fast-track channels; long-standing siloed standard-setting (by department or by chain stage) with weak cross-chain interfaces, making synchronized updates difficult; non-harmonized key definitions and scopes, alongside the absence of mandatory data and indicator repositories, so that evidence is insufficient to support iterative updates; and weak academic-to-standards translation and international coordination.

Core harms manifest as out-of-date norms, unstable expectations, and poor interoperability: new technologies and practices cannot be normalized and adopted; inaccuracies in labelling/date information lead to improper resource handling; regional and cross-border acceptance is impeded; and the costs of institutional learning and adjustment rise—eroding food-system order and public credibility.

In orientation, a dynamic-updating system should be built from a Shiology-informed (eater-centred, holistic) perspective: establish a national standards catalogue with version control; implement periodic reviews and risk-tiered fast-track update channels; and affirm a "food-system priority" principle that places the drafting, revision, and review of relevant laws and standards high on the policy agenda.

The quadrant table for Lagging Updates of Laws and Standards is as follows (see Table 5-10):

Table 5-10. Quadrant Analysis Table of Lagging Updates of Laws and Standards

Category	Content
Phenomenon	The revision speed and methods of food-system laws and technical standards lag behind real-world changes.
Cause	Insufficient "food-system first" prioritization; long update cycles; lack of forward-looking scans and fast-track channels.
Hazard	Out-of-date norms that weaken food-system order and credibility.
Response	Build a dynamic-updating system grounded in the Shiology knowledge framework.

5-1.2.3 Lack of Harmonized National Food Laws

Lack of Harmonized National Food Laws [SI-1312300] is a Level-5 issue within the food-system issue framework, under Gaps in Laws and Standards for the Food System.

It refers to situations in which food-system–related laws within the same country are inconsistent or even conflicting, including divergences between central and subnational levels and across regions. Given the breadth of food-related legislation, if ministries draft laws solely from their own sectoral standpoint, they often overlook the integrated needs of acquisition–utilization–order, leading—by way of example—to "food-safety" laws and "agriculture" laws (titles vary by country) speaking past one another in goals, scope, and key definitions; similar disparities readily arise between central and local texts and across regions.

Root causes include the absence of an integrated legislative framework and shared understanding, long-standing siloed drafting by separate departments that leaves interfaces and boundaries undesigned, non-standardized key terms and non-aligned data/indicator catalogues, and asynchronous revision cycles—all of which hinder cross-sector and cross-jurisdiction alignment. Consequences include divergent interpretations among departments/regions, mutual constraint or gaps between central and local arrangements, and coordination failures for cross-chain measures such as price/strategic reserves and nutrition provisioning. Governance should adopt a Shiology-informed, system-wide perspective to establish a national food-system framework law, standardize terminology and classification, create a national standards catalogue with conflict-clearing/alignment and version management mechanisms, clarify legal hierarchy and order of application, and underpin cross-sector and multi-level updates with national baseline thresholds, regional equivalence/mutual recognition, and unified data/indicator foundations.

The quadrant analysis for Lack of Harmonized National Food Laws is as follows (see Table 5-11):

Table 5-11. Quadrant Analysis Table of Lack of Harmonized National Food Laws

Category	Content
Phenomenon	Food-system laws are non-uniform—or even conflicting—across departments, regions, and between central and local levels.
Cause	Lack of an integrated legislative framework and shared understanding; long-term siloed drafting by departments.
Hazard	Divergent interpretations by departments/regions; mutual constraints or gaps between central and local arrangements.
Response	From a holistic perspective, establish a national food-system framework law and standardize terminology and classification.

5-1.2.4 Absence of a Globally Applicable Food-System Convention

Absence of a Globally Applicable Food-System Convention [SI-1312400] is a Level-5 issue within the food-system issue framework, under Gaps in Laws and Standards for the Food System.

It refers to the current lack of a universally applicable, framework-level convention that can govern the food system's integrated triad of acquisition–utilization–order at the global scale. At present, food-system rules are largely developed separately by individual countries or regions, making it difficult to deliver a unified response to cross-border, cross-chain, and cross-disciplinary common challenges. Existing international documents are limited in number and fragmented; many take the form of declaratory principles or soft law. In the absence of binding global enforcement and coordination mechanisms, these rules often remain at the level of principles and initiatives rather than being translated into operable and sustainable international cooperation.

Meanwhile, interactions among countries and regions are intensifying, and new agenda items keep emerging—supply-chain shocks, temporary export restrictions, cross-border e-commerce and platform governance, food loss and waste, nutrition and public provisioning, resource recovery and circularity, and antimicrobial resistance, among others. These challenges surpass single-sovereign boundaries and exceed the remit of any one sector.

Given this, building a globally applicable convention system for food systems is imperative. A framework convention should integrate acquisition–utilization–order, articulate the right to adequate and healthy food together with risk- and evidence-based principles, standardize key terminology and indicator definitions, and establish international data and assessment foundations. The framework can be complemented by topic-specific protocols—in areas such as food safety, loss and waste reduction and redistribution, nutrition and public provisioning, emergency response and strategic reserves, resource circularity, and digital/cross-border transactions—to progressively enable alignment and mutual recognition. In parallel, compliance facilitation and capacity building should underpin an iterative and collaborative global governance architecture. This is essential not only for predictability and interoperability of rules, but also for safeguarding food-system order and the global public interest.

The quadrant table for Absence of a Globally Applicable Food-System Convention is as follows (see Table 5-12):

Table 5-12. Quadrant Analysis Table of Absence of a Globally Applicable Food-System Convention

Category	Content
Phenomenon	Absence of a globally applicable and binding framework convention; rules are fragmented and "soft-law" in character.
Cause	Relevant rules are primarily developed separately by individual countries or regions.
Hazard	Insufficient cross-border coordination; in emergencies, fragmented unilateral actions; weak concerted effort in addressing systemic problems (e.g., hunger).
Response	Establish a universally applicable, framework-level convention for the food system at the global scale.

5-1.3 The Failure of Education, Science, and Culture to Address Food System Unsustainability

The Failure of Education, Science, and Culture to Address Food System Unsustainability [SI-1313000] is a Level-4 issue within the food-system issue framework, under Intra-Human (Internal) Conflict.

It denotes that education supply, research capacity, and the cultural ecosystem are, in aggregate, insufficient to support the long-term stability and transformation of food systems. This issue comprises five sub-issues: Weak Public Food and Eating Education; Insufficient Training Pipeline for Food-System Workers; Missing Research Domains and Underinvestment; Insufficient Protection and Dissemination of Exemplary Food Culture; and Cultural Norm Deviations or Conflicts.

At a macro level, the main causes are threefold: (1) insufficient system-level recognition and prioritization of food systems on national and societal agendas, leading to long-term underinvestment; (2) incomplete dual recognition of food education—education for eaters has long been neglected, while education for practitioners lacks system-wide design; and (3) a fragile cultural ecosystem, with inadequate preservation and modern dissemination of high-quality food-related culture. The core hazard is the weakening of the knowledge and cultural underpinnings of food systems, which results in limited public understanding of food-and-health issues and persistent shortages of relevant talent, thereby affecting eaters' survival and health. Consequences include regulatory blind spots and rising risks, market fragmentation and greater trade frictions, and adverse impacts on the affordability and accessibility of healthy diets.

In orientation, food systems should be elevated on national and societal agendas, while both ends of education are strengthened in parallel—systematic public food education for eaters and vocational education plus in-service training for practitioners—accompanied by expanded, aligned investment in science/technology and culture.

The quadrant table for The Failure of Education, Science, and Culture to Address Food System Unsustainability is as follows (see Table 5-13):

Table 5-13. Quadrant Analysis Table of The Failure of Education, Science, and Culture to Address Food System Unsustainability

Category	Content
Phenomenon	Education supply, research capacity, and the cultural ecosystem are, overall, unable to sustain the long-term stability and transformation of food systems.
Cause	Insufficient recognition and prioritization of food systems on national and societal agendas; fragile cultural ecosystem.
Hazard	Limited public understanding of food-and-health; persistent shortages of relevant talent, undermining eaters' survival and health.
Response	Prioritize food systems on national and societal agendas; strengthen education at both ends; expand aligned investments in science/technology and culture.

5-1.3.1 Weak Public Food and Eating Education

Weak Public Food and Eating Education [SI-1313100] is a Level-5 issue within the food-system issue framework, under The Failure of Education, Science, and Culture to Address Food System Unsustainability.

It refers to the absence of a systematized, population-wide, life-course food-and-eating education system in some countries: school curricula are missing or fragmented; continuing education for adults and older persons is insufficient; teacher training and teaching-material systems are thin; and public awareness of "body–food coupling" is low.

The principal causes are that, in some countries, education for eaters has not been mainstreamed into national and societal agendas or embedded in statutory systems; unified norms and a complete instructional framework are lacking; and the topic has not been systematically incorporated into general education. Direct consequences include a poor match between individual dietary behaviors and physiological needs, leading to shortened healthy life expectancy, a higher burden of diet-related diseases, and rising social healthcare costs. Accordingly, policies should mainstream food-and-

eating education and place it high on the agenda: establish a life-course, multi-setting framework (preschool, compulsory education, community, workplace, etc.); define age-specific learning goals and core competencies; strengthen teacher pipelines and curricular resources; and promote dietary guidelines based on "body–food coupling" to enhance public literacy in methods of eating.

The quadrant table for Weak Public Food and Eating Education is as follows (see Table 5-14):

Table 5-14. Quadrant Analysis of Weak Public Food and Eating Education

Category	Content
Phenomenon	No population-wide, life-course, systematized food-and-eating education in place.
Cause	Eater education is not integrated into national/societal agendas or statutory systems; lack of unified norms and a complete instructional framework.
Hazard	Healthy life expectancy constrained; rising burden of diet-related diseases and higher social healthcare costs.
Response	Mainstream food-and-eating education and place it in the policy priority sequence.

5-1.3.2 Insufficient Training Pipeline for Food-System Workers

Insufficient Training Pipeline for Food-System Workers [SI-1313200] is a Level-5 issue within the food-system issue framework, under The Failure of Education, Science, and Culture to Address Food System Unsustainability.

It refers to the fact that, although most countries offer education for food-system workers, content and pathways are fragmented and siloed, and there is still no integrated training system that spans the three domains of food acquisition—food utilization—food-system order. Resources and curricula are over-concentrated in "acquisition" (e.g., agriculture, fisheries/livestock, primary processing), while education supply is clearly insufficient in "use" (processing, distribution, food service, nutrition and public provisioning) and "order" (governance, traceability, risk management, loss/waste reduction, market and price mechanisms), producing a structural imbalance.

The root causes lie in discipline- and department-led curriculum design over long periods; the absence of a national occupational competency framework and shared core competencies; weak articulation between vocational education, higher education, and in-service training; and insufficient industry participation and demand-feedback

mechanisms. Harms include fragmented skill structures, mismatches between job requirements and worker capabilities, and shortages of talent in specific domains.

Accordingly, systems should establish an end-to-end, integrated competency framework and tiered curricula covering the full chain; promote co-development across faculties, disciplines, and departments; build school–industry collaboration and practice/apprenticeship pathways; and embed cross-cutting core competencies—food safety, loss and waste reduction, traceability, and digital technologies—into the main training tracks to improve system fitness and capacity for sustainable transformation.

The quadrant table for Insufficient Training Pipeline for Food-System Workers is as follows (see Table 5-15):

Table 5-15. Quadrant Analysis of Insufficient Training Pipeline for Food-System Workers

Category	Content
Phenomenon	Training pipelines do not integrate acquisition–utilization–order; structural over-specialization persists.
Cause	Absence of a national occupational competency framework.
Hazard	Fragmented skills, job–capability mismatches, and talent shortages in certain fields.
Response	Build an integrated, full-chain competency framework with tiered curricula; advance cross-faculty/discipline/department co-development.

5-1.3.3 Missing Research Domains and Underinvestment

Missing Research Domains and Underinvestment [SI-1313300] is a Level-5 issue within the food-system issue framework, under The Failure of Education, Science, and Culture to Address Food System Unsustainability.

It denotes a long-standing pattern in which food-system research advances along disciplinary or sectoral silos, lacking an integrated agenda with stable investment that spans food acquisition—food utilization—food-system order. As a result, critical directions are undersupplied and knowledge translation is slow. Typical manifestations include: research topics split across agricultural science, food science, public health, etc., without an overarching architecture; insufficient system-level understanding of inter-individual physiological differences (interventions in practice often rely only on height/weight or organ indices, overlooking eater somatotype and other individual differences); weak inquiry into "eating–brain" mechanisms; and conspicuous gaps in

public provisioning and institutional nutrition, food loss and waste/resource recovery, digitalization and data infrastructures, and legal/governance evaluation.

Principal causes include the low overall prioritization of food-system research on national and societal agendas; topic setting and evaluation biased toward short-term outputs; and inadequate cross-disciplinary organization and longitudinal cohorts. The harms are: fragile evidence chains for policy and standards; lagging personalized dietary management; and rising social costs from chronic and nutrition-related diseases—collectively undermining food-system order and resilience. In orientation, food-system research should be elevated to a strategic priority: redesign national research agendas from a holistic perspective, establish multi-year, stable funding, and prioritize domains related to eater health and longevity.

The quadrant table for Missing Research Domains and Underinvestment is as follows (see Table 5-16):

Table 5-16. Quadrant Analysis of Missing Research Domains and Underinvestment

Category	Content
Phenomenon	Siloed research lines; gaps in critical directions (e.g., inter-individual differences and eating–brain mechanisms).
Cause	Low overall prioritization; evaluation biased to the short term; insufficient cross-disciplinary organization and long-term cohorts.
Hazard	Fragile evidence chains; lagging personalized management; slower diffusion of innovation.
Response	Elevate food-system research to a strategic priority; rebuild the national agenda holistically; institute multi-year stable funding with emphasis on eater health and longevity.

5-1.3.4 Insufficient Protection and Dissemination of Exemplary Food Culture

Insufficient Protection and Dissemination of Exemplary Food Culture [SI-1313400] is a Level-5 issue within the food-system issue framework, under The Failure of Education, Science, and Culture to Address Food System Unsustainability.

It refers to inadequate efforts to identify, document, transmit, and communicate exemplary food-related culture and agri-food heritage (e.g., civility, cleanliness, frugality, moderation, health-promoting practices), such that sustainable, adoptable, and routinized mechanisms have not been formed. Manifestations include "campaign-

style, short-cycle" advocacy of positive food customs that is prone to distortion; homogenization and broken inheritance chains for intangible techniques and local flavors; insufficient protection of agri-food heritage (e.g., terraces, fish–salt traditions, fermentation systems); limited embedding in school curricula and public institutions; and high-quality communication diluted by algorithm-optimized, engagement-chasing narratives.

At the macro level, causes include the failure to mainstream food culture and agri-food heritage into national and societal agendas and statutory frameworks, the absence of unified standards and sustained mechanisms, and weak "modern translation" capacity—i.e., difficulty connecting traditional practices with contemporary life-settings. Direct consequences are loss of cultural diversity and social memory; positive customs such as frugality and cleanliness fail to settle into stable social norms; and social uptake of waste reduction and healthy diets declines.

Accordingly, policies should mainstream the protection of exemplary culture and agri-food heritage; establish integrated identification procedures and a national registry; systematically embed related courses in general and vocational education; build platforms for "modern translation" to interface exemplary customs and traditional techniques with contemporary life and produce operational guidelines; and improve Geographical Indications (GI) evaluation mechanisms to enhance social uptake and intergenerational transmission.

The quadrant table for Insufficient Protection and Dissemination of Exemplary Food Culture is as follows (see Table 5-17):

Table 5-17. Quadrant Analysis of Insufficient Protection and Dissemination of Exemplary Food Culture

Category	Content
Phenomenon	Insufficient identification, documentation, transmission, and modern communication of exemplary food customs and traditional techniques.
Cause	Not mainstreamed into national/societal agendas or statutory frameworks; lack of unified standards and sustained mechanisms; weak capacity for "modern translation."
Hazard	Loss of cultural diversity and social memory; positive food customs fail to consolidate into stable social norms.
Response	Mainstream protection of exemplary culture and agri-food heritage; build "modern translation" platforms.

5-1.3.5 Cultural Norm Deviations or Conflicts

Cultural Norm Deviations or Conflicts [SI-1313500] is a Level-5 issue within the food-system issue framework, under The Failure of Education, Science, and Culture to Address Food System Unsustainability.

It denotes the social diffusion of beliefs and behaviors that deviate from exemplary food customs and scientific principles, and the resulting value clashes across groups, regions, and generations. On one side, wasteful extravagance, sensationalist novelty-seeking consumption, and algorithm-driven, engagement-maximizing dissemination run counter to the exemplary norms of civility, cleanliness, frugality, moderation, and health. On the other, differences in taboos, aesthetics, and identity across groups, regions, and generations are amplified into confrontation and resistance. Salient manifestations concentrate in the "five detrimental customs"—waste, ostentation, sensationalism, uncleanliness, and superstition: lavish banquets and status-signalling consumption (face-saving banquets) that generate large volumes of leftovers and packaging waste; equating luxury tableware, staging, and excessive ornamentation with quality; consuming rare wild flora and fauna under the banner of novelty; neglect of cleanliness and cross-contamination; and reliance on pseudo-science and quick fixes in lieu of evidence-based dietary practice.

Root causes include under-prioritization of cultural governance and food-and-eating education, an imbalance between rule-of-law tools and social norms, platform and engagement incentives that amplify sensationalism and status competition, and the lack of contemporary reframing and translation (of traditional norms into current life settings) within general education. Harms span ethics and health: heightened resource waste and environmental damage, biodiversity loss and elevated zoonotic risks, misguided dietary decisions and rising healthcare burdens, and the fueling of status competition and social division.

Accordingly, policy should mainstream food-culture governance and anchor it in the values of civility, cleanliness, frugality, moderation, and health, adopting a combined strategy of institutional constraints plus social cultivation (food-and-eating education), alongside high-quality public communication (e.g., table etiquette before meals).

The quadrant table for Cultural Norm Deviations or Conflicts is as follows (see Table 5-18):

Table 5-18. Quadrant Analysis of Cultural Norm Deviations or Conflicts

Category	Content
Phenomenon	Beliefs and behaviors that deviate from exemplary food customs and scientific principles spread socially, provoking value clashes and confrontation.
Cause	Cultural governance and food-and-eating education are under-prioritized; imbalance between rule-of-law instruments and social norms.
Hazard	Increased resource waste and environmental damage; misguided dietary decisions and higher healthcare burdens.
Response	A combined strategy of institutional constraints + social cultivation (food-and-eating education), with high-quality public communication.

5-1.4 External Shocks and Geopolitical Risks to the Food System

External Shocks and Geopolitical Risks to the Food System [SI-1314000] is a Level-4 issue within the food-system issue framework, under Intra-Human (Internal) Conflict.

It refers to sudden, exogenous, event-driven shocks—including domestic or international policy games and trade measures, as well as major epidemic events—that are rapidly transmitted to the food system via trade, energy, finance, and shipping/cold-chain channels, resulting in disrupted supply, higher costs, and reduced affordability and accessibility. This issue comprises two sub-issues: Geopolitical and Trade Shocks and Major Epidemic/Pandemic Shocks. In essence, these are short-term, high-intensity pressures on the system; their impact magnitude depends on the adequacy of national buffering devices—monitoring and early-warning, strategic reserves, price-stabilization, and emergency logistics—and on whether there exists an inclusive, globally unified food-system order that accounts for everyone.

The quadrant table for External Shocks and Geopolitical Risks to the Food System is as follows (see Table 5-19):

Table 5-19. Quadrant Analysis of External Shocks and Geopolitical Risks to the Food System

Category	Content
Phenomenon	External shocks occur frequently and propagate rapidly, increasing volatility in supply and prices.
Cause	Absence of an inclusive, globally unified food-system order; insufficient domestic emergency-buffer capacity.
Hazard	Disrupted food supply, rising costs, and declines in affordability and accessibility.
Response	Internationally, build an inclusive, globally unified food-system order; nationally, reinforce an integrated monitoring/early-warning, strategic-reserve, and price-stabilization toolkit.

5-1.4.1 Geopolitical and Trade Shocks

Geopolitical and Trade Shocks [SI-1314100] is a Level-5 issue within the food-system issue framework, under External Shocks and Geopolitical Risks to the Food System.

It refers to wars (including armed conflicts) or trade measures (e.g., sanctions, export restrictions, tariff quotas, port/route disruptions) that are sudden, exogenous, and event-driven, and that propagate rapidly to the food system via trade, energy, finance, and shipping/cold-chain channels—resulting in disrupted supply, rising costs, and unstable expectations.

Root causes include the absence of an inclusive, coordinated food-system order and crisis-response mechanisms at the international level (insufficient common rules, equivalence/mutual recognition, and emergency coordination), high dependence on single sources or critical nodes in some economies, and incomplete domestic buffers such as monitoring/early-warning–strategic reserves–price-stabilization arrangements. Harms manifest as declines in the affordability and accessibility of healthy diets, heightened price volatility, and widening regional and group disparities.

In orientation, the international level should advance rules-based cooperation (e.g., "green channels" for staple foods, data transparency), while the national level should strengthen the monitoring/early-warning–strategic reserve–price-stabilization toolkit, diversify sources and shipping routes and build redundancy at critical nodes, establish emergency logistics corridors, and deploy risk communication and food-and-eating education to curb panic buying and waste.

The quadrant table for Geopolitical and Trade Shocks is as follows (see Table 5-20):

Table 5-20. Quadrant Analysis of Geopolitical and Trade Shocks

Category	Content
Phenomenon	Wars or trade measures trigger transmission; supply interruptions and price turbulence follow.
Cause	Insufficient global unified order and coordination; high single-source dependence; incomplete domestic buffers.
Hazard	Impaired affordability/accessibility; widening disparities; declining food order and resilience.
Response	International rules coordination (green channels, mutual recognition, information sharing) + domestic monitoring–reserves–stabilization mechanism.

5-1.4.2 Major Epidemic/Pandemic Shocks

Major Epidemic/Pandemic Shocks [SI-1314200] is a Level-5 issue within the food-system issue framework, under External Shocks and Geopolitical Risks to the Food System.

It refers to sudden, high-impact infectious-disease events—occurring within a single country, across multiple countries, or at global pandemic scale (including major animal diseases closely linked to the food system)—that rapidly spill over to the food system via channels such as labor supply, human and logistics mobility, cold-chain and port/point-of-entry management, and market demand and policy response. The result is phase-specific yet pronounced supply disruptions, rising costs, and unstable expectations.

By nature these are exogenous, event-driven acute pressures. Amplifying factors include: the absence of an inclusive, globally unified food-system order; incomplete domestic buffers (e.g., monitoring/early-warning–strategic reserve–price-stabilization arrangements); insufficient public-health and biosecurity capacity; limited data transparency and risk communication, which more easily trigger panic behavior and resource misallocation. Harms manifest as declines in the affordability and accessibility of healthy diets, widening nutritional inequality, heightened price volatility, growing regional and group disparities, and weakened production and investment expectations.

In orientation, the international level should advance rules-based cooperation, including harmonized key terminology and notification mechanisms and "green channels" for staples; the national level should strengthen the monitoring/early-warning–strategic reserve–price-stabilization toolkit, diversify sources and routes with redundancy at critical nodes, build emergency logistics corridors, reinforce public-health and biosecurity capacity, and use risk communication and food-and-eating education to curb panic consumption and waste, thereby improving society's self-adjustment capacity.

The quadrant table for Major Epidemic/Pandemic Shocks is as follows (see Table 5-21):

Table 5-21. Quadrant Analysis of Major Epidemic/Pandemic Shocks

Category	Content
Phenomenon	Disease outbreaks transmit rapidly via human flows/logistics/cold chains, causing supply interruptions and price turbulence.
Cause	Insufficient global coordination and mutual recognition; weak domestic buffers and emergency governance; gaps in public health and risk communication.
Hazard	Impaired affordability/accessibility; widening disparities; declining food order and resilience.
Response	International rules coordination (green channels, information sharing) + domestic monitoring–reserves–stabilization mechanism.

5-1.5 Economically Unsustainable Development of the Food System

Economically Unsustainable Development of the Food System [SI-1315000] is a Level-4 issue within the food-system issue framework, under Intra-Human (Internal) Conflict.

It refers to patterns in production, distribution, and consumption where market structure, price mechanisms, and incentive design are oriented toward short-term efficiency and profit maximization, while failing to account for the dual nature of food—both a market commodity and a survival necessity—thereby undermining long-term, stable, and inclusive growth. This issue comprises seven sub-items: Insufficient Recognition of Food's Dual Nature (Commodity and Survival Necessity); Market Structure and Competition Imbalances; Fragile Business Models; Inequitable Income Distribution; Failures of Price Mechanisms and Risk Management; Insufficient Incentives and Safety-Net Mechanisms; and Externalized Environmental and Health Costs (Unpriced Externalities).

These dynamics produce a "concentrated yet fragmented" paradox. On the one hand, a small number of multinational and large actors dominate critical segments—production, processing, transport, and trade—leading to excessive concentration of bargaining and pricing power. On the other hand, shared, chain-spanning rules and coordination arrangements are lacking across and within countries, so information, prices, and risks are not effectively aligned. As a result, price and risk transmit asymmetrically between upstream and downstream, with weaker actors bearing greater pressure; public investment in data infrastructures, cold chains, reserves, research, and nutrition/social protection remains inadequate; and environmental damage and health losses are kept off corporate balance sheets, accumulating as hidden liabilities.

Underlying causes include insufficient recognition of food as a survival necessity, the absence of unified and interoperable institutional supply, and excessive market power at critical nodes. Consequences are declines in the affordability and accessibility of healthy diets, widening regional and group disparities, weakened willingness of firms and farmers to invest long-term or undertake green transitions (leaving business models more shock-prone), and continued accumulation of environmental and health costs, which together erode the sustainability of economic development. Moving toward sustainability requires adopting food's dual nature as a baseline: establish fairer, more orderly rules for competition, pricing, and risk sharing, while closing public-investment gaps in data, reserves, cold chains, research, and social protection.

The quadrant table for Economically Unsustainable Development of the Food System is as follows (see Table 5-22):

Table 5-22. Quadrant Analysis of Economically Unsustainable Development of the Food System

Category	Content
Phenomenon	Structural concentration with fragmented rules; asymmetric transmission of prices and risks along the chain.
Cause	Insufficient recognition of food's dual nature as both commodity and survival necessity.
Hazard	Declining affordability and accessibility of healthy diets.
Response	Use food's dual nature as a baseline: build fair, orderly rules for competition, pricing, and risk sharing, and close public-investment gaps.

5-1.5.1 Insufficient Recognition of Food's Dual Nature

Insufficient Recognition of Food's Dual Nature (Commodity and Survival Necessity) [SI-1315100] is a Level-5 issue within the food-system issue framework, under Economically Unsustainable Development of the Food System.

It refers to the long-standing tendency of policy and markets to treat food as an ordinary commodity, neglecting its baseline attribute as a survival necessity. As a result, objectives skew toward short-term efficiency and profit. Typical manifestations include price as the sole "commanding signal," underinvestment in foundational functions such as public reserves, price stabilization, risk sharing, cold-chain and data infrastructures, and the marginalization of nutrition and loss-reduction requirements. Consequences include declines in affordability and accessibility—with disproportionate impacts on vulnerable groups—amplified volatility, weakened expectations, and erosion of social trust and system resilience.

In orientation, "food as a survival necessity" should be established as a foundational principle for the food-related economy: reset governance objectives; strengthen an integrated mechanism of monitoring–reserves–price stabilization–risk sharing; and embed nutrition and loss-reduction requirements into public procurement and market rules—thereby restoring a sustainable development path for the food-system economy that balances efficiency and equity.

The quadrant table for Insufficient Recognition of Food's Dual Nature (Commodity and Survival Necessity) is as follows (see Table 5-23):

Table 5-23. Quadrant Analysis of Insufficient Recognition of Food's Dual Nature

Category	Content
Phenomenon	Food is treated as an ordinary commodity; price–profit becomes the single commanding signal.
Cause	Lack of top-level design and legal confirmation that "food is a survival necessity" as an institutional principle.
Hazard	Affordability and accessibility decline; volatility rises with greater harm to vulnerable groups.
Response	Establish "food as a survival necessity" as a foundational principle and embed it in laws and planning.

5-1.5.2 Market Structure and Competition Imbalances

Market Structure and Competition Imbalances [SI-1315200] is a Level-5 issue within the food-system issue framework, under Economically Unsustainable Development of the Food System.

Its core manifestation is high concentration: over time, global agricultural trade and related segments (production, processing, transport, settlement, and retail) have come under the control of a small number of multinational actors through capital, network, and scale effects, yielding de facto control of critical nodes and pricing power. Meanwhile, although international coordination bodies have mandates for relief and stabilization, limited authorities and rule tools make it difficult to correct this imbalance at the root.

The results are compressed competitive space, asymmetric transmission of prices and risks along the chain (with small and medium-sized enterprises (SMEs) bearing greater pressure), narrower consumer choice, greater sensitivity to external shocks, and declines in affordability and accessibility. Mitigation requires rules-based, order-oriented fair competition with improved coordination rules domestically and internationally: at the international level, advance more operational competition and transparency frameworks; at the national level, close public-infrastructure gaps (data and price information, cold chains and reserves, risk-sharing and stabilization tools), and promote multi-sourcing, multi-routing, and regional cooperation, gradually realigning market efficiency with the public interest.

The quadrant table for Market Structure and Competition Imbalances is as follows (see Table 5-24):

Table 5-24. Quadrant Analysis of Market Structure and Competition Imbalances

Category	Content
Phenomenon	High concentration in critical global and domestic segments; a few actors hold key nodes and pricing power.
Cause	Scale and network effects drive concentration; high dependence on critical nodes; insufficient cross-border and domestic rules for competition and coordination.
Hazard	Declining affordability and accessibility of healthy diets; amplified price volatility; SMEs squeezed; widening regional gaps.
Response	Establish "food as a survival necessity" as a baseline and, under rules-based, order-oriented fair competition, strengthen coordination rules at home and abroad.

5-1.5.3 Fragile Business Models

Fragile Business Models [SI-1315300] is a Level-5 issue within the food-system issue framework, under Economically Unsustainable Development of the Food System.

It refers to the condition faced by small-scale, dispersed farm operators who are persistently low-margin, volatility-prone, and weakly shock-resilient: they are price takers and find it difficult to pass through rising input costs; perishability and fast-changing market conditions compound exposure; and when confronted with wars or trade shocks, major epidemics/pandemics, or extreme weather, cash flows are easily broken, leading to output cuts, crop abandonment, or forced exit.

The consequences are not only unstable household incomes and declining intergenerational continuity, but also weaker local supply stability and affordability, thereby undermining food-system order and resilience. In orientation, an order-centred approach should "hold the floor" through more predictable price and risk arrangements and stronger basic conditions: on one hand, deploy purchase orders and long-term contracts, moderate reserves and price-stabilization tools, together with inclusive credit and basic insurance, to cushion the impact of market swings on farmers; on the other, close infrastructure gaps in on-farm storage and basic cold chains, rural logistics and information services; strengthen cooperatives and production–marketing linkages; set stable channels in public procurement (e.g., schools and institutions); and build capacity in cost management and moderate diversification of varieties and timing—helping smallholders shift from "low-margin and brittle" to "steady and sustainable."

The quadrant table for Fragile Business Models is as follows (see Table 5-25):

Table 5-25. Quadrant Analysis of Fragile Business Models

Category	Content
Phenomenon	Small-scale, dispersed operations with persistent low margin – high volatility – weak shock resistance.
Cause	Small scale and weak bargaining power; inadequate basics in storage/cold chain, logistics, and information; limited finance and insurance coverage; overly single crops and sales channels.
Hazard	More output cuts, crop abandonment, and exits; unstable local supply.
Response	Combine purchase orders/long-term contracts, moderate reserves and price stabilization, and basic insurance; strengthen cooperatives and production–marketing linkages; expand public procurement channels.

5-1.5.4 Inequitable Income Distribution

Inequitable Income Distribution [SI-1315400] is a Level-5 issue within the food-system issue framework, under Economically Unsustainable Development of the Food System.

It refers to uneven value distribution along the chain, whereby upstream producers—especially smallholders and frontline workers—receive a low and volatile share, while midstream actors and channels capture higher and more stable returns due to concentration and bargaining advantages. This skews price signals: food prices are pushed below the necessary costs of producing quality food, making them unable to reflect intrinsic value and quality requirements.

The most serious harm is quality deterioration and the induction of a "negative loop" in the food economy: prices that appear to "hurt farmers" in fact also hurt consumers. When producers cannot cover the costs required for quality inputs, they down-spec, underinvest, or exit, damaging both the quantity and quality of supply. Consumers then face less stable, lower-quality products and higher health risks, while society pays larger hidden costs and suffers trust erosion. Over time, a low-price——low investment——low quality——weakening demand——further price suppression cycle becomes entrenched, pushing down system resilience and the willingness to invest long term.

Governance should be order-centred, restoring the correct correspondence between price, value, and quality:

1. Build a verifiable cost–quality data foundation with public disclosure; promote tiered/graduated pricing and quality-premium rules to keep prices from falling below the costs of quality.

2. Improve fair trading and timely payment; expand long-term contracts/public procurement linked to cost elements; and deploy "price-stabilization bands + risk-sharing" toolkits (reserves, insurance, hedging, etc.) to stabilize expectations and cushion point shocks.
3. Strengthen producer organization and bargaining capacity, supported by public basics such as cold chain, storage, and information services.
4. Use standards and labelling systems to embed quality attributes into transactions and incentives, making "better quality–better price–better margin" a sustainable equilibrium.

Only by doing so can we break the cycle captured by the adage "low grain prices harm farmers—and ultimately consumers", stabilize quality and supply, and enhance food-system order and credibility.

The quadrant table for Inequitable Income Distribution is as follows (see Table 5-26):

Table 5-26. Quadrant Analysis of Inequitable Income Distribution

Category	Content
Phenomenon	Value concentrates in midstream/channels; upstream—especially smallholders and frontline workers—receive low and volatile incomes.
Cause	Coexistence of asymmetric market power and opaque information; insufficient producer organization and collective bargaining.
Hazard	Forced quality downgrades and a self-reinforcing negative loop.
Response	Restore price–value–quality correspondence; advance quality grading with premium-for-quality; improve fair trading and long-term cooperation.

5-1.5.5 Failures of Price Mechanisms and Risk Management

Failures of Price Mechanisms and Risk Management [SI-1315500] is a Level-5 issue within the food-system issue framework, under Economically Unsustainable Development of the Food System.

Its core features are: price formation deviates from true costs and quality value, asymmetric transmission between upstream and downstream, and amplified volatility—while stabilization and risk-sharing devices are underdeveloped (gaps in monitoring, reserves, price-stabilization bands, insurance, and hedging).

Under this structure, markets with high concentration and weak disclosure are more prone to behavioral distortions: a few large actors with significant market power may

restrict spot supply, adjust quotation practices, or steer expectations, pushing grain prices away from fundamentals for a time, extracting excess rents and passing risk to farmers and consumers. The results are declines in affordability and accessibility, with vulnerable groups hurt first; weakened business expectations; a low-price → underinvestment → lower quality negative loop; and erosion of social trust and food-system order and resilience.

In orientation, "food as a survival necessity" should anchor price and risk policy. Strengthen an integrated toolkit of monitoring–reserves–price-stabilization bands–risk sharing, and add an institutional gate against manipulation and gouging: tighten antitrust and anti-manipulation enforcement; establish rapid investigation and correction for abnormal prices; advance tiered disclosure and early-warning on inventories, shipments, fees, and large positions; expand long-term contracts and public procurement coverage; operationalize strategic and working reserves; and diversify sources and nodes to reduce single-point manipulation space.

The quadrant table for Failures of Price Mechanisms and Risk Management is as follows (see Table 5-27):

Table 5-27. Quadrant Analysis of Failures of Price Mechanisms and Risk Management

Category	Content
Phenomenon	Prices deviate from value; volatility is amplified.
Cause	The necessity-good attribute is neglected, leaving institutional gaps; market concentration and weak disclosure create room for price elevation.
Hazard	Affordability and accessibility decline; vulnerable groups are hit first; underinvestment and quality downgrades trigger a negative loop.
Response	Use the survival-necessity principle as a baseline; strengthen monitoring–reserves–price-stabilization bands–risk sharing; tighten antitrust/anti-manipulation and rapid correction mechanisms.

5-1.5.6 Insufficient Incentives and Safety-Net Mechanisms

Insufficient Incentives and Safety-Net Mechanisms [SI-1315600] is a Level-5 issue within the food-system issue framework, under Economically Unsustainable Development of the Food System.

Its crux is a two-sided gap or misalignment in supports for producers and consumers. On the supply side, smallholders and small and medium-sized enterprises face price volatility, rising input costs, and climate/epidemic risks without rules-based, predictable producer supports (e.g., premium subsidies, input subsidies, rewards for

green practices, price-stabilization bands with order backstops, and reserve linkages). This triggers a chain of low margins → underinvestment → quality downgrades → exit. On the demand side, vulnerable groups and critical settings (e.g., school/institutional meals) lack stable nutrition supports (nutrition subsidies/vouchers, school meal programs, time-bound price subsidies), reducing affordability and accessibility and widening nutritional inequality.

The root causes lie in treating food as an ordinary commodity, reliance on short-term fiscal and policy tools, and the absence of institutional arrangements grounded in the principle that "food is a survival necessity," alongside weak targeting/assessment capacity. Immediate harms include unstable supply and weaker quality, constrained healthy intake on the demand side, amplified price volatility, and erosion of food-system order and resilience.

In orientation, establish a rules-based, transparent, and evaluable "two-sided support" system:

- Supply side: implement producer supports linked to cost/quality (producer and premium subsidies, rewards for green practices), long-term contracts, and price-stabilization bands connected to strategic/working reserves.
- Demand side: institutionalize nutrition subsidies and school meals, provide targeted vouchers for vulnerable groups, and activate time-bound price subsidies during crises.

On both sides, use open data and performance evaluation to prevent drift and ensure that good production is incentivized and healthy consumption is safeguarded—making supports sustainable.

The quadrant table for Insufficient Incentives and Safety-Net Mechanisms is as follows (see Table 5-28):

Table 5-28. Quadrant Analysis of Insufficient Incentives and Safety-Net Mechanisms

Category	Content
Phenomenon	Two-sided supports are missing or misaligned.
Cause	Food governed as an ordinary commodity; lack of an institutional principle that food is a survival necessity.
Hazard	Supply side falls into low margin □ quality downgrade □ exit; demand-side affordability and accessibility decline.
Response	Build rules-based, evaluable two-sided supports to ensure incentives for better production and safeguards for healthy eating.

5-1.5.7 Externalized Environmental and Health Costs (Unpriced Externalities)

Externalized Environmental and Health Costs (Unpriced Externalities) [SI-1315700] is a Level-5 issue within the food-system issue framework, under Economically Unsustainable Development of the Food System.

It refers to the fact that, across production–processing–distribution–consumption, environmental damage and health harms are not reflected in product prices or corporate accounts, thereby becoming implicit burdens borne by society and future generations.

Typical manifestations include "low prices" achieved at the expense of resource overdraft, pollution emissions, single-use packaging, and food waste; health externalities from excess salt/sugar/fats, trans fats, antimicrobial resistance risks, and intensive animal farming being shifted to healthcare systems and public budgets; and insufficient incentives for green production, loss reduction, and circular reuse due to lack of returns. Root causes lie in governing food as an ordinary commodity and neglecting its survival-necessity attribute, resulting in missing tools for pricing externalities and unclear responsibility boundaries, weak data and accounting systems, non-integrated standards and fiscal/tax incentives, and insufficient cross-sectoral coordination. The harm is not short-term cheapness but long-term expense: accumulating ecological and health deficits, declining quality and trust, damaged investment expectations and system resilience, and ultimately higher total social costs.

The response should focus on internalizing real costs while protecting basic entitlements. In practice:

- Set and rigorously enforce baseline standards on emissions, veterinary/medical use, nutrition, and safety; embed polluter-pays and extended producer responsibility (EPR) into the rule set, so that emissions, packaging, and waste carry explicit costs and circular reuse earns returns.
- Use simple price and fiscal instruments (e.g., differential taxes/fees, deposit–refund schemes) to send clear market signals—high-consumption/high-pollution costs more; low-consumption/low-pollution is preferred—while providing targeted subsidies or nutrition vouchers to low-income groups to prevent burden spillovers.
- Leverage public procurement to amplify the better quality → better price → better margin incentive, and pair with clear labelling and disclosure to raise recognizability.

The quadrant table for Externalized Environmental and Health Costs (Unpriced Externalities) is as follows (see Table 5-29):

Table 5-29. Quadrant Analysis of Externalized Environmental and Health Costs

Category	Content
Phenomenon	Externalities are not priced, producing "apparently cheap but actually overdrawing" low prices and high consumption.
Cause	Neglect of food's survival-necessity attribute; missing instruments for externality pricing and unclear responsibility boundaries.
Hazard	Accumulating ecological and health deficits; declining quality and trust; rising long-term social costs.
Response	Follow an order + real-cost approach: set baseline standards and internalize externalities via polluter-pays/EPR, price/fiscal tools, and supportive labelling and procurement.

5-2 Human–Environment (External) Conflict

Human–Environment (External) Conflict [SI-1320000] is a Level-3 issue within the food-system issue framework, under Eater Sustainability Issues.

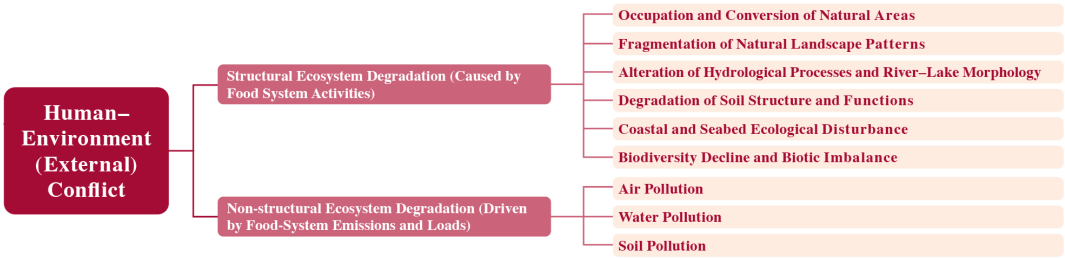
It denotes the over-appropriation and disturbance of the Earth's ecological systems—under sustained expansion of human activities and long-unpriced externalities—while those systems provide food and wider ecosystem services. As ecological structure and function become imbalanced and degraded, the quantity and quality of both wild (natural) and domesticated food sources are impaired, weakening the stability and resilience of the food system. If left unaddressed, the loss is not only to ecosystems themselves; human livelihoods and development frontiers are also pressed toward their limits.

This issue comprises two superimposed mechanisms:

1. **Structural Ecosystem Degradation** — direct modification or fragmentation of the ecological "skeleton"; these shocks are often rapid and hard to reverse.
2. **Non-structural Ecosystem Degradation** — processes that erode ecological function without immediately altering the "skeleton," e.g., persistent pollution loads and other pressures.

Combined, they accelerate biodiversity loss and environmental degradation, feeding back as greater yield and quality volatility, higher production costs and risks, and weakened nutrition security and system resilience.

Figure 5-2. Framework of Human–Environment (External) Conflict



Root causes include space-taking and resource-intensive use oriented toward short-term output, long-standing failure to price externalities, fragmented governance and weak coordination, and the amplifying effects of climate change. A prudent response can be organized around four macro principles:

- Hold the line (baseline protection): define structural red lines and intensity caps; secure basic space for key habitats and ecological flows.
- Ease the pressure: optimize intensity and timing of withdrawals/uses; promote frugal consumption and loss/waste reduction to relieve sustained stress on ecological function.
- Enable restoration: implement connectivity and habitat restoration at basin, basin–coastal, and habitat-network scales to rebuild self-regulation.
- Strengthen collaboration: establish long-term monitoring and open evaluation; advance co-governance across sectors, regions, and communities; and internalize ecological costs and restoration responsibilities to form durable constraints and positive incentives. The pathway need not be complex; what matters is directional consistency and steady pacing to return ecosystems to a sustainable track of carrying capacity and provision.

The quadrant table for Human–Environment (External) Conflict is as follows (see Table 5-30):

Table 5-30. Human–Environment (External) Conflict

Category	Content
Phenomenon	The Earth's ecological systems are over-appropriated and disturbed while providing food and ecosystem services.
Cause	Space-taking and resource-intense use geared to short-term output; long- unpriced externalities.
Hazard	Biodiversity loss and environmental degradation.
Response	Hold the line, ease the pressure, enable restoration, strengthen collaboration.

5-2.1 Structural Ecosystem Degradation (Caused by Food-System Activities)

Structural Ecosystem Degradation (Caused by Food-System Activities) [SI-1321000] is a Level-4 issue within the food-system issue framework, under Human–Environment (External) Conflict.

It refers to the direct modification or fragmentation of the ecological "skeleton"—that is, the spatial configuration, connectivity, and key ecological processes—typically characterized by long recovery cycles, high costs, and partial irreversibility. This issue comprises six sub-items: Occupation and Conversion of Natural Areas; Fragmentation of Natural Landscape Patterns; Alteration of Hydrological Processes and River–Lake Morphology; Degradation of Soil Structure and Functions; Coastal and Seabed Ecological Disturbance; and Biodiversity Decline and Biotic Imbalance. These changes are irreversible or hard to repair over the long term, jointly weakening critical services such as pollination, soil and water conservation, ecological flows, and spawning/nursery habitats. The consequence is a sustained decline in the quantity and quality of both natural and domesticated foods, with greater yield volatility and significantly higher production costs.

Root causes include land/sea overexpansion and high-intensity use aimed at short-term output; infrastructure and engineered alterations that encroach on ecological processes; long-standing failure to price externalities; fragmented governance; and the amplifying effects of climatic extremes. The response should be led by an integrated ecosystem-governance framework: secure spatial red lines for irreplaceable areas; set process thresholds (e.g., minimum requirements for connectivity, ecological flows, soil fertility/soil organic carbon) to constrain all incremental activities; and institutionalize system-scale restoration and carbon-sink enhancement (e.g., habitat networks, basin/coastal integrated restoration) as routine public works.

The quadrant table for Structural Ecosystem Degradation (Caused by Food-System Activities) is as follows (see Table 5-31):

Table 5-31. Quadrant Analysis Table of Structural Ecosystem Degradation

Category	Content
Phenomenon	The ecological "skeleton" is modified/fragmented; connectivity and key processes are impaired; ecosystem services decline.
Cause	Excessive spatial expansion and intensity; externalities not accounted for; fragmented governance; amplification by climatic extremes.
Hazard	Irreversible or long-lasting losses; sustained declines in the quantity and quality of natural and domesticated foods; markedly higher volatility.
Response	Govern under an integrated ecosystem framework—lock in spatial red lines; constrain incremental activities with process thresholds; make systemic restoration and sink enhancement routine.

5-2.1.1 Occupation and Conversion of Natural Areas

Occupation and Conversion of Natural Areas [SI-1321100] is a Level-5 issue within the food-system issue framework, under Structural Ecosystem Degradation (Caused by Food-System Activities).

It refers to land- and seascape occupation and outward expansion directly or indirectly driven by food-system activities—for example, advancing into forests, grasslands, wetlands, river–lake floodplains, and near-shore zones to plant food/feed/forage crops or site aquaculture facilities, or the spillover of land uses for storage, processing, and cold-chain infrastructure—thereby shrinking habitat area, increasing fragmentation, and impairing connectivity.

Principal drivers include: a mismatch between growing food demand (especially feedland associated with animal-source foods) and gains in output efficiency; price and incentive structures biased toward "more land, more volume" rather than efficiency gains and loss reduction, with ecological values excluded from decisions; and weak alignment between national spatial constraints and sectoral planning.

Harms are irreversible or difficult to repair over long cycles: habitat loss, impeded ecological flows in rivers and lakes, declines in soil organic carbon, and contraction of near-shore nursery habitats—all of which often recover only on decadal to centennial timescales. As a result, key services such as pollination, soil and water conservation, ecological flows, and coastal fisheries nurseries are weakened, leading to lower and more volatile quantities and quality of both natural and domesticated foods, higher production costs, and visibly diminished food-system stability and resilience.

A unified response applicable across settings is to adopt the baseline "meet food

demand with the least possible new land take." Concretely: constrain new occupation through spatial red lines and a no-net-loss principle; meet demand first via loss/waste reduction, sustainable yield increases, and reuse of degraded lands; and embed natural-capital accounting and open evaluation into food-system planning and investment so that development targets and ecological carrying capacity are aligned within a single decision frame.

The quadrant table for Occupation and Conversion of Natural Areas is as follows (see Table 5-32):

Table 5-32. Quadrant Analysis of Occupation and Conversion of Natural Areas

Category	Content
Phenomenon	Forests, grasslands, wetlands, river–lake floodplains, and near-shore zones are occupied for planting, aquaculture, and spillover siting of storage/processing/cold-chain facilities.
Cause	Mismatch between demand growth and efficiency gains; incentives favor "more land, more volume"; ecological costs unpriced; weak linkage between spatial controls and sectoral planning.
Hazard	Reduced and fragmented habitats; degraded services (pollination, soil/water conservation, ecological flows); declines and higher volatility in natural and domesticated foods.
Response	Use "least new land take" as the baseline: apply spatial red lines and no net loss; meet demand via loss/waste reduction, sustainable intensification, and reuse of degraded lands; integrate natural-capital accounting and open evaluation.

5-2.1.2 Fragmentation of Natural Landscape Patterns

Fragmentation of Natural Landscape Patterns [SI-1321200] is a Level-5 issue within the food-system issue framework, under Structural Ecosystem Degradation (Caused by Food-System Activities).

It denotes loss of ecological connectivity and habitat fragmentation directly or indirectly caused by food-system activities: to expand planting and aquaculture; build farm roads and irrigation–drainage works; conduct reclamation and nearshore aquaculture; harden shorelines; and site spillover land uses for storage/processing/cold-chain facilities—actions that create extensive linear and areal barriers and break formerly continuous forest–grassland–wetland–river–lake–nearshore belts into isolated patches.

The principal drivers are supply expansion and intensification without a "connectivity baseline"; project approval and spatial regulation that fail to hardwire ecological corridors,

ecological flows, and species-migration needs as binding constraints; and ecological costs omitted from pricing and investment decisions. The harms are irreversible or long-cycling: gene exchange is impeded; pollination and natural-enemy regulation decline; fish and migratory-bird routes are severed; edge effects and invasive-species pressure rise; and flood storage/attenuation and water-retention functions weaken—feeding through to lower quantity and quality of natural and domesticated foods, higher volatility and costs, and a reduced resilience and safety margin for the system.

A unifying response applicable across settings is to establish a "protect connectivity" baseline in national spatial and sectoral planning: make ecological corridors, critical habitats, and ecological flows hard conditions in approvals and in financing; follow "no cutting—crossable—restorable—verifiable" norms; and, through natural-capital accounting and long-term monitoring–reporting–verification (MRV), internalize real ecological costs into rules and prices so that development and ecological carrying capacity operate within the same decision frame.

The quadrant table for Fragmentation of Natural Landscape Patterns is as follows (see Table 5-33):

Table 5-33. Quadrant Analysis of Fragmentation of Natural Landscape Patterns

Category	Content
Phenomenon	Planting, aquaculture, and associated facilities create linear/areal barriers, fragmenting continuous ecological belts.
Cause	Lack of a connectivity baseline and spatial red lines; corridors/ecological flows not embedded as binding rules; ecological costs unpriced.
Hazard	Blocked migration and gene exchange; weakened ecosystem services; increased volatility and long-lasting/irreversible losses in food supply and quality.
Response	Establish a protect-connectivity baseline and corridor networks; enforce no-cutting/crossable norms and spatial red lines; embed these constraints in planning and financing.

5-2.1.3 Alteration of Hydrological Processes and River–Lake Morphology

Alteration of Hydrological Processes and River–Lake Morphology [SI-1321300] is a Level-5 issue within the food-system issue framework, under Structural Ecosystem Degradation (Caused by Food-System Activities).

It refers to water-system modifications and withdrawals directly or indirectly driven by food-system activities—such as large-scale irrigation diversions and groundwater

extraction, channelization/straightening, reclamation and hardened shorelines, wetland drainage, weirs, dams, and aquaculture enclosures—that change the magnitude and timing of river–lake flows, the connectivity of terrestrial–aquatic wetlands, and sediment regimes and shoreline forms. Consequences include disconnection of floodplains and storage/attenuation spaces, lower baseflows with intensified flood–drought extremes, degradation of spawning and nursery habitats, secondary soil salinization, accelerated delta and nearshore erosion, and greater instability of fisheries and irrigation water supplies.

Principal drivers are meeting food demand through incremental expansion and engineering solutions while failing to set ecological flows and connectivity as binding baselines; longstanding separation of water, agriculture, and ecosystem governance; and ecological costs omitted from decisions, with climatic anomalies amplifying the imbalance. Harms are often irreversible or long-cycling: once channel incision, wetland degradation, and groundwater funnels/salinization take hold, only decadal to centennial recovery is possible at best—producing long-term declines in the quantity and quality of natural and domesticated foods and weakening food-system stability and resilience.

In orientation, adopt basin-scale integration as the organizing line: establish a baseline of ecological flows + land–water connectivity + sediment balance; implement controls on withdrawals, stabilize flow seasonality, restore wetlands, and strengthen monitoring within a unified governance framework; and embed natural-capital accounting and public disclosure into planning, permitting, and investment so that all cases are covered under a single, coherent approach.

The quadrant table for Alteration of Hydrological Processes and River–Lake Morphology is as follows (see Table 5-34):

Table 5-34. Quadrant Analysis of Alteration of Hydrological Processes and River–Lake Morphology

Category	Content
Phenomenon	Irrigation diversions, channelization, and reclamation alter flow timing and connectivity; river–lake and wetland morphology becomes imbalanced.
Cause	Engineering-led expansion to meet demand; absence of ecological-flow and connectivity baselines; siloed governance; ecological costs not priced in.
Hazard	Lower baseflows, intensified flood–drought and salinization; less stable fisheries and irrigation; many losses are irreversible or long to repair.
Response	Use basin-wide integration to set the ecological flow–connectivity–sediment balance baseline; advance a unified framework of controlled withdrawals and wetland restoration with natural-capital accounting and transparent MRV (monitoring–reporting–verification).

5-2.1.4 Degradation of Soil Structure and Functions

Degradation of Soil Structure and Functions [SI-1321400] is a Level-5 issue within the food-system issue framework, under Structural Ecosystem Degradation (Caused by Food-System Activities).

It refers to a process—driven by the pursuit of short-term output and outward expansion—whereby soil structure (aggregates, porosity, load-bearing capacity) and functions (water and nutrient retention, carbon sequestration and nutrient cycling, microbial diversity and biotic regulation) are progressively weakened. Typical manifestations include topsoil erosion and fertility loss, tillage compaction and hard-pan formation, surface sealing and enhanced runoff due to insufficient cover, declines in organic matter and soil carbon, secondary salinization/acidification from irrigation–drainage imbalance, and rangeland overstocking leading to degradation and desertification.

Primary drivers are expansion and intensification (deep/repeated tillage, monocropping, off-field removal of residues/stover, overgrazing, heavy machinery traffic, and imbalanced water–nutrient management), compounded by unpriced ecological costs and weak coordination in governance. The harms are often irreversible or very slow to repair: topsoil formation takes decades to centuries; soil organic carbon recovers slowly; once salinization or desertification occurs, remediation is costly and protracted. The result is declining yields and quality, higher water and input costs, and amplified output volatility under extremes, which together erode food-system stability and resilience.

A unifying, setting-agnostic response is to adopt a soil-health baseline and rebuild key processes through "limit disturbance – maintain cover – promote diversity – add organics – balance water and salts – verify performance." Concretely:

- Embed soil carbon and soil-fertility indicators into planning, incentive, and procurement rules.
- Implement monitoring–reporting–verification (MRV) and natural-capital accounting to create durable constraints and open evaluation.
- Restore carrying and provisioning capacity without expanding land by prioritizing reduced disturbance, continuous or seasonal cover, diversified rotations/intercropping, organic amendments (e.g., manures/compost/returning residues), and rational irrigation–drainage with salt management.

The quadrant table for Degradation of Soil Structure and Functions is as follows (see Table 5-35):

Table 5-35. Quadrant Analysis of Degradation of Soil Structure and Functions

Category	Content
Phenomenon	Erosion; compaction/hard-pan; declines in organic matter; salinization/ acidification from irrigation–drainage imbalance.
Cause	Intensive operations and inappropriate tillage/grazing; monocropping and insufficient cover; imbalanced irrigation and nutrient management; ecological costs unpriced and coordination weak.
Hazard	Weakened water/nutrient retention and biotic functions; falling yields and quality; higher input and water costs; greater sensitivity to extremes.
Response	Use a soil-health baseline: limit disturbance – maintain cover – promote diversity – add organics – balance water and salts – verify performance; integrate soil carbon/fertility metrics into planning and incentives.

5-2.1.5 Coastal and Seabed Ecological Disturbance

Coastal and Seabed Ecological Disturbance [SI-1321500] is a Level-5 issue within the food-system issue framework, under Structural Ecosystem Degradation (Caused by Food-System Activities).

It refers to nearshore and seabed habitat modification and high-intensity disturbance directly or indirectly driven by food-system activities—such as expansion and infill for nearshore aquaculture, navigation-channel dredging and shoreline hardening to serve fisheries/supply chains, and high-intensity bottom trawling—which damage nursery and habitat systems (mangroves, salt marshes, seagrass meadows, reef structures), resuspend sediments and degrade water quality, and unbalance food webs and species composition.

Root causes include meeting marine-food demand through incremental expansion and engineering-heavy approaches without binding baselines for connectivity, ecological flows, and sediment balance; natural capital excluded from prices and decisions; and insufficient land–sea integration and cross-sector coordination. Harms are often irreversible or very slow to repair: once key habitats are lost or degraded (e.g., reef damage, seagrass contraction), recovery typically takes decades to centuries. Consequences include declining nearshore fishery replenishment, higher aquaculture disease risk and input costs, accelerating shoreline erosion and saltwater intrusion, and ultimately reduced quantity and quality of marine-derived foods and lower system resilience.

A unified, setting-agnostic response is advisable: use coastal-buffer zones plus ecological red lines to secure irreplaceable habitats; constrain incremental activities with thresholds for connectivity and for ecological-flow/sediment balance; institutionalize

habitat-network restoration and carbon-sink enhancement (e.g., mangrove, seagrass, and reef rebuilding) as routine programs; and, through natural-capital accounting, monitoring–reporting–verification (MRV), and public disclosure, embed real ecological costs into planning, permitting, and investment so that development and carrying capacity operate within the same decision frame.

The quadrant table for Coastal and Seabed Ecological Disturbance is as follows (see Table 5-36):

Table 5-36. Quadrant Analysis of Coastal and Seabed Ecological Disturbance

Category	Content
Phenomenon	Aquaculture expansion, dredging and shoreline hardening, and bottom trawling damage nearshore and seabed habitats.
Cause	Expansion and engineering-led responses without baselines for connectivity/ ecological flows/sediment balance; natural capital not priced in; weak land–sea coordination.
Hazard	Water-quality and food-web imbalance; loss of nurseries and key habitats; falling fishery replenishment and rising aquaculture risks; intensified shoreline erosion; many losses are irreversible or long to repair.
Response	Prioritize buffers + red lines, process thresholds, and systemic restoration; embed natural-capital accounting and MRV in planning and investment to apply unified constraints across activities.

5-2.1.6 Biodiversity Decline and Biotic Imbalance

Biodiversity Decline and Biotic Imbalance [SI-1321600] is a Level-5 issue within the food-system issue framework, under Structural Ecosystem Degradation (Caused by Food-System Activities).

It denotes concurrent declines in species richness, genetic diversity, and functional diversity under the direct or indirect influence of food-system activities—such as land/sea expansion and habitat loss/fragmentation, intensified use and overfishing/ overharvesting, biological invasions, and chemical pressures and nutrient imbalance. Food-web structures are simplified, with symptoms including fewer pollinators, imbalances between natural enemies and pests, and the absence of top/keystone species. These changes weaken critical ecosystem services—pollination, natural regulation, soil and water conservation, and nursery habitats.

The harms are often irreversible or extremely slow to repair: once local extinctions occur or germplasm degrades, recovery—even partial—may take decades to centuries.

Missing functional groups amplify yield volatility and quality risks over the long term, increase dependence on chemical inputs and external remediation, raise system costs, and reduce resilience.

A unifying, settings-agnostic response is to: establish habitat protection and connectivity as the foundation (spatial red lines / ecological corridors); use source conservation of genetic resources as the lever (in situ + ex situ measures, germplasm banks, and protection of local varieties/strains); on the production side, increase agri-fishery biodiversity (rotations/intercropping, ecological buffer strips, mixed habitats, science-based catch limits and closed seasons); and embed biodiversity goals in planning, permitting, standards, and public procurement through long-term monitoring–reporting–evaluation (MRV) and natural-capital accounting—so that protect habitats – stabilize networks – safeguard genetic resources – enable co-governance becomes a coherent constraint set.

The quadrant table for Biodiversity Decline and Biotic Imbalance is as follows (see Table 5-37):

Table 5-37. Quadrant Analysis of Biodiversity Decline and Biotic Imbalance

Category	Content
Phenomenon	Declines in species and genetic diversity; simplified food webs; fewer pollinators; imbalances in natural enemy–pest and predator–prey relationships.
Cause	Habitat loss/fragmentation and intensified use; overfishing/overharvesting; invasive species; cumulative chemical and nutrient pressures; insufficient collaborative governance.
Hazard	Degraded key ecosystem services and increased volatility in food quantity and quality.
Response	Base on habitat protection + connectivity; conserve genetic resources in situ/ex situ; raise agri-fishery diversity; embed targets via MRV and natural-capital accounting into rules and procurement.

5-2.2 Non-structural Ecosystem Degradation (Driven by Food-System Emissions and Loads)

Non-structural Ecosystem Degradation (Driven by Food-System Emissions and Loads) [SI-1322000] is a Level-4 issue within the food-system issue framework, under Human–Environment (External) Conflict. It denotes sustained pollution and pressure exerted on the environment by human activities, which progressively erode ecological

functions and overdraw environmental carrying capacity, ultimately weakening the supply and stability of the food system.

This issue comprises three sub-items: Air Pollution, Water Pollution, and Soil Pollution. The three are coupled via material cycles and energy flows—for example, atmospheric deposition enters soils and waters, then moves through crops, fisheries, and livestock into the food chain—often presenting compound, cross-media, and transboundary risks. The outcomes include declines in the yield and quality of grains and aquatic products, heightened food-safety and public-health risks, and rising governance and healthcare costs.

Principal causes include emission loads and intensities exceeding natural self-purification thresholds; unpriced externalities from agricultural inputs (fertilizers, pesticides, veterinary drugs) and industrial/urban discharges; governance segmented by sector and medium with insufficient basin–coastal coordination; and non-unified monitoring systems and data definitions, which impede timely detection and correction.

In orientation, adopt a single, unified pathway that covers air, water, and soil: lead with source reduction and total-load control, complemented by circular use and process loss reduction; promote basin–coastal joint prevention and control within a unified monitoring–reporting–evaluation (MRV) and public-disclosure framework; gradually internalize ecological and health costs into rules and prices; and provide safe substitutes and nutrition safeguards during transition for affected groups—turning diffuse, non-structural pressures into clear, governable targets.

The quadrant table for Non-structural Ecosystem Degradation (Driven by Food-System Emissions and Loads) is as follows (see Table 5-38):

Table 5-38. Quadrant Analysis of Non-structural Ecosystem Degradation

Category	Content
Phenomenon	Air, water, and soil are polluted, with effects that interweave and compound across media.
Cause	Emission totals and intensities exceed self-purification thresholds.
Hazard	Continued decline of ecosystem services; falling food yields and quality; rising food-safety and public-health risks.
Response	Lead with source reduction and total-load control, complemented by process loss reduction and circular use, and strengthen regulation and legislation under a unified MRV and disclosure framework.

5-2.2.1 Air Pollution

Air Pollution [SI-1322100] is a Level-5 issue within the food-system issue framework, under Non-structural Ecosystem Degradation (Driven by Food-System Emissions and Loads).

It refers to the regional—and often transboundary—accumulation of particulate matter and ozone precursors caused by the combined emissions from agricultural sources (e.g., farm-machinery exhaust, open burning of crop residues, ammonia volatilization from fertilizers and livestock manure, pesticide volatilization and drift, and tillage dust) and from other sectors. Air quality deteriorates and, via dry/wet deposition and photochemical reactions, pollutants interweave and compound across media, affecting soils and waters and thereby weakening the food system's stable supply.

Principal causes include emission intensities that chronically exceed self-purification thresholds; poor nitrogen management and residue handling in agriculture; low energy efficiency of farm machinery and substandard fuels; siloed governance lines; and insufficiently transparent monitoring. Harms include crop sensitivity to ozone and deposited pollutants (yield and quality losses); soil acidification and aquatic eutrophication from deposition; rising food-safety and public-health risks and higher governance and healthcare costs. Some pollutants (e.g., persistent organic pollutants, fine particles and their adsorbates) persist long-term and are hard to reverse.

A unified and streamlined pathway is recommended: lead with source reduction and total-load control, complemented by process loss reduction and resource recovery—including nitrogen reduction and ammonia control, substitution and slow-release technologies, bans on open burning and high-value utilization of residues, and low-emission farm machinery with cleaner fuels. Advance regional joint prevention and control under a unified monitoring–reporting–evaluation (MRV) and public-disclosure framework, and gradually internalize ecological and health costs into rules and prices to create durable, long-term constraints and incentives.

The quadrant table for Air Pollution is as follows (see Table 5-39):

Table 5-39. Quadrant Analysis of Air Pollution

Category	Content
Phenomenon	Accumulation and transboundary transport of particulates and ozone precursors; worsening air quality.
Cause	Emission intensities exceed self-purification thresholds; poor nitrogen management and residue handling; low-cleanliness machinery/fuels; siloed governance and opaque monitoring.
Hazard	Crop yield and quality losses; pressure on soils and waters; rising food-safety and public-health risks.
Response	An integrated pathway of source reduction – total-load control – process loss reduction – resource recovery – MRV + regional joint control, while internalizing real ecological costs into institutions and prices.

5-2.2.2 Water Pollution

Water Pollution [SI-1322200] is a Level-5 issue within the food-system issue framework, under Non-structural Ecosystem Degradation (Driven by Food-System Emissions and Loads).

It refers to nutrients (nitrogen/phosphorus), pesticides and veterinary drugs, pathogens, and contaminants such as heavy metals, persistent organic pollutants (POPs), and microplastics entering rivers, lakes, groundwater, and estuarine–coastal waters via surface runoff, outfalls, groundwater recharge, and atmospheric deposition. When inputs exceed natural self-purification capacity, water quality degrades and aquatic ecosystems become imbalanced, undermining irrigation, fisheries, and drinking-water safety.

Principal causes include insufficient source controls and load limits (agricultural nonpoint sources and aquaculture effluents; municipal/industrial wastewater); governance segmented by sector/medium with weak basin–coastal coordination; incomplete monitoring and open data; and ecological and health externalities not priced into decisions. Harms manifest as eutrophication and algal blooms, benthic hypoxia and fishery declines, degraded quality of farmed and wild products, and rising treatment and healthcare costs. Of special concern, heavy metals, POPs, and microplastics can reside long-term in sediments and bioaccumulate along food webs, making reversal difficult and exerting a persistent drag on the quantity and quality of food, as well as on system resilience and public trust.

A unified pathway applicable across water bodies should be followed: lead with source reduction and total-load control, complemented by process loss reduction and resource recovery (N/P reduction, regulated manure/tailwater management and

pretreatment); restore wetlands and riparian buffers to enhance natural purification capacity; and advance governance under basin–coastal joint prevention and control with a common monitoring–reporting–evaluation (MRV) and public-disclosure framework. Gradually internalize ecological and health costs into policy and price signals, and, where necessary, provide safe substitutes and nutrition safeguards for affected groups.

The quadrant table for Water Pollution is as follows (see Table 5-40)

Table 5-40. Quadrant Analysis of Water Pollution

Category	Content
Phenomenon	Pollutants and excess nutrients accumulate in rivers, lakes, groundwater, and estuarine–coastal waters, degrading water quality and destabilizing aquatic ecosystems.
Cause	Loads exceed self-purification thresholds; insufficient controls on agricultural/aquaculture and municipal–industrial discharges; segmented governance; weak monitoring and open data; external costs unpriced.
Hazard	Algal blooms and hypoxia; fishery declines and higher water-use risks; long-term retention of heavy metals/POPs/microplastics that erode food quantity/quality and raise social costs.
Response	Source reduction + total-load control + process loss reduction/resource recovery + wetland & buffer restoration + basin–coastal joint control + MRV & disclosure, with ecological/health costs reflected in policies and prices.

5-2.2.3 Soil Pollution

Soil Pollution [SI-1322300] is a Level-5 issue within the food-system issue framework, under Non-structural Ecosystem Degradation (Driven by Food-System Emissions and Loads).

It refers to heavy metals, persistent organic pollutants (POPs), excess nutrients, pesticide and veterinary-drug residues, microplastics, and pathogens entering farmland and adjacent soils via industrial/urban "three wastes" (air, water, solid), contaminated irrigation and improper sludge use, traffic-related deposition and atmospheric deposition, and imbalanced agricultural inputs. When concentrations exceed environmental and agronomic safety thresholds, soil physico-chemical and biological functions degrade and contaminants are transmitted across media through "soil → crops → food chain" and "soil → waters/air", undermining food safety and public health.

Principal causes include insufficient source controls and load limits (industrial/urban discharges; agricultural nonpoint loads); gaps or weak enforcement in risk zoning

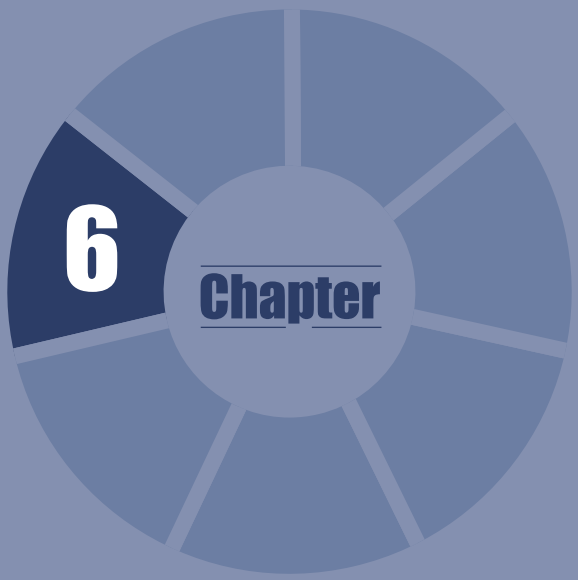
and access thresholds; incomplete monitoring and public data; and ecological and health externalities not reflected in decisions or price signals. Harms manifest as declines in soil fertility and ecosystem services, lower crop yields and quality, more frequent food-safety incidents, and rising remediation and healthcare costs. Of particular concern, heavy metals, POPs, and microplastics exhibit long residence times and poor reversibility: once deposited in topsoil and sediments, they can persist for years or longer, creating a long-term, implicit burden on the quantity and quality of food, as well as on system resilience and public trust.

A unified pathway applicable across settings should be followed: lead with source reduction and total-load control; implement zoned and tiered risk management and process loss reduction/resource recovery (e.g., standards for sludge and irrigation-water quality, less fertilizer/pesticide with manure valorization, and agronomic/varietal measures that reduce crop uptake); prioritize key sites for action using in situ immobilization/containment, and advance remediation–monitoring–evaluation (MRV) with public disclosure. In parallel, internalize ecological and health costs into policy and market instruments, and provide safe substitutes and nutrition safeguards for affected groups during transition—shifting soil pollution from a latent risk to clear, governable, and accountable targets.

The quadrant table for Soil Pollution is as follows (see Table 5-41):

Table 5-41. Quadrant Analysis of Soil Pollution

Category	Content
Phenomenon	Accumulation of heavy metals, POPs, excess nutrients, and microplastics above limits in farmland and adjacent soils.
Cause	Weak source control of industrial/urban discharges and agricultural nonpoint loads; poor management of sludge and irrigation-water quality.
Hazard	Declining yields and quality; rising food-safety and public-health risks.
Response	Source reduction + total-load control, with zoned/tiered risk management and process loss reduction/resource recovery; prioritize key sites for remediation and containment, under MRV and public disclosure.



Dual Mappings:

Country–Issue & Issue–Solution

Building on Chapters 3–5, which construct an eater-centered food-system issue framework, this chapter translates diagnosis into action. It integrates global country–issue mapping with a issue–solution alignment for all 193 UN Member States and 2 observer states, providing a policy-ready bridge from identifying where and why burdens arise to specifying how they can be addressed through modular, transferable measures tailored to national contexts.

The chapter's purpose is not to add new concepts but to operationalize the preceding framework: prioritizing issues, sequencing interventions, and enabling transparent benchmarking and peer learning among similarly situated countries. Methods, indicators, and coding remain consistent with earlier chapters to ensure comparability, replicability, and accountability. In doing so, Chapter 6 closes the loop from evidence to execution, supporting differentiated pathways toward healthier, more resilient, and sustainable food systems aligned with the SDGs.

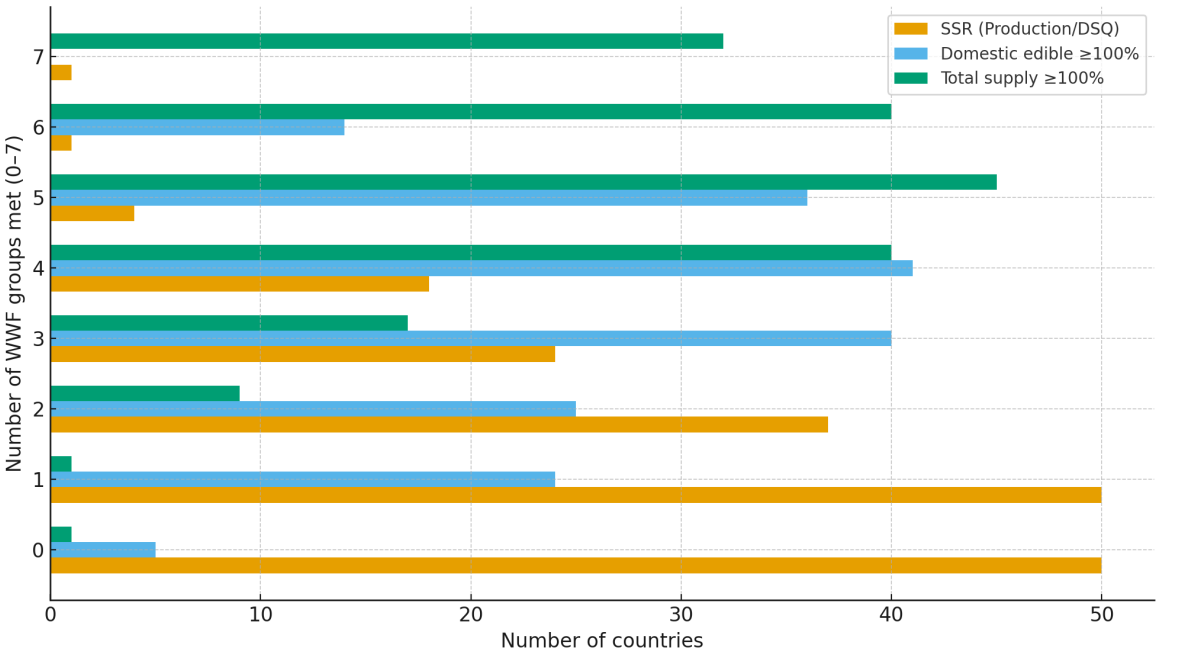
6-1 Establishing the Baseline of National Food Supply Capacity — A Three-Step Assessment from Structure to Health

To ground the issue–country mapping, we first establish a coherent, internationally comparable baseline of national food supply capacity—the foundational layer of any food system. We implement a three-step assessment that tightens from structure to health: (1) structural self-sufficiency (SSR); (2) domestic edible production vs. health thresholds (a production-only adequacy test); and (3) total edible supply incl. imports vs. health thresholds (a real-world attainability test). Each step uses FAO Food Balance Sheets (FBS) accounting concepts to move consistently from supply structure to edible availability, and applies the WWF Livewell seven-group targets[1] (age-weighted) as the health benchmark

1 WWF. (2017). *Eating for 2 Degrees — New and Updated Livewell Plates: Summary Report* (Revised edition). WWF-UK.

where relevant. This design allows us to diagnose (i) the domestic structure of supply, (ii) a resilience-style lower bound without trade, and (iii) the extent to which trade enables populations to reach healthy diet minima.

Figure 6-1. Distribution of countries by groups met across three metrics(2020-2022)



Step 1 — Structural self-sufficiency (SSR). We compute SSR as Production/DSQ by WWF food group (starchy staples; legumes, nuts & seeds; vegetables; fruits; total meats; dairy; fish & seafood), aggregated over 2020–2022. In the FAO Food Balance Sheets, DSQ denotes the total quantity available for domestic use during the reference period; it precedes allocation to uses such as food, feed, seed, processing, losses, other non-food, and tourism consumption. SSR therefore indicates source structure (domestic share of supply) and is not itself a health metric. Empirically, only one country attains SSR≥100% in all seven groups, underscoring how rare complete structural self-reliance is at the group level. Use SSR only as a structural supply indicator: Production/DSQ does not measure diet adequacy.

Table 6-1. Top 10 countries by SSR (incl. ties)

Rank	Country	Groups met count	Starchy staples	Legumes, nuts and seeds	Vegetables	Fruits	Total meats	Dairy	Fish & seafood	Bottleneck_ group
1	Argentina	7	268.3	201.1	102.6	124.5	115.2	120.2	262.4	Vegetables
2	United Republic of Tanzania	6	103.1	141.8	110.1	100.4	100.9	99	121.4	Dairy
3	India	5	109.7	94.8	102.2	100.8	111.9	99.9	111.3	Legumes, nuts and seeds
-	Myanmar	5	118.8	165.6	105.2	108.8	99.9	82.1	138.8	Dairy
-	New Zealand	5	64.9	31.8	138.8	174.5	287.5	217.8	280.8	Legumes, nuts and seeds
-	Nicaragua	5	61.2	183.6	85.9	153.9	148.7	124	150.6	Starchy staples
7	Australia	4	300	266.5	58.8	89.7	154.4	106.9	35.7	Fish & seafood
-	Chile	4	46	163.7	136.6	191.1	88.1	82.9	278.3	Starchy staples
-	Denmark	4	109.8	57	27.4	10.4	472	107	314.4	Fruits
-	Estonia	4	222	231.7	13.1	4.6	80.4	139	297.8	Fruits
-	Latvia	4	257.3	175	25	13.6	63.5	135.3	193.8	Fruits
-	Madagascar	4	85.8	191.8	104.6	101.7	99.6	87.7	105.8	Starchy staples
-	Malawi	4	100.4	119	100	99.6	100.1	91	96.8	Dairy
-	Mexico	4	63.1	106.7	194.9	123.2	80.6	71.3	103.3	Starchy staples
-	Morocco	4	39	67.8	138.1	113.4	100.6	70.6	225.6	Starchy staples
-	Pakistan	4	114.9	34.2	94.7	106.3	108.9	99.1	156.4	Legumes, nuts and seeds
-	Paraguay	4	156	273.6	58.3	95.9	265.7	107.3	85	Vegetables
-	Poland	4	124.9	73.4	92.2	142	151.2	103.5	49.9	Fish & seafood
-	South Africa	4	103.6	87.2	105.7	193.5	89.5	89.1	106.1	Legumes, nuts and seeds
-	Thailand	4	151.1	92.9	91.7	152.7	157.9	45.1	104.4	Dairy
-	Uganda	4	96.7	130.2	94.8	100	100	108	102	Vegetables
-	Uruguay	4	163.9	2.1	52.6	99.5	361.3	162.7	173	Legumes, nuts and seeds
-	Viet Nam	4	101.5	73.9	100.2	123.5	89.6	36.8	136.1	Dairy
-	Zambia	4	108.3	115.4	101.9	86.8	93.2	348.5	61	Fish & seafood

Step 2 — Domestic edible production vs. WWF thresholds. In the second step—explicitly adopting the production-to-guidance approach introduced by a 2025 Nature Food study2—we estimate the edible amount that reaches eaters from domestic production alone by subtracting feed, seed, losses, other non-food uses, and tourist consumption (FBS utilizations), convert to per-capita/day, and compare against age-weighted WWF Livewell thresholds for each group. This operationalizes a no-trade, resilience-style lower bound. Using this method in our main text, we find zero countries meet all seven groups solely from domestic production at ≥100% of the Livewell targets—demonstrating that healthy diet minima are broadly unattainable without trade.

Table 6-2. Top 10 countries by Domestic edible vs. WWF thresholds (incl. ties)

Rank	Country	Groups met count	Starchy staples	Legumes, nuts and seeds	Vegetables	Fruits	Total meats	Dairy	Fish & seafood	Bottleneck_ group
1	Argentina	6	1235.2	225.1	98.8	283.2	1109.6	446.5	154.6	Vegetables
-	Cameroon	6	261.6	216.4	149.1	434.2	125.6	17.9	107.6	Dairy
-	Chile	6	35.2	120.8	114.4	629.6	673.6	189.4	982.4	Starchy staples
-	Croatia	6	377.4	9.3	300.9	107.5	477.6	195.4	133.4	Legumes, nuts and seeds
-	Guyana	6	694.4	8.5	333	596.5	578.1	102	429.4	Legumes, nuts and seeds
-	Iran (Islamic Republic of)	6	28.8	113.1	158.7	308.7	264.4	157.4	104.7	Starchy staples
-	Mexico	6	41.3	119.5	154.5	331	518.2	151.6	121.3	Starchy staples
-	Nepal	6	220.6	103.8	164.9	107.6	153.6	156.3	25.3	Fish & seafood
-	Peru	6	107.4	64.4	101.5	410.7	431.2	114.5	1212	Legumes, nuts and seeds
-	Republic of Moldova	6	507.5	161.9	113.6	858.8	274.9	184.5	12	Fish & seafood
-	Russian Federation	6	488.1	128.8	104.4	60.5	659.5	317.4	269.8	Fruits
-	Spain	6	21.1	115.6	328.9	646.1	1313.5	277.5	161.5	Starchy staples
-	Sudan	6	109.3	129.3	103	140.4	185.4	173.1	9.9	Fish & seafood
-	United States of America	6	391.5	154.8	97	109	1186.2	516.6	101.3	Vegetables

2 **Stehl, J. et al., 2025,** *Nature Food*: "Gap between national food production and food-based dietary guidance highlights lack of national self-sufficiency"

Step 3 — Total edible supply (including imports) vs. WWF thresholds (real-world attainability). We then incorporate trade by using the DSQ-to-edible pathway (i.e., DSQ net of the same non-food utilizations) and comparing to the same age-weighted Livewell thresholds. With imports accounted for, the number of countries meeting all seven groups rises to 32—a stark contrast to Step 2. Across the three steps, the most persistent global bottlenecks are vegetables, legumes/nuts/seeds, and fish & seafood—categories that are perishable, seasonally constrained, and/or geographically concentrated, and thus benefit most from cross-border complementarities. This three-step ladder therefore clarifies why open, rules-based agrifood trade is a necessary condition for attaining population-scale diet adequacy while domestic policy focuses on addressing structural gaps.

Table 6-3. Top 10 countries by Total edible vs. WWF thresholds (incl. ties)

Country	Groups met count	Starchy staples	Legumes, nuts and seeds	Vegetables	Fruits	Total meats	Dairy	Fish & seafood	Bottleneck_ group
Australia	7	150.4	144.2	162.1	264.2	948	545.3	191.2	Legumes, nuts and seeds
Austria	7	252	125	182.3	315.4	652.5	626.9	106.4	Fish & seafood
Bahrain	7	163.4	272	191.4	278.5	693.3	241.3	167.4	Starchy staples
Barbados	7	177.2	135.8	114.5	180.5	781.8	194.3	339.2	Vegetables
Belgium	7	393.7	216.7	238.1	223.3	566.8	772.5	187.1	Fish & seafood
Canada	7	154.9	319.2	138.4	250.9	749.8	450.1	157.8	Vegetables
Denmark	7	307	209.1	175.8	256.9	583.1	1259.8	177.5	Vegetables
Estonia	7	153.2	170.5	157.9	177.6	572.4	774.2	100.8	Fish & seafood
Finland	7	182.8	151.9	135	211.7	611.7	853.7	244.2	Vegetables
France	7	205.2	112.7	140.5	422.5	724	633	262.2	Legumes, nuts and seeds
Greece	7	141.3	192.9	169.8	435.8	626.9	350.6	140.8	Fish & seafood
Ireland	7	168.6	112.4	175.1	260.2	702.1	2974	160.1	Legumes, nuts and seeds
Israel	7	175.9	183.9	209.5	265.2	972.4	371.6	211.9	Starchy staples
Italy	7	183.5	172.8	114.6	502.2	607.8	508.6	220.9	Vegetables
Kuwait	7	177.6	196.4	239.4	246.5	629.5	276.9	116	Fish & seafood
Libya	7	170.1	193	257.6	194.2	401.1	223.7	176.1	Starchy staples
Luxembourg	7	142.7	105.6	194.6	321.2	709	301.5	242.6	Legumes, nuts and seeds

Country	Groups met count	Starchy staples	Legumes, nuts and seeds	Vegetables	Fruits	Total meats	Dairy	Fish & seafood	Bottleneck_ group
Maldives	7	174.2	206.3	177.1	305.3	326.2	260.9	645	Starchy staples
Malta	7	171	116.8	174.1	154.6	561.9	429	231.7	Legumes, nuts and seeds
Morocco	7	246	141.2	115.5	233.8	273.9	112.8	141.4	Dairy
New Zealand	7	188.9	150.9	131.2	351.7	834.7	3318.9	196.4	Vegetables
Norway	7	161.9	381.6	172.3	247.7	604.7	522.9	390	Starchy staples
Oman	7	105.6	179.2	275.5	377.4	388.4	546.7	261.9	Starchy staples
Qatar	7	194.6	253.2	223.6	192.9	685.7	179.2	183.8	Dairy
Saudi Arabia	7	176.9	122.8	136.8	201.1	477.7	169	101.2	Fish & seafood
Seychelles	7	196.2	176.5	181.2	258.2	704.1	234.4	413.8	Legumes, nuts and seeds
Spain	7	159.8	166.8	110.9	440.3	842.5	384.5	303.6	Vegetables
Sweden	7	177	166.9	186.9	215	607.5	563.9	241.3	Legumes, nuts and seeds
Switzerland	7	155.3	307.5	172.9	271.7	554.7	677.1	128.7	Fish & seafood
Tunisia	7	196.6	135.1	313	271.1	246.8	246.2	129.1	Fish & seafood
United Arab Emirates	7	152	229.6	147.5	199.7	661.7	184.5	202.7	Vegetables
United States of America	7	232.5	104.8	145.8	359	1036.6	527.1	176.1	Legumes, nuts and seeds

The three metrics collectively form the empirical and methodological baseline for the issue–country mapping that follows. SSR identifies structural strengths and gaps (which groups a country structurally covers or not). The domestic-edible test sets a resilience lower bound (what happens if trade is disrupted). The total-supply test shows real-world attainability with trade.

Building on the three-step assessment (SSR → domestic edible adequacy → total edible adequacy), we can rank countries by their bottleneck groups and quantify gaps (g/cap/day), then target trade diversification, cross-border cold chains and loss reduction, and standards/clearance harmonization to where shortfalls are most acute. More fundamentally, the results reveal the structural interdependence of the global food system: no country can sustain dual adequacy (production and health) across all seven groups itself,

so cross-border food flows are essential to turn unattainable healthy diets into attainable ones (our Step-2 vs Step-3 contrast: from 0 to 32 countries meeting all seven groups).

6-2 Global Food-System Issues Country-Level Distribution (Country–Issue Mapping)

Global food-system issues are not uniformly distributed across countries; rather, they display pronounced heterogeneity and imbalance. Accordingly, this section adopts a country-level lens, covering 193 UN Member States and 2 observer states (effective analytical sample: 194), and develops a bidirectional Country–Issue mapping that links specific issues to countries and countries to their predominant issues. This exercise reveals the global distributional patterns of diverse issues and provides an empirical basis for differentiated governance strategies in subsequent sections.

To enhance analytical precision and operational utility, we use the fourth-level issues in the eater-centered food-system issue framework as the unit of mapping. This level offers an appropriate degree of specificity—capturing concrete manifestations of problems—while maintaining cross-national comparability, making it well suited for country-scale analysis.

Through quantitative burden assessment and visual classification at the country level, we delineate a geographical atlas of global food-system issues and identify the principal challenges faced by different country types. Beyond its research value, this mapping yields actionable insights for global food-system governance and the design of context-specific, prioritized responses.

6-2.1 Quantification and Determination Criteria

This study is organized around the fourth-level problem framework and defines 28 fourth-level problems. In empirical measurement, sub-items that are highly correlated and point to the same causal channel are methodologically merged to avoid duplicate measurement and enhance robustness. For example, under the eating-methodology issues, the three stages originally listed as pre-eating, eating, and post-eating are strongly correlated in behavior and health outcomes and share the same core mechanism; therefore, they are integrated into an Eating-Method Composite Indicator for cross-country assessment.

6-2.2 Methodological approach:

- Indicators are standardized to ensure "higher = better/worse";
- Min–max normalization (0–100) applied;
- Linear weighted aggregation based on preset or empirical justifications (e.g., higher weight for irreversible impacts);
- Structured adjustments introduced where necessary (e.g., asymmetric penalties for ecological risks);
- Missing values handled via within-domain, within-country mean imputation; if an entire domain is missing, that country is excluded for that problem;
- Country classification uses a **quantile-threshold method**: countries in the lower-tail are flagged as "issue present." In some cases, a baseline/residual approach is used (e.g., negative residuals from life expectancy–per-capita GDP regression). Robustness checks include weight perturbation and breakpoint shifts.
- Data sources are primarily authoritative and public.

6-2.3 Reading Guide and Layout Notes

The two-dimensional "Country × Issue" mapping table presents 28 fourth-level issues across the header row, with countries (ISO3/name) listed in the leftmost column. Each cell records the determination for that country–issue pair:

- Red ● = issue present
- Green ✓ = no issue
- Grey — = not evaluated / no data

At the end of each country row, a summary count of "issues present" is included. This covers 193 UN Member States and 2 observer states; Vatican City is excluded, leaving 194 rows.

6-2.4 Interpretation and Use

The table is intended to quickly identify two patterns:

1. **Country perspective** — the **count and types** of entries marked "issue present" for a given country (to support a **priority governance list**);
2. **Issue perspective** — the **regional concentration** and **vulnerability belts** of a given issue worldwide.

Table 6-4. Country–Issue Mapping Table for Food Systems

	1 Food Production Inadequacy	2 Food Loss and Waste	3 Supply Chain Vulnera-bility	4 Increased Food Demand	5 Insufficient Native Species	6 Insufficient Introduction of Food Species	7 Food Contami-nation	8 Food Spoilage	9 Improper Use of Synthetic Chemicals	10 Toxic Food Issues	11 Pre-Eating Stage Issues	12 Eating Stage Issues	13 Post-Eating Stage Issues	14 Prevalence of Under-Eating Diseases	15 Prevalence of Food-Borne Diseases	16 Prevalence of Diseases from Dietary Imbalance	17 Prevalence of Overeating Diseases	18 Prevalence of Food Sensitivity Diseases	19 Prevalence of Appetite Deficiency Diseases	20 Dual-Aesthetic Imbalance	21 Five-Sense Aesthetic Bias	22 Public Adminis-tration Issues in the Food System	23 Gaps in Laws and Standards for the Food System	24 The Failure of Education, Science, and Culture to Address	25 External Shocks and Geopolitical Risks to the Food System	26 Economically Unsustainable Development of the Food System	27 Structural Ecosystem Degradation (Caused by Food-System Activities)	28 Non-structural Ecosystem Degradation (Emissions/ Leads from the Food System)	Issue Count
Afghanistan	●	●	●	●	●	●	✓	●	✓	✓	✓	✓	✓	●	✓	●	✓	✓	✓	✓	✓	●	✓	✓	●	●	✓	✓	12
Albania	✓	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	4
Algeria	✓	✓	✓	✓	✓	✓	●	✓	●	●	✓	✓	✓	✓	●	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	5
Andorra	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	—	✓	✓	✓	✓	●	✓	●	3
Angola	●	●	●	●	✓	✓	●	✓	●	●	●	●	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	14
Antigua and Barbuda	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	●	3
Argentina	✓	●	✓	✓	✓	●	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	●	✓	✓	✓	✓	✓	✓	✓	●	8
Armenia	✓	●	✓	●	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	5
Australia	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	5
Austria	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Azerbaijan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	●	✓	✓	●	✓	4
Bahamas, The	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	●	✓	●	●	✓	✓	✓	●	✓	✓	✓	●	8
Bahrain	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	●	✓	●	✓	●	✓	✓	✓	✓	✓	5
Bangladesh	✓	✓	✓	✓	●	✓	●	✓	●	●	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	●	✓	9
Barbados	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	●	●	✓	✓	✓	✓	●	●	●	7
Belarus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	●	3
Belgium	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	●	✓	✓	✓	✓	✓	✓	✓	2
Belize	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	●	✓	✓	✓	●	✓	✓	✓	●	6
Benin	✓	●	✓	●	✓	✓	●	●	●	●	●	●	●	●	●	●	✓	✓	✓	✓	●	✓	✓	✓	●	✓	●	✓	15
Bhutan	✓	✓	✓	✓	✓	●	●	✓	●	●	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	●	✓	●	●	✓	✓	✓	✓	8
Bolivia	●	✓	●	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	●	6
Bosnia and Herzegovina	✓	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3
Botswana	●	●	✓	✓	✓	✓	●	✓	●	●	●	●	●	●	●	●	✓	✓	●	✓	✓	●	✓	●	✓	✓	✓	✓	15
Brazil	✓	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	●	✓	✓	✓	●	✓	✓	●	8
Brunei Darussalam	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	●	●	✓	●	✓	✓	✓	✓	●	7
Bulgaria	✓	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	4
Burkina Faso	✓	●	●	●	✓	●	●	●	●	●	●	●	●	✓	●	●	✓	✓	✓	✓	✓	✓	✓	●	●	✓	●	✓	16

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Cameroon
Canada
Central African Republic
Chad
Chile
China
Colombia
Comoros
Congo, Rep.
Costa Rica
Cote d'Ivoire
Croatia
Cuba
Cyprus
Czechia
Korea, Dem. People's Rep.
Congo, Dem. Rep.
Denmark
Djibouti
Dominica
Dominican Republic
Ecuador
Egypt, Arab Rep.
El Salvador
Equatorial Guinea
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	1 Food Production Inadequacy	2 Food Loss and Waste	3 Supply Chain Vulnera-bility	4 Increased Food Demand	5 Insufficient Native Species	6 Insufficient Introduction of Food Species	7 Food Contami-nation	8 Food Spoilage	9 Improper Use of Synthetic Chemicals	10 Toxic Food Issues	11 Pre-Eating Stage Issues	12 Eating Stage Issues	13 Post-Eating Stage Issues	14 Prevalence of Under-Eating Diseases	15 Prevalence of Food-Borne Diseases	16 Prevalence of Diseases from Dietary Imbalance	17 Prevalence of Overeating Diseases	18 Prevalence of Food Sensitivity Diseases	19 Prevalence of Appetite Deficiency Diseases	20 Dual-Aesthetic Imbalance	21 Five-Sense Aesthetic Bias	22 Public Adminis-tration Issues in the Food System	23 Gaps in Laws and Standards for the Food System	24 The Failure of Education, Science, and Culture to Address	25 External Shocks and Geopolitical Risks to the Food System	26 Economically Unsustainable Development of the Food System	27 Structural Ecosystem Degradation (Caused by Food-System Activities)	28 Non-structural Ecosystem Degradation (Emissions/ Lands from the Food System)	Issue Count
Eritrea	✓	✓	✓	●	●	●	●	✓	●	●	—	—	—	●	●	✓	✓	✓	✓	—	✓	●	●	✓	✓	●	✓	✓	11
Estonia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Eswatini	✓	✓	✓	✓	●	✓	●	✓	●	●	●	●	●	✓	●	✓	●	✓	✓	●	●	●	●	✓	✓	●	✓	✓	14
Ethiopia	●	●	✓	●	✓	●	●	✓	●	●	—	—	—	●	●	●	✓	✓	✓	—	✓	✓	✓	✓	●	●	✓	✓	12
Fiji	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	●	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	7
Finland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	3
France	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	2
Gabon	●	✓	●	●	✓	✓	●	✓	●	●	●	●	●	✓	●	●	●	✓	●	✓	✓	●	✓	✓	✓	✓	●	✓	15
Gambia, The	●	●	●	●	●	●	●	✓	●	●	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	●	✓	13
Georgia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	●	✓	✓	✓	✓	✓	●	✓	✓	4
Germany	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	2
Ghana	✓	●	✓	●	✓	✓	●	●	●	●	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	●	✓	10
Greece	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	●	✓	✓	✓	✓	✓	✓	✓	●	✓	3
Grenada	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	3
Guatemala	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	●	✓	●	✓	●	✓	✓	✓	✓	✓	✓	✓	5
Guinea	✓	●	✓	●	✓	✓	●	●	●	●	●	●	●	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	14
Guinea-Bissau	●	●	✓	●	✓	●	●	✓	●	●	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	11
Guyana	✓	●	●	✓	✓	✓	✓	●	✓	✓	●	●	●	✓	✓	✓	●	●	✓	●	✓	✓	✓	✓	✓	✓	✓	●	10
Haiti	●	●	●	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	●	✓	✓	✓	●	●	✓	●	✓	✓	✓	9
Honduras	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	●	✓	✓	✓	●	✓	✓	✓	4
Hungary	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	●	●	✓	✓	✓	✓	✓	●	✓	4
Iceland	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	●	✓	✓	✓	✓	✓	✓	●	6
India	✓	✓	✓	✓	✓	✓	●	✓	●	●	✓	✓	✓	●	●	✓	✓	✓	✓	✓	●	✓	✓	✓	●	✓	●	✓	8
Indonesia	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	3
Iran, Islamic Rep.	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	●	✓	✓	✓	●	✓	●	✓	✓	✓	5
Iraq	✓	●	●	●	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	●	✓	●	●	✓	●	●	✓	●	✓	✓	✓	12
Ireland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	●	✓	✓	✓	✓	✓	✓	✓	●	5

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Jamaica
Japan
Jordan
Kazakhstan
Kenya
Kiribati
Kuwait
Kyrgyz Republic
Lao PDR
Latvia
Lebanon
Lesotho
Liberia
Libya
Liechtenstein
Lithuania
Luxembourg
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Marshall Islands
Mauritania
Mauritius
Mexico

	1 Food Production Inadequacy	2 Food Loss and Waste	3 Supply Chain Vulnerability	4 Increased Food Demand	5 Insufficient Native Species	6 Insufficient Introduction of Food Species	7 Food Contamination	8 Food Spoilage	9 Improper Use of Synthetic Chemicals	10 Toxic Food Issues	11 Pre-Eating Stage Issues	12 Eating Stage Issues	13 Post-Eating Stage Issues	14 Prevalence of Under-Eating Diseases	15 Prevalence of Food-Borne Diseases	16 Prevalence of Diseases from Dietary Imbalance	17 Prevalence of Overeating Diseases	18 Prevalence of Food Sensitivity Diseases	19 Prevalence of Appetite Deficiency Diseases	20 Dual-Aesthetic Imbalance	21 Five-Sense Aesthetic Bias	22 Public Administration Issues in the Food System	23 Gaps in Laws and Standards for the Food System	24 The Failure of Education, Science, and Culture to Address	25 External Shocks and Geopolitical Risks to the Food System	26 Economically Unsustainable Development of the Food System	27 Structural Ecosystem Degradation (Caused by Food-System Activities)	28 Non-structural Ecosystem Degradation (Emissions/ Loads from the Food System)	Issue Count
Micronesia, Fed. Sts.	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	●	●	●	●	✓	✓	●	✓	✓	9
Monaco	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	—	✓	●	✓	✓	●	✓	✓	5
Mongolia	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	5
Montenegro	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	●	✓	✓	✓	●	4
Morocco	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3
Mozambique	✓	✓	✓	●	✓	✓	✓	✓	●	●	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	●	●	●	●	✓	✓	10
Myanmar	✓	●	✓	✓	✓	●	●	✓	●	●	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	●	●	●	●	●	●	✓	13
Namibia	✓	●	✓	●	✓	✓	●	✓	●	●	●	●	●	✓	●	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	●	12
Nauru	✓	✓	✓	✓	●	●	●	✓	✓	✓	●	●	●	✓	✓	✓	●	✓	✓	●	—	✓	●	✓	✓	●	●	●	11
Nepal	✓	●	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	7
Netherlands	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	3
New Zealand	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	4
Nicaragua	✓	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	●	✓	●	✓	●	6
Niger	✓	●	✓	●	●	✓	✓	●	●	●	●	●	●	●	●	●	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	16
Nigeria	●	●	✓	●	✓	✓	●	●	●	●	●	●	●	●	●	✓	✓	✓	✓	●	✓	✓	✓	✓	●	✓	●	✓	15
North Macedonia	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	2
Norway	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	2
Oman	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	4
Pakistan	●	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	●	✓	✓	✓	●	✓	✓	✓	●	✓	●	✓	7
Palau	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	●	✓	✓	●	—	✓	●	✓	✓	✓	✓	✓	7
Panama	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	3
Papua New Guinea	●	●	✓	●	●	✓	✓	✓	✓	✓	●	●	●	●	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	11
Paraguay	✓	●	✓	✓	✓	●	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	7
Peru	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Philippines	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	3
Poland	✓	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	4
Portugal	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	3

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Korea, Rep.
Moldova
Romania
Russian Federation
Rwanda
St. Kitts and Nevis
St. Lucia
St. Vincent and the Grenadines
Samoa
San Marino
Sao Tome and Principe
Saudi Arabia
Senegal
Serbia
Seychelles
Sierra Leone
Singapore
Slovak Republic
Slovenia
Solomon Islands
Somalia
South Africa
South Sudan
Spain
Sri Lanka

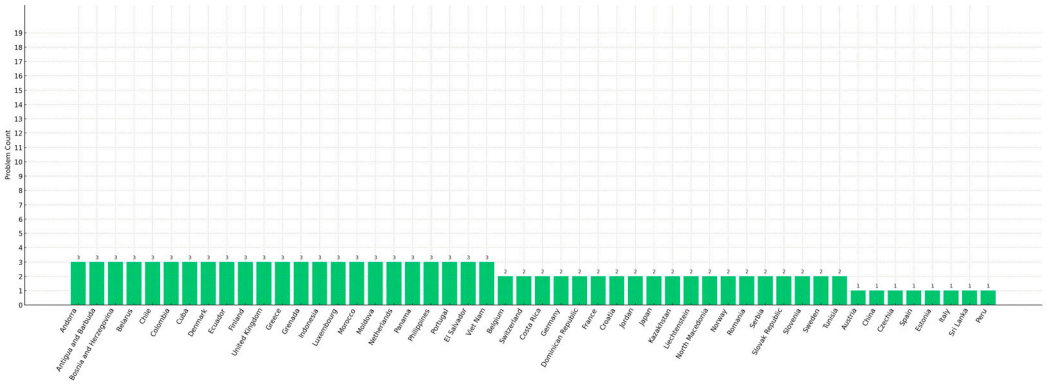
	1 Food Production Inadequacy	2 Food Loss and Waste	3 Supply Chain Vulnerability	4 Increased Food Demand	5 Insufficient Native Species	6 Insufficient Introduction of Food Species	7 Food Contamination	8 Food Spoilage	9 Improper Use of Synthetic Chemicals	10 Toxic Food Issues	11 Pre-Eating Stage Issues	12 Eating Stage Issues	13 Post-Eating Stage Issues	14 Prevalence of Under-Eating Diseases	15 Prevalence of Food-Borne Diseases	16 Prevalence of Diseases from Dietary Imbalance	17 Prevalence of Overeating Diseases	18 Prevalence of Food Sensitivity Diseases	19 Prevalence of Appetite Deficiency Diseases	20 Dual-Aesthetic Imbalance	21 Five-Sense Aesthetic Bias	22 Public Administration Issues in the Food System	23 Gaps in Laws and Standards for the Food System	24 The Failure of Education, Science, and Culture to Address	25 External Shocks and Geopolitical Risks to the Food System	26 Economically Unsustainable Development of the Food System	27 Structural Ecosystem Degradation (Caused by Food-System Activities)	28 Non-structural Ecosystem Degradation (Emissions' Loads from the Food System)	Issue Count
Sudan	✓	●	●	✓	✓	●	✓	●	✓	✓	✓	✓	✓	※	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	●	●	✓	✓	8
Suriname	✓	●	✓	✓	✓	●	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	●	●	✓	✓	✓	✓	●	8
Sweden	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	2
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	2
Syrian Arab Republic	✓	✓	●	●	●	●	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	●	●	✓	✓	●	●	●	✓	10
Tajikistan	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	6
Thailand	✓	●	✓	✓	✓	●	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	●	✓	●	✓	6
Timor-Leste	●	✓	✓	✓	●	●	●	✓	●	●	✓	✓	✓	●	●	✓	✓	✓	✓	✓	●	✓	●	●	✓	●	✓	✓	12
Togo	✓	●	✓	●	✓	✓	●	●	●	●	✓	✓	✓	●	●	✓	✓	✓	✓	✓	●	●	✓	●	●	✓	●	✓	13
Tonga	✓	✓	✓	✓	●	●	✓	✓	✓	✓	●	●	●	✓	✓	✓	●	✓	✓	●	✓	✓	✓	✓	✓	✓	●	✓	8
Trinidad and Tobago	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	●	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	●	6
Tunisia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	2
Turkiye	✓	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	●	✓	●	✓	5
Turkmenistan	✓	✓	✓	✓	●	●	✓	✓	✓	✓	●	●	●	✓	✓	✓	●	●	✓	✓	✓	●	✓	●	✓	●	●	✓	11
Tuvalu	✓	✓	✓	✓	●	●	✓	✓	✓	✓	●	●	●	✓	✓	✓	●	✓	✓	●	—	●	●	✓	✓	●	●	✓	11
Uganda	●	●	✓	●	✓	✓	●	✓	●	●	✓	✓	✓	●	●	✓	✓	●	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	10
Ukraine	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	●	✓	●	✓	4
United Arab Emirates	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	4
United Kingdom	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	3
Tanzania	●	●	✓	●	✓	✓	●	●	●	●	✓	✓	✓	●	●	●	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	11
United States	✓	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	●	●	✓	✓	✓	✓	✓	✓	✓	7
Uruguay	✓	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	●	●	●	●	●	✓	✓	✓	✓	✓	✓	●	8
Uzbekistan	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	●	✓	✓	✓	✓	✓	●	✓	✓	●	✓	6
Vanuatu	✓	✓	✓	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	●	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	5
Venezuela, RB	✓	✓	●	✓	✓	●	✓	✓	✓	✓	—	—	—	✓	✓	●	●	✓	✓	—	✓	✓	✓	✓	●	●	✓	✓	6
Viet Nam	✓	●	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	3
Yemen, Rep.	✓	●	●	●	●	✓	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	✓	✓	✓	✓	—	✓	●	●	●	●	✓	✓	9
Zambia	●	✓	✓	●	✓	✓	●	✓	●	●	✓	✓	✓	●	●	✓	✓	✓	✓	✓	—	●	✓	✓	✓	✓	✓	✓	8
Zimbabwe	●	●	✓	●	✓	●	●	✓	●	●	●	●	●	●	●	✓	✓	✓	✓	✓	—	✓	✓	✓	✓	●	●	✓	14

6-2.5 Country Grouping by the Number of Food-System Issues

Countries can also be grouped by the number of food-system issues they face across the 28 fourth-level issues. For the purpose of comparison, four broad types are used here: role-model countries (3 issues or fewer), learning countries (4–6), catching-up countries (7–9), and survival countries (10 or more). Although these are simple groupings, they help illustrate several common patterns.

1. Role-model countries (≤3 issues)

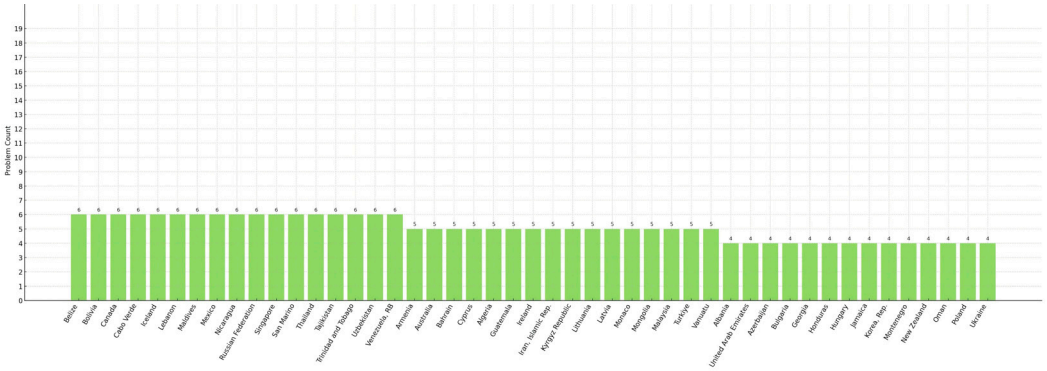
Figure 6-2. Countries with Less than 3 Food-System Issues (Role-Model Group)



This group includes 50 countries. These countries show only a small number of issues, usually in a few non-structural or behavioural areas, such as food waste or certain dietary habits. Most structural aspects of the food system—food availability, nutrition, supply-chain stability—do not show major weaknesses, suggesting that these systems generally run smoothly.

2. Learning countries (4–6 issues)

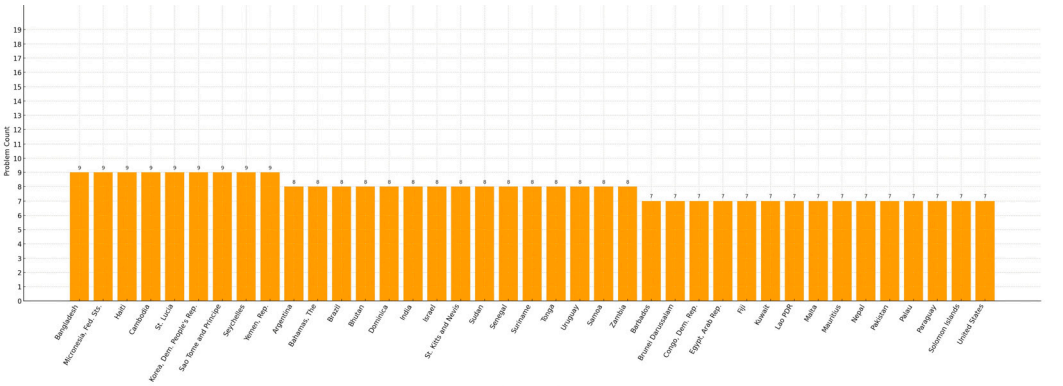
Figure 6-3. Countries with 4–6 Food-System Issues (Learning Group)



There are 47 countries in the learning group. These countries show slightly more issues, but most of them are still concentrated in specific areas that can be improved. These may include dietary balance, food-safety oversight, or the efficiency of parts of the supply chain. The overall structure of the food system is mostly in place, but there is clear room for strengthening.

3. Catching-up countries (7–9 issues)

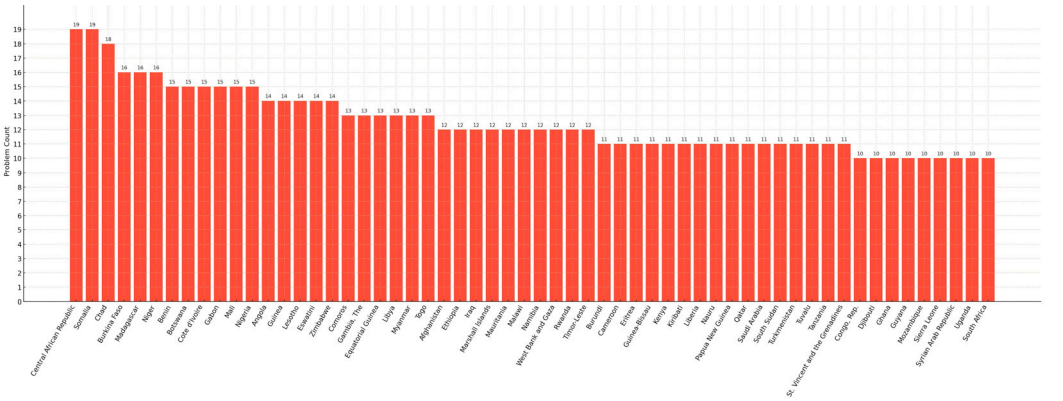
Figure 6-4. Countries with 7–9 Food-System Issues (Catching-Up Group)



The catching-up group consists of 39 countries, where issues begin to appear across several dimensions at the same time. It is common to see problems linked to dietary diversity, nutrition, food safety, and supply-chain reliability. These patterns suggest that the food system faces pressure on several fronts and that its resilience is relatively limited.

4. Survival countries (≥10 issues)

Figure 6-5. Countries with 10 or More Food-System Issues (Survival Group)



A total of 58 countries fall into the survival group. These countries experience the highest number of issues. Structural, behavioural, and governance challenges often

appear together—for example, food shortages, low dietary diversity, fragile supply chains, and limited regulatory or institutional capacity. These food systems are highly vulnerable and require significant, long-term support.

6-2.6 Food-System Issue Burdens and National Life Expectancy Across Countries

Life expectancy is a multidimensional outcome shaped by a wide constellation of factors—health-care access, socioeconomic conditions, education, sanitation, environmental quality, and the broader stability of society. Within this complex system, food systems constitute one of the most influential pathways through which population-level health is produced. Dietary quality, food safety, nutritional adequacy, and eating behaviours each contribute substantially to the long-term risks of non-communicable diseases and to overall healthy lifespan, as consistently demonstrated in global evidence from WHO and other international bodies.

Importantly, the burden of food-system issues does not determine life expectancy on its own; rather, it interacts with the wider policy, institutional, and socioeconomic environment of a country. Nevertheless, cross-country patterns reveal that countries facing multiple, persistent food-system problems—whether in adequacy, diversity, safety, or behavioural dimensions—tend to encounter greater challenges in achieving high levels of population health and longevity. Conversely, countries that manage to reduce food-system risks often display stronger performance in life expectancy relative to their income levels.

The following analysis therefore examines the correspondence between the number of food-system issues identified in each country and its national life expectancy, in order to highlight observable associations and to illustrate how food systems may contribute to divergences in longevity outcomes across countries.

Countries are classified into four groups according to their national life expectancy: (reference year = 2023; source = United Nations, World Population Prospects (WPP) 2024 revision) low-life-expectancy (<60 years), lower-middle (60–69 years), upper-middle (70–79 years), and high-life-expectancy (≥80 years). The distribution of food-system issue burdens across these groups exhibits a clear, stepwise pattern: countries with higher life expectancy tend to face fewer food-system issues, whereas those with lower life expectancy carry substantially heavier burdens.

1. High-life-expectancy group (≥80 years).

Table 6-5, Issue Burdens and Life Expectancy: ≥80-Year Countries

Country	Issue Count	Life Expectancy
Monaco	5	86.372
San Marino	6	85.706
Liechtenstein	2	84.84146341
Switzerland	2	84.05609756
Japan	2	84.04121951
Andorra	3	84.041
Spain	1	83.88292683
Italy	1	83.7
Malta	7	83.50731707
Korea, Rep.	4	83.42926829
Luxembourg	3	83.35853659
Sweden	2	83.3097561
Israel	8	83.19512195
Kuwait	7	83.18780488
Norway	2	83.11219512
Australia	5	83.05121951
New Zealand	4	83.00487805
France	2	82.92926829
United Arab Emirates	4	82.909
Singapore	6	82.89512195
Ireland	5	82.86097561
Iceland	6	82.60731707
Belgium	2	82.39756098
Qatar	11	82.368
Portugal	3	82.2804878
Slovenia	2	81.97804878
Netherlands	3	81.91463415
Denmark	3	81.85365854
Finland	3	81.68536585
Cyprus	5	81.648
Canada	6	81.64658537
Austria	1	81.54146341

Country	Issue Count	Life Expectancy
Greece	3	81.53658537
Bahrain	5	81.284
United Kingdom	3	81.23809756
Chile	3	81.167
Maldives	6	81.041
Costa Rica	2	80.799
Germany	2	80.54146341
Oman	4	80.031

As shown in Table 6-5, this group comprises 40 countries with an average of 3.85 food-system issues, the lowest among all four groups. These countries typically feature strong public-health systems, diversified diets, well-developed supply chains, and mature governance arrangements. Remaining challenges tend to be non-structural—such as food waste or overconsumption—rather than issues related to adequacy, safety, or access.

2. Upper-middle-life-expectancy group (70–79 years).

Table 6-6, Issue Burdens and Life Expectancy: 70–79-Year Countries

Country	Issue Count	Life Expectancy
Czechia	1	79.87804878
Albania	4	79.602
Panama	3	79.594
Saudi Arabia	11	78.732
Poland	4	78.50731707
Estonia	1	78.4902439
Croatia	2	78.47317073
United States	7	78.38536585
Uruguay	8	78.138
Cuba	3	78.085
Slovak Republic	2	78.01707317
China	1	77.953
Bosnia and Herzegovina	3	77.85
Lebanon	6	77.817
Jordan	2	77.814
Peru	1	77.74

Country	Issue Count	Life Expectancy
Colombia	3	77.725
Iran, Islamic Rep.	5	77.654
Antigua and Barbuda	3	77.598
Montenegro	4	77.58780488
Sri Lanka	1	77.483
Armenia	5	77.46585366
Argentina	8	77.395
Ecuador	3	77.392
Turkiye	5	77.156
Lithuania	5	76.98780488
Hungary	4	76.77073171
Malaysia	5	76.657
Romania	2	76.60731707
Tunisia	2	76.508
Thailand	6	76.412
Algeria	5	76.261
Serbia	2	76.22097561
Barbados	7	76.178
Cabo Verde	6	76.059
Brazil	8	75.848
Bulgaria	4	75.70731707
Latvia	5	75.67804878
Brunei Darussalam	7	75.327
North Macedonia	2	75.31609756
Morocco	3	75.313
Grenada	3	75.205
Mexico	6	75.069
Seychelles	9	74.95853659
Nicaragua	6	74.947
Bangladesh	9	74.672
Viet Nam	3	74.588
Bahamas, The	8	74.552
Georgia	4	74.496
Azerbaijan	4	74.429

Country	Issue Count	Life Expectancy
Kazakhstan	2	74.402
Belarus	3	74.18378049
Paraguay	7	73.844
Dominican Republic	2	73.72
Korea, Dem. People's Rep.	9	73.642
Suriname	8	73.631
Belize	6	73.566
Trinidad and Tobago	6	73.49
Ukraine	4	73.422
Mauritius	7	73.41219512
Russian Federation	6	73.25463415
Bhutan	8	72.975
Tonga	8	72.895
Honduras	4	72.884
St. Lucia	9	72.697
Guatemala	5	72.602
Venezuela, RB	6	72.514
Uzbekistan	6	72.388
Iraq	12	72.324
Kyrgyz Republic	5	72.24878049
St. Kitts and Nevis	8	72.145
Mongolia	5	72.12243902
Syrian Arab Republic	10	72.12
El Salvador	3	72.099
India	8	72.003
Tajikistan	6	71.79
Samoa	8	71.698
Egypt, Arab Rep.	7	71.633
Jamaica	4	71.479
Vanuatu	5	71.477
St. Vincent and the Grenadines	11	71.23
Moldova	3	71.198
Indonesia	3	71.146

Country	Issue Count	Life Expectancy
Dominica	8	71.132
Cambodia	9	70.668
Solomon Islands	7	70.528
Nepal	7	70.354
Guyana	10	70.18
Turkmenistan	11	70.073

According to Table 6-6, this group includes 89 countries with an average of 5.36 issues, a notable increase relative to the high-life-expectancy category. Although basic supply and nutrition conditions remain relatively robust, food-safety risks, dietary imbalances, and supply-chain inefficiencies are more prevalent. This group represents the global "moderate-burden" segment in food-system performance.

3. Lower-middle-life-expectancy group (60–69 years).

Table 6-7, Issue Burdens and Life Expectancy: 60–69-Year Countries

Country	Issue Count	Life Expectancy
Philippines	3	69.833
Sao Tome and Principe	9	69.718
Libya	13	69.339
Yemen, Rep.	9	69.295
Palau	7	69.269
Botswana	15	69.163
Lao PDR	7	68.964
Senegal	8	68.683
Eritrea	11	68.624
Bolivia	6	68.581
Mauritania	12	68.484
Gabon	15	68.337
Uganda	10	68.252
Rwanda	12	67.785
Timor-Leste	12	67.689
Pakistan	7	67.649
Namibia	12	67.385

Country	Issue Count	Life Expectancy
Malawi	12	67.353
Fiji	7	67.316
Ethiopia	12	67.315
Micronesia, Fed. Sts.	9	67.198
Tuvalu	11	67.105
Tanzania	11	66.995
Marshall Islands	12	66.945
Myanmar	13	66.889
Comoros	13	66.777
Kiribati	11	66.473
Zambia	8	66.349
Sudan	8	66.331
South Africa	10	66.139
Papua New Guinea	11	66.134
Afghanistan	12	66.035
Djibouti	10	65.987
Gambia, The	13	65.86
Congo, Rep.	10	65.772
Ghana	10	65.498
West Bank and Gaza	12	65.17
Haiti	9	64.936
Angola	14	64.617
Eswatini	14	64.123
Guinea-Bissau	11	64.085
Equatorial Guinea	13	63.707
Cameroon	11	63.7
Burundi	11	63.651
Kenya	11	63.646
Madagascar	16	63.632
Mozambique	10	63.611
Zimbabwe	14	62.775
Togo	13	62.739
Liberia	11	62.163

Country	Issue Count	Life Expectancy
Nauru	11	62.109
Cote d'Ivoire	15	61.944
Congo, Dem. Rep.	7	61.895
Sierra Leone	10	61.786
Niger	16	61.183
Burkina Faso	16	61.092
Benin	15	60.774
Guinea	14	60.74
Mali	15	60.439

As presented in Table 6-7, 59 countries fall within this interval, with average issue counts rising sharply to 11.19—nearly three times the level observed in high-life-expectancy countries. Countries in this category frequently experience structural constraints, including insufficient food availability, low dietary diversity, weaker food-safety oversight, higher malnutrition burdens, and constrained health and social protection systems. This group marks a key inflection point where food-system vulnerabilities begin to accumulate rapidly.

4. Low-life-expectancy group (<60 years).

Table 6-8, Issue Burdens and Life Expectancy: <60-Year Countries

Country	Issue Count	Life Expectancy
Somalia	19	58.816
South Sudan	11	57.617
Central African Republic	19	57.408
Lesotho	14	57.375
Chad	18	55.069
Nigeria	15	54.462

Table 6-8 shows that this group contains only six countries, yet it faces the heaviest burden, with an average of 16 issues, approaching the upper bound of all measured problems. These countries commonly confront multiple overlapping risks—severe food shortages, extremely low dietary diversity, fragile supply chains, heightened exposure to climate and environmental shocks,

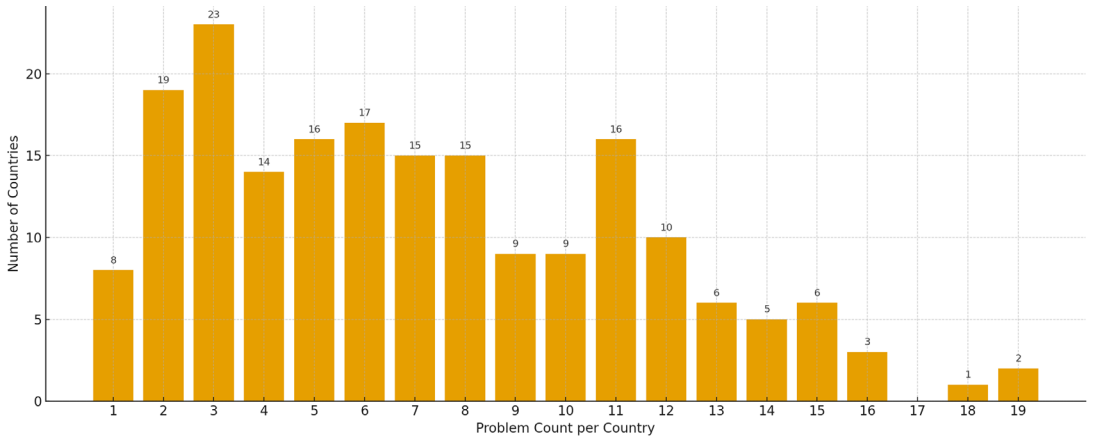
governance limitations, and in some cases conflict or protracted instability. Notably, the three countries registering the highest number of food-system issues globally are all located within this low-life-expectancy group, underscoring the concentration of extreme systemic vulnerabilities at the lower end of the global longevity distribution.

6-2.7 Key Findings

1. Marked global unevenness with clear regional contrasts

From the cross-country distribution of issue counts, it is evident that every country exhibits food-system problems to some degree, with none being exempt. Most countries face approximately 3–9 issues, while a small subset reports very few and another subset nearly spans the full range. Summary statistics show a median of about 5, a mean of about 6, and a standard deviation of 4.4, indicating substantial dispersion.

Figure 6-6. Global Distribution of Food-System Issues



By region, the aggregate burden differs markedly. Africa averages about 10.8 issues, the highest across regions, with a wide spread (interquartile range 9–13) and maxima reaching 17 issues. In contrast, Europe averages about 3 issues (median 3), with most countries falling between 2 and 4, clearly lower than other regions. Asia averages about 6.3, Latin America about 5.8, Oceania about 6.9, and North America about 5.4, all between Europe and Africa. This pattern indicates that African countries generally face more complex and severe food-system challenges, while European (and other high-income) regions tend to exhibit fewer and more concentrated issues. Asia and Latin

America occupy an intermediate position but with notable within-region heterogeneity (e.g., Yemen and Afghanistan approaching African levels, whereas Japan and Singapore are closer to European levels). Oceania's higher average is influenced by several Pacific Small Island Developing States (e.g., Vanuatu, Solomon Islands) that score poorly on food and nutrition and environmental vulnerability, thereby raising the regional mean.

2. Coastal countries generally outperform landlocked countries, with context-specific exceptions

A clear difference in total issue counts is associated with coastline status: landlocked countries average ≈8.4 issues, whereas coastal countries average ≈6.3. Landlocked economies face structural constraints—absence of seaports, restricted trade and import routes, and higher logistics costs—that disadvantage them on supply adequacy, price stability, and dietary diversity. For example, Niger, Mali, and Uganda not only produce insufficient grain domestically but also struggle to replenish shortfalls promptly via international markets, resulting in compounded risks of malnutrition and food price volatility. By contrast, coastal countries more readily rebalance through trade and access diverse food sources, and coastal status often coincides with denser infrastructure and economic hubs, collectively dampening food-system vulnerability. These landlocked disadvantages can be mitigated through regional cooperation and infrastructure investment (e.g., transnational transport corridors, cross-border trade facilitation, and dry-port/rail links) to reduce geography-driven accumulation of risks.

At the same time, Small Island Developing States (SIDS) are an important context-specific exception to the "coastal advantage." Despite being coastal, many SIDS exhibit high import dependence and elevated climate exposure, and therefore do not necessarily show low issue counts.

3. Severe food-system challenges confronting African countries

In our global mapping and assessment, African countries as a whole face more severe and complex food-system challenges. Notably, the countries with the highest aggregate burdens are concentrated in Africa.

For example, four countries each register 17 issues—the global maximum: the Central African Republic, Chad, Madagascar, and Somalia. These countries are generally low-income and governance-fragile and/or landlocked. Chad and the Central African Republic are landlocked, with underdeveloped economies and long-standing exposure to food shortages and conflict; Somalia is affected by conflict and climate hazards; Madagascar combines pervasive poverty with frequent natural disasters, yielding a particularly complex set of food-

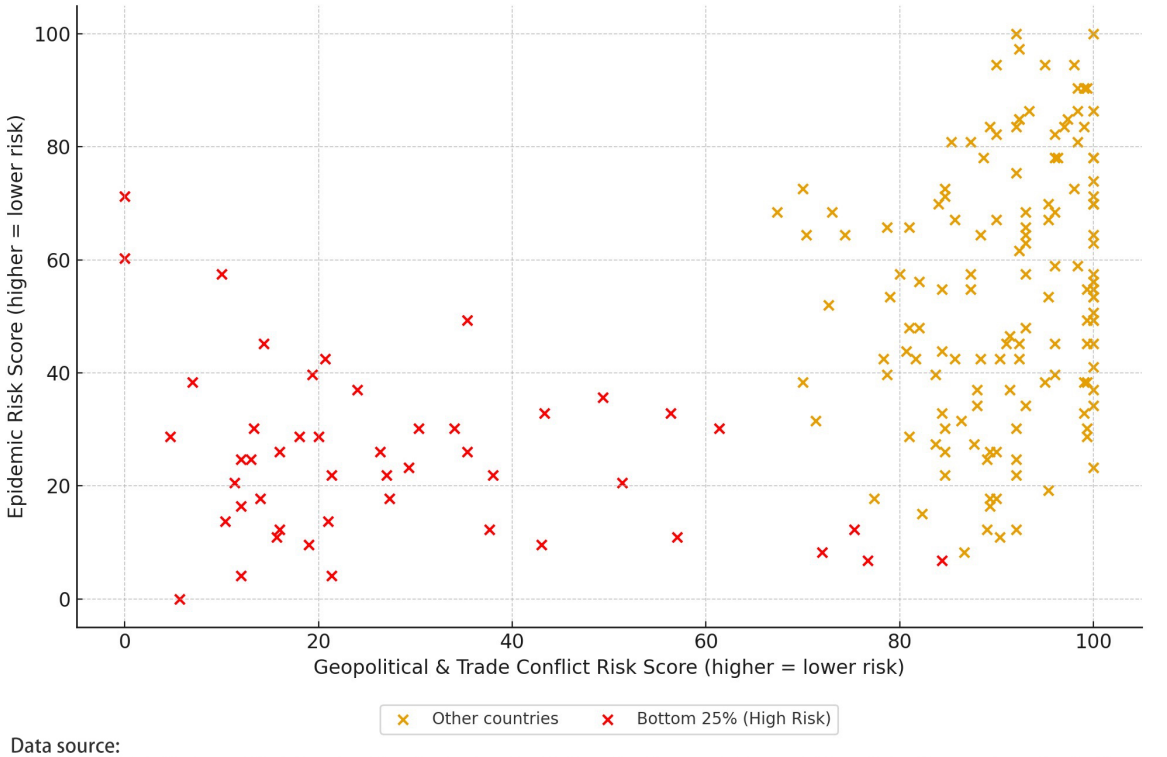
system stressors. In our assessment, their per-capita GDP levels are below one-tenth of the global average, placing them among the least developed countries. Geography also compounds constraints: some are embedded deep in the continental interior (e.g., Chad, Central African Republic), while others are remote from major shipping lanes (e.g., the island of Madagascar). These structural and infrastructural factors restrict food-supply-chain development and contribute to deficits across quantity, quality, nutrition, and environmental dimensions.

Several West African countries—such as Niger, Burkina Faso, and Nigeria—also display 14 issues, ranking immediately behind the most burdened group. Overall, the countries with the largest problem sets are clustered in less-developed subregions of Africa and tend to share common characteristics: low income, landlocked status or weak infrastructure, high disaster exposure, and, in some cases, conflict and governance fragility.

4. Clear "polarization" patterns in several issue domains

The distribution of education, science, and culture in the food system shows a pronounced bimodal pattern: roughly half of countries score near zero, indicating minimal or no relevant public education and cultural measures, while the other half cluster at high scores, revealing a clear gap between two groups. This suggests that many low-income countries have almost no nutrition education or science-based cultural guidance, whereas many high-income countries have established and institutionalized food-education and cultural systems—forming two distinct cohorts.

Figure 6-7. Scatterplot of External Shocks and Geopolitical Risk (Geopolitics–Trade vs. Epidemics)



Data source:
Nuclear Threat Initiative (NTI); Johns Hopkins Center for Health Security; Economist Impact; Global Health Security Index 2021.

A similar segmentation appears for external shocks and geopolitical risk: scores span the 0–100 range in a three-tier (trimodal) pattern (see Figure 6-7)—a small subset of highly vulnerable countries with very low scores (<10); a majority in the mid-to-high band (50–80); and a small group approaching the upper bound (>90). This indicates sharp global disparities in resilience to climate events, disasters, and other shocks: most countries exhibit some resilience, yet a vulnerable tail remains heavily exposed, while a limited number achieve very robust preparedness.

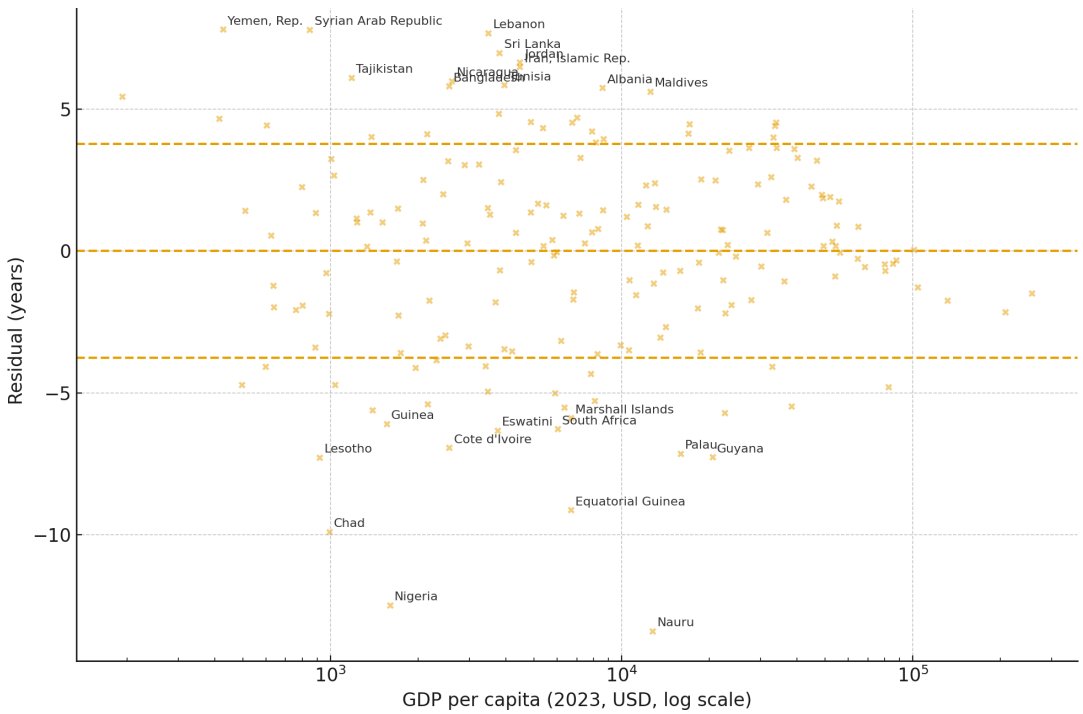
5. Eating-methods and health outcomes are not strictly monotonic with GDP

While the total number of food-system issues tends to be negatively correlated with per-capita GDP, eater health performance does not follow a simple "the richer, the better" rule. To further illuminate the behavioral–health mechanisms operating within food systems, we construct a nonlinear regression model using 2023 per-capita GDP (USD) and average life expectancy (years), with log(GDP) as the explanatory variable. This

model estimates the life expectancy a country "should" attain at its given income level. Comparing the predicted values with actual life expectancy yields a residual indicator that reflects eater health performance and the efficiency with which the food system converts income into longevity. A positive residual indicates that a country achieves additional health gains beyond what income alone would predict; a negative residual signals underperformance relative to its income-implied benchmark.

The residual distribution reveals an important pattern (see figure 6-8). A cohort of middle-income East and Southeast Asian economies demonstrates notably strong performance across the "pre-meal–intra-meal–post-meal" stages of dietary methodology—including intake quantity, speed, sequence, temperature, rhythm, and degree of processing—yielding consistently positive residuals and life-expectancy outcomes that surpass those of some high-income countries. By contrast, performance across much of Africa remains relatively weak. This pattern underscores that behavioral–cultural–educational levers can generate above-income gains, enabling improvements in health outcomes that do not depend strictly on high income.

Figure 6-8. One of the Eating-Method Assessment Indicators: Life Expectancy–Income Residual



This evidence shows that supply-side measures alone cannot sufficiently improve healthy life expectancy. Eating methodology (Eatology) itself constitutes a critical governance variable within food systems: when food education (public education and social norming) systematically influences the entire "before–during–after eating" process, low-cost, high-return health improvements become attainable. Therefore, behavioral and dietary-practice interventions should be embedded in national dietary guidelines and integrated into school and community education systems, making them a priority for building sustainable, health-enhancing food systems.

6. Intra-human (internal) conflict — a small lower tail with concentrated risk

Across countries, scores for administrative governance, legal governance, and economic sustainability cluster around the middle range (see Figures 6-9 to 6-11). This implies that while most countries have not reached best-practice governance, they are not failures either. The number of very low-scoring countries is small; however, vulnerability is highly concentrated in this lower tail, implying elevated systemic risk. In addition, the three scores exhibit strong positive correlations, suggesting that administrative governance, legal governance, and economic sustainability are structurally reinforcing.

Figure 6-9. Global Distribution of Food-System Administrative Governance (Regulations and Standards) Scores — Boxplot

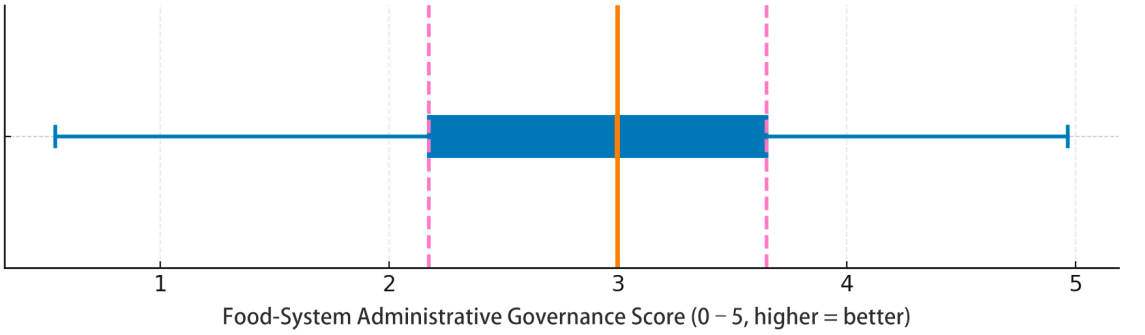


Figure 6-10. Global Scores for the Completeness of Food-System Laws, Regulations, and Standards—Box-and-Jitter

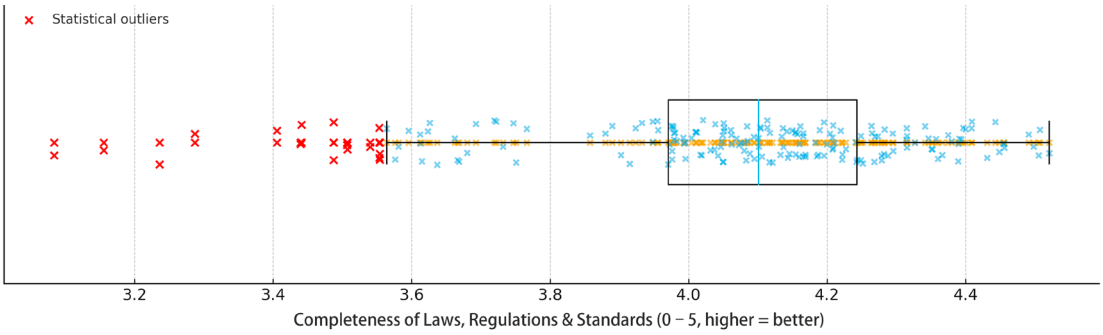
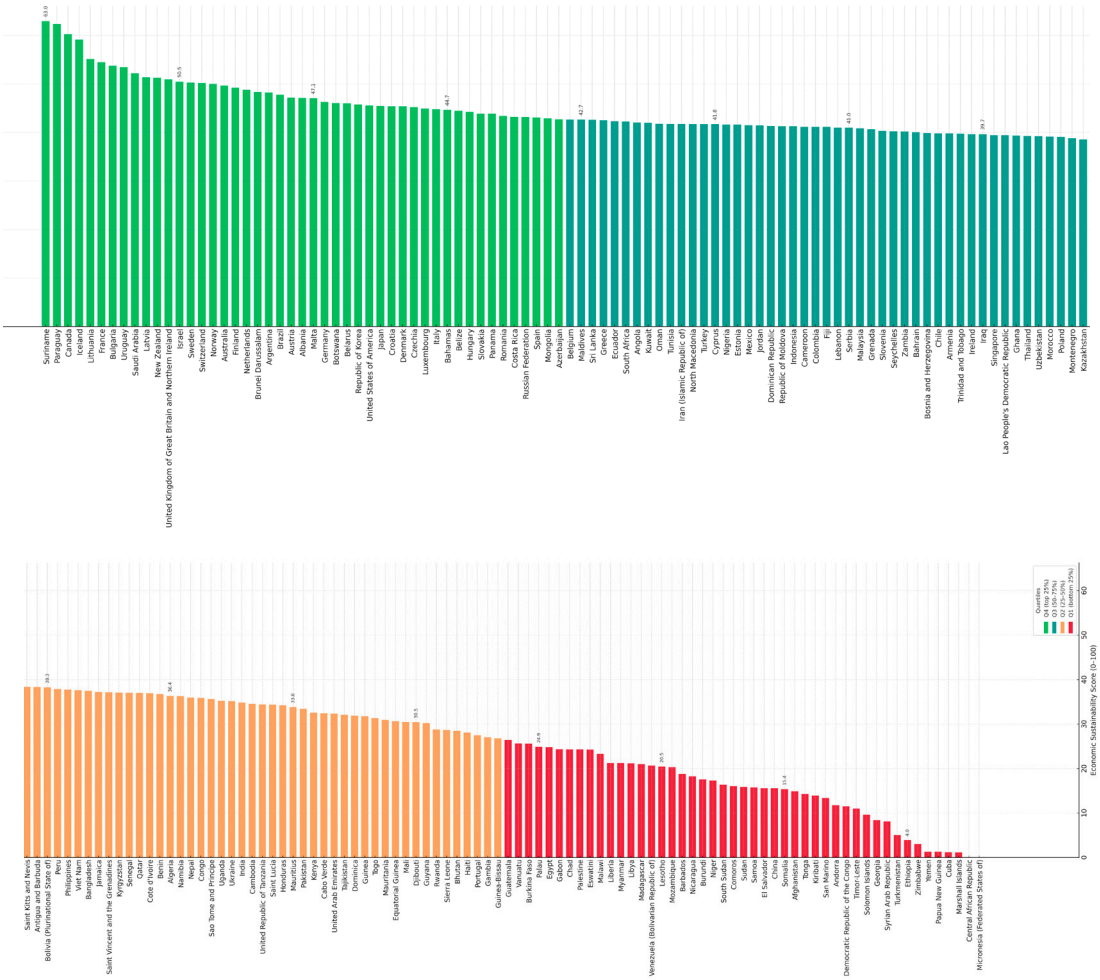


Figure 6-11. Food-System Economic Sustainability Scores — Global Ranking



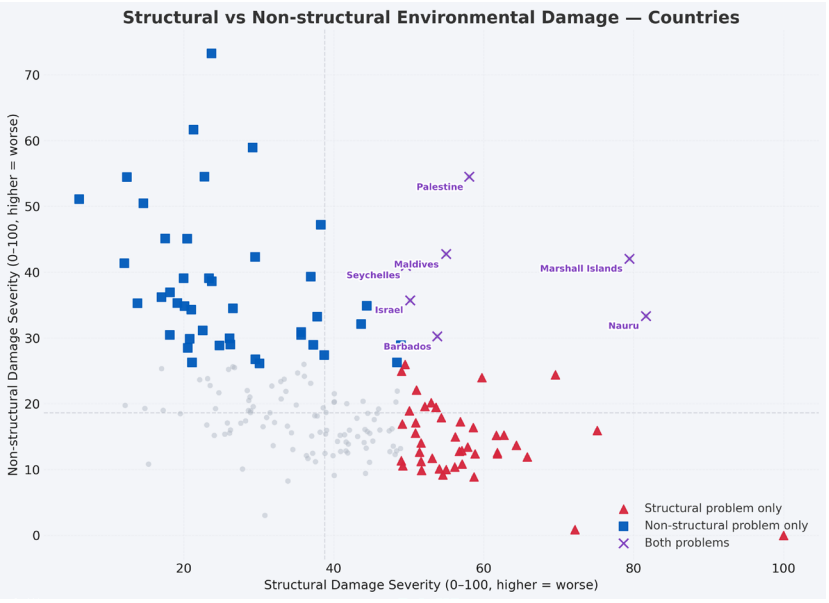
7. Most countries fall within a mid-damage band for ecological–environmental issues in food systems

Ecological–environmental pressures are widespread rather than localized: the majority of countries sit in a moderate-damage band, still short of "best practice" (Figure 6-12). A clear two-mode pattern emerges—one structure-led (dominated by ecosystem destruction) and the other pollution-led (dominated by ecosystem pollution). At the country level these modes often trade off (a negative association): where one pressure is pronounced, the other tends to be lighter—though they are not mutually exclusive. A small subset of countries falls into a "double-high" zone, where structural damage and pollution are both elevated; risks compound and resilience is thin. These cases are typical of Small Island Developing States (SIDS) and other fragile economies and should be prioritized for intervention.

Implications for differentiated governance (by dominant pressure):

- Structure-led: prioritize curbing land-use expansion and advancing ecosystem restoration.
- Pollution-led: prioritize emissions reduction, pollution control, and circular-economy measures.
- Double-high: adopt integrated packages (restoration + pollution abatement), with enhanced external support and climate-resilience building.
- Moderate/low: focus on consolidation and prevention (standards, monitoring, early warning).

Figure 6-12. Scatterplot of Food-System Ecological–Environmental Issues



6-3 Multidimensional Solution Analysis of Global Food-System Issues

6.3.1 Framing and Governance Premise

In the face of complex, interlocking food-system issues, single-dimension interventions rarely suffice. Shortfalls in production, gaps in legal and administrative capacity, ecological degradation, and aesthetic/cultural biases are simultaneously cross-sectoral and cross-regional, and in practice they intertwine and amplify one another. A growing international consensus holds that effective solutions must be grounded in systems thinking, interdisciplinary tools, and multi-stakeholder cooperation. Against this backdrop, Shiology adopt a global-governance lens, advocating global governance anchored in the Five Eater Needs (5E) and enabled by a shared taxonomy and coding system. In practice, this entails:

1. Common standards and interoperable data (definitions for safety, nutrition, loss/waste, sustainability metrics) so that countries can compare like with like and coordinate action.
2. Rules-based trade and crisis cooperation (transparent export policies, emergency grain corridors, strategic reserves coordination, early-warning and risk-communication protocols) to prevent local shocks from cascading globally.
3. Global public goods for the food system: open datasets, pathogen and contaminant surveillance networks, climate-smart R&D platforms, and evidence clearinghouses linking problems to interventions through the 5E.
4. Peer learning and capability exchange, including South–South and triangular cooperation on regulatory practice, cold-chain/logistics, digital traceability, and nutrition-sensitive programs.
5. Financing mechanisms that align incentives with the 5E (e.g., sustainability-linked instruments, results-based nutrition financing, and blended finance for resilience and safety infrastructures).

In this way, Shiology supplies a common language—survival, health/longevity, and sustainability—so that national diagnostics roll up into regional and global dashboards, enabling burden-sharing and joint problem-solving where unilateral action is insufficient.

6.3.2 Issue–Solution Mapping with a Fourteen-Dimension Solution Framework

Building on the global-governance premise, this section provides a panoramic analysis of solution options to make food systems more resilient, equitable, and sustainable. Centering on the fourth-level classification of the Food-System Issue Framework, the study covers 28 specific issues and—for the first time—organizes solutions into a fourteen-dimension framework. These dimensions are:

A. Law (legislation, regulations, standards)
B. Food governance/administration (coordination, enforcement, oversight)
C. Population policy
D. Trade (market access, facilitation, risk management, diversification)
E. Pricing/incentives (price policy, stabilization instruments)
F. Investment (public, private, blended finance)
G. Subsidies (targeting, efficiency, safeguards)
H. Taxation (health-promoting and environmental tax instruments)
I. Technology (R&D, diffusion, appropriate tech)
J. Digitalization (data systems, platforms, traceability, early warning)
K. Education/food literacy (public education, school & community programs)
L. Aid and international cooperation (donor support, capacity building, technology transfer)
M. Eater experience (self-check during eating)
N. Medical & public health (prevention, screening, treatment, surveillance)

The analysis proceeds in two steps. First, for each of the 28 issues we synthesize current solutions drawn from policy and practice. Second, we propose missing but actionable complements, especially those informed by the Shiology perspective on eater–food–order (governance) integration. Not every issue maps to all fourteen dimensions; tables and discussion present only relevant measures and rank them by importance and priority, thereby highlighting critical gaps and signaling new directions for policy and research.

Tables 6-9, 6-10, and 6-11 present the issue–solution mappings for Eater Survival, Eating for Health and Longevity, and Eater Sustainability, respectively.

Table 6-9. Issue-Solution Mapping: Eater Survival

Issue	Existing Solutions	Supplementary Solutions
1. Food Quantity Issues **Food Production Inadequacy** **[SI-1111000]**	I - Technology: Enhance agricultural productivity through technological innovation.	
	J - Digitalization: Leverage big data analytics to enhance yields and optimize labor efficiency.	
	D - Trade: Expand food imports to diversify supply sources.	
	B - Policy: Expand the cultivated land area.	
	L - Donation: Accept international food aid.	
	C - Population	
	F - Investment: Prioritize investment in scientific research and infrastructure to drive long-term growth.	
	G - Subsidy: Provide financial support for critical agricultural inputs such as fertilizers, seeds, irrigation systems, and machinery.	
	K - Education: Equip farmers with new techniques through targeted training to drive agricultural productivity.	
2. Food Quantity Issues **Food Loss and Waste [SI-1112000]**	A - Legislation: Implement regulations that discourage resource inefficiency in commerce and industry by accounting for full lifecycle costs.	
	K - Education: Implement educational initiatives on the value of food to prevent waste in daily life.	Educate producers and food industry professionals to enhance their judgment and crisis awareness, thereby minimizing loss and waste across the supply chain. Implement food education programs that raise awareness of the food security crisis and curb food waste.
	I - Technology: Leverage advanced technologies—including warehouse automation, cold-chain monitoring, and remote monitoring—to minimize spoilage and reduce food loss.	
	J - Digitalization: Streamline supply chain management with real-time inventory monitoring to cut food loss across the distribution system.	Develop a data-driven, collaborative platform to monitor and track food loss in real-time across the entire supply chain.
	B - Policy: Mandate that supermarkets and restaurants donate unsold, safe-to-consume food to charitable organizations, and establish protocols to facilitate the donation process.	
	F - Investment: Boost investment in logistics and storage infrastructure to mitigate losses caused by delays and physical damage.	
	G - Subsidy: Implement a program of subsidies and preferential loans to facilitate the acquisition of cold storage and warehouse infrastructure.	
	E - Pricing: Implement dynamic pricing and discount incentives for near-expiration products to minimize waste from discards.	

Issue	Existing Solutions	Supplementary Solutions
3. Food Quantity Issues **Supply Chain Vulnerability [SI-1113000]**	I - Technology: Deploy precision agriculture technologies, such as sensors and AI-driven analytics, to mitigate vulnerabilities and production shocks at the source of the supply chain.	
	J - Digitalization: Leverage digital technologies to monitor inventory, forecast demand, optimize distribution, and enhance resilience against supply chain disruptions.	
	B - Trade: Lower import tariffs, diversify trading partners, and strengthen trade facilitation measures to enhance economic resilience.	
	E - Pricing: Implement measures to monitor and stabilize grain prices across the wholesale-to-retail supply chain, preventing volatility from undermining food affordability and access.	
	F - Investment: Prioritize strategic investments in agricultural infrastructure to guarantee a stable and sufficient domestic supply.	
4. Food Quantity Issues **Increased Food Demand [SI-1114000]**	C - Population	
	B - Policy: Prioritize food over fuel by managing industrial demand for agricultural commodities.	Manage the competing demands for agricultural commodities to ensure food security, including reviewing their use in sectors like aquaculture, animal husbandry, and brewing.
	A - Legislation: Enact legislation to ensure food security and protect cultivated land.	
	I - Technology: Adopt high-yielding and genetically modified crops and leverage advanced agricultural technologies to boost productivity.	
	J - Digitalization: Implement big data-driven demand forecasting to achieve a more precise and efficient supply chain.	
	F - Investment: Boost investment in key agricultural infrastructure, including irrigation, and cold-chains.	
	G - Subsidy: Provide direct production subsidies and enhance planting incentives.	
	H - Taxation: Leverage tax incentives to boost grain production and ensure the stability of reserve supplies.	
5. Food Variety Issues **Insufficient Native Species [SI-1121000]**	D - Trade: Introduce and adapt foreign crop species.	
	B - Policy: Conserve local biodiversity, implement crop diversification policies, and actively promote the commercialization of unique local crops.	
	A - Legislation: Strengthen legal protections for biodiversity through the enactment of specific conservation regulations.	

Issue	Existing Solutions	Supplementary Solutions
	F - Investment: Invest in germplasm conservation, modern breeding capacity, and diversified agricultural models to build a more resilient food system.	
	G - Subsidy: Provide targeted subsidies and financial incentives to farmers for cultivating traditional crops and underutilized plant species.	
	H - Taxation: Offer tax relief to farmers who adopt diversified operations or produce certified specialty agricultural products.	
	I - Technology: Innovate in plant breeding to deliver more productive and stress-tolerant crops.	
	J - Digitalization: Build and maintain a secure germplasm data bank and a public-facing portal to democratize access to genetic information.	
	M - Eater Self Check:	Cultivate and promote local specialty food cultures to stimulate diverse culinary experiences.
6. Food Variety Issues **Insufficient Introduction of Food Species [SI-1122000]**	D - Trade: Facilitate the import of food commodities in which there is a structural domestic shortfall.	
	L - Donation: Utilize international humanitarian assistance to supplement domestic food supplies during periods of critical shortage.	
	A - Legislation: Negotiate and enact free trade agreements while lowering tariff rates.	
	B - Policy: Formulate a robust food security plan that includes a diversified import strategy.	
	E - Pricing: Implement measures to stabilize the price and ensure the consistent supply of imported food commodities.	
	F - Investment: Upgrade port, warehousing, and cold-chain facilities to improve the efficiency and reliability of food imports.	
	G - Subsidy: Implement targeted subsidy programs for the importation of essential food commodities.	
	H - Taxation: Implement tax incentives to encourage a diversification of imported goods.	
	I - Technology: Accelerate the research and development of local substitute products and advance processing technologies to diversity food options.	
	J - Digitalization: Leverage cross-border e-commerce and digital information platforms to diversify import channels.	
	M - Eater Self Check:	Cultivate an appreciation for diverse food cultures and accelerate the acceptance of alternative foods.

Issue	Existing Solutions	Supplementary Solutions
7. Food Quality Issues **Food Contamination [SI-1131000]**	A - Legislation: Enact and enforce comprehensive food safety legislation, including specific standards for maximum levels of contaminants.	
	I - Technology: Implement an integrated system of rapid detection, traceability, and purification technologies to effectively control and mitigate contamination.	
	J - Digitalization: Establish an integrated food safety platform leveraging traceability and big data monitoring.	
	K - Education: Implement comprehensive public awareness campaigns to disseminate food safety knowledge and enhance risk awareness.	Implement food education programs to increase awareness of contamination risks and their health impacts.
	B - Policy: Fully implement and enforce the national food safety strategy, ensuring a robust and effective regulatory system.	
	D - Trade: Implement stringent border inspection and quarantine controls for imports and exports, alongside a proactive international alert system.	
	F - Investment: Prioritize and increase investment in critical food safety areas, including advanced testing technologies, purification infrastructure, and green production methods.	
	G - Subsidy: Allocate targeted funding to incentivize green agricultural practices and strengthen safety controls across the production chain.	
	H - Taxation: Implement a system of tax incentives to encourage enterprises to adopt pollution control technologies and enhance safe production standards.	
	M - Eater Self Check:	Promote the adoption of organic, green, and sustainable food choices among eaters.
8. Food Quality Issues **Food Spoilage [SI-1132000]**	A - Legislation: Establish and enforce comprehensive regulations governing product shelf-life and labeling requirements.	
	I - Technology: Accelerate the adoption of advanced preservation technologies, including refrigeration, controlled atmosphere packaging, and vacuum packaging, to extend food shelf life and reduce spoilage.	
	J - Digitalization: Implement smart monitoring and end-to-end traceability to identify spoilage risks at the earliest stage.	
	B - Policy: Develop a robust policy framework that sets clear standards for food preservation and logistics management.	
	K - Education: Promote public awareness and adoption of proper food preservation techniques and household cold chain practices.	Deliver food education programs that build producer capacity for risk assessment and empower eaters with preventive knowledge.

Issue	Existing Solutions	Supplementary Solutions
	D - Trade: Optimize the management of cross-border cold chains to enhance time-efficiency and ensure product integrity.	
	F - Investment: Prioritize investment in warehousing infrastructure, cold-chain logistics, and processing capabilities to strengthen the food supply chain.	
	G - Subsidy: Introduce subsidies to support the adoption of cold-chain infrastructure and advanced preservation technologies.	
	H - Taxation: Implement tax incentives to encourage enterprises to adopt advanced preservation technologies.	
9. Food Quality Issues **Improper Use of Synthetic Chemicals [SI-1133000]**	A - Legislation: Establish and rigorously enforce regulatory standards governing the use of chemical additives in food products.	
	B - Policy: Restrict the use of chemical additives and establish a long-term policy to transition the industry from high-additive to low-additive or additive-free products.	
	K - Education: Increase public awareness and understanding of chemical additives used in food products.	Implement food education programs to increase public knowledge and promote informed practices.
	I - Technology: Advance the development of rapid detection methods and safe alternative technologies to effectively mitigate risks.	
	J - Digitalization: Establish an integrated database for chemical additives, linked to a comprehensive traceability system.	
	D - Trade: Enforce rigorous import and export inspection and quarantine measures that adhere to international standards.	
	E - Pricing: Apply pricing mechanisms to disincentivize the production and consumption of low-quality, high-additive food products.	
	F - Investment: Boost investment in the research and development of natural additives and clean-label technologies.	
	G - Subsidy: Provide financial support for the research, development, and market promotion of healthier food alternatives.	
	H - Taxation: Implement tax incentives to encourage and support enterprises engaged in green and organic food production.	
	M - Eater Self Check:	Encourage everyone to enjoy more additive-free, organic, and natural foods.

Issue	Existing Solutions	Supplementary Solutions
10. Food Quality Issues **Toxic Food [SI-1134000]**	A - Legislation: Enact and rigorously enforce the food safety law, including its definitive list of prohibited toxic substances.	
	K - Education: Equip the public with the skills to identify toxic foods and practice safer food selection and handling.	Deliver comprehensive food education that incorporates essential food safety and toxicology knowledge from an early age.
	N - Healthcare: Seek immediate medical treatment in cases of suspected poisoning.	
	I - Technology: Deploy integrated detection, purification, and alternative technologies to systematically mitigate risks.	
	J - Digitalization: Establish an integrated platform for food traceability and risk early-warning.	
	B - Policy: Fully implement and operationalize the national food monitoring and recall system.	
	D - Trade: Establish and enforce border quarantine measures for imports and exports, along with a corresponding international alert system.	
	F - Investment: Prioritize investment in testing laboratory capabilities and safe production facility infrastructure.	
	G - Subsidy: Increase subsidies for production methods that ensure food safety and eliminate toxic substances, promoting a healthier food supply.	

Table 6-10. Issue –Solution Mapping: Eater Health and Longevity

Issue	Existing Solutions	Supplementary Solutions
11. Eating Methodology Issues **Pre - Eating Stage Issue [SI -1211000]**	A - Legislation: Implement legal frameworks that require food education in school curricula.	
	B - Policy: Establish a standardized food nutrition labeling system to empower eaters to make informed and healthier choices.	
	E - Pricing: Leverage pricing mechanisms, to encourage eaters to prioritize healthy and sustainable food options.	
	G - Subsidy: Provide subsidies to lower the economic barriers that prevent vulnerable groups from accessing healthy food.	
	H - Taxation: Employ taxation on unhealthy food to make healthier options more economically attractive for vulnerable groups.	
	I - Technology: Leverage wearable devices and diagnostic tools to empower individuals with precise, personalized nutritional insights for informed dietary choices.	Integrate the study of food's fundamental natures and eater's physiological natures into a unified modern scientific framework, establishing the field of 'Shiology'.
	J - Digitalization:	Develop digital platforms that integrate personal health data with food supply information to generate intelligent, personalized dietary recommendations.
	K - Education	Integrate food education into the national curriculum, emphasizing pre-eating principles such as mindful selection and nutritional awareness.
	L - Donation:	Incorporate education on pre-eating habits and rational food selection into the framework of aid programs.
	M - Eater Self Check:	Encourage the public to check in with their physiological state before a meal.
12. Eating Methodology Issues **Eating Stage Issues [SI - 1212000]**	A - Legislation: Enact legislative measures, such as a Food Labeling and Advertising Act, to guide healthy eating behaviors, and establish dedicated legislation to institutionalize food education.	
	B - Policy: Formulate national dietary guidelines and introduce supporting regulations to ensure the provision of healthy food in the catering industry, schools, and communities.	Formally establish 'Eatology' as the science of eating, recognizing it as a distinct branch of modern science.
	E - Pricing: Leverage pricing mechanisms to disincentivize the consumption of unhealthy food products and incentivize healthier dietary choices.	
	F - Investment:	Direct investment toward healthy food innovation and facilitate the transformation of processing and catering enterprises toward healthier models.
	G - Subsidy: Provide financial subsidies to support the provision of healthy meals by public catering services and for nutritionally vulnerable groups.	

Issue	Existing Solutions	Supplementary Solutions
	H - Taxation: Employ taxation to steer catering market supply away from unhealthy food choices and toward healthier alternatives.	
	I - Technology: Utilize smart technology to track individual food consumption and analyze nutritional intake.	
	J - Digitalization:	Develop digital platforms that deliver real-time dietary feedback, enabling individuals to make informed and rational food choices.
	K - Education:	Implement a comprehensive dietary guide covering stages before, during and after eating, and incorporate food education into the national system, promoting the 'Seven Couplings during Eating' principle.
	L - Donation:	Incorporate during-eating guidance into aid programs to enhance the nutritional quality and safety of meals for beneficiaries.
	M - Eater Self Check:	Encourage eaters to be mindful of their satiety cues and physical comfort, adjusting their eating pace and food intake accordingly.
13. Eating Methodology Issues **Post - Eating Stage Issues [SI - 1213000]**	A - Legislation: Enact food education legislation requiring schools to teach children how to assess their physical condition after eating.	
	B - Policy:	Integrate a post-eating health monitoring module into the national health strategy, supported by government-led initiatives that promote regular health check-ups and research on dietary feedback.
	G - Subsidy:	Provide subsidies for post-prandial health services, including nutritional counseling and metabolic assessment.
	I - Technology:	Leverage wearable technology and instant testing kits (for breath and biomarkers) to track individualized responses to food intake in real time.
	J - Digitalization:	Develop digital platforms that integrate individual health data—including digestive, metabolic, and immune responses—to generate personalized, proactive health alerts.
	K - Education:	Integrate postprandial observation into health education curricula to equip individuals with the skills to identify adverse physiological responses and understand their association with long-term chronic disease risks.
	L - Donation:	Expand public health assistance programs to include no-cost post-meal testing, providing a critical tool for the early identification of dietary-related health issues.
	M - Eater Self Check:	Monitor digestive function and metabolic changes following meals to assess short-term physiological responses to food intake.

Issue	Existing Solutions	Supplementary Solutions
14. Prevalence of Eating-Related Illnesses **Prevalence of Under-Eating Diseases [SI-1221000]**	B - Policy: Expand arable land capacity while implementing integrated national strategies to strengthen food supply chains and enhance nutritional security.	
	I - Technology: Integrate advanced agricultural technologies to cultivate high-yield, nutritionally enhanced, and stress-tolerant crops for improved food security.	
	J - Digitalization: Leverage big data analytics to enhance yields and optimize labor efficiency.	
	D - Trade: Utilize imports to compensate for domestic production deficits and maintain consistent supply.	
	L - Donation: Source essential food commodities through international assistance programs to stabilize domestic supply.	
	N - Healthcare: Provide immediate nutritional support to every patient identified as food-insecure.	
	C - Population	
	A - Legislation: Establish a statutory right to food and nutrition security.	
	F - Investment: Prioritize and increase investment in agricultural development and evidence-based nutrition programs to enhance food security.	
	G - Subsidy: Implement targeted direct subsidy programs for smallholder farmers and economically vulnerable households.	
	H - Taxation: Implement a tax exemption for staple foods to enhance the affordability of a nutritious diet for low- and middle-income households.	
15. Prevalence of Eating-Related Illnesses **Prevalence of Food -Borne Diseases [SI-1222000]**	A - Legislation: Formulate and rigorously enforce science-based food safety laws, including maximum limits for contaminants to protect public health.	
	K - Education: Implement public education campaigns to improve knowledge and adoption of food safety practices and healthy dietary choices.	Implement a comprehensive dietary guide covering stages before, during and after eating. Complement this with food education courses that emphasize the concept of body-food coupling.
	N - Healthcare: Deliver prompt and comprehensive care to individuals affected by food-borne diseases.	
	I - Technology: Accelerate the adoption of advanced technologies for pathogen detection, supply chain traceability, and proactive contamination control to enhance food safety outcomes.	
	J - Digitalization: Implement a national, integrated traceability system and real-time risk monitoring platform to enhance food safety surveillance and enable rapid response to incidents.	Develop evidence-based digital platforms to empower individuals in making informed choices, reducing the risk of food-borne illness.

Issue	Existing Solutions	Supplementary Solutions
	B - Policy: Establish a comprehensive national system for food safety monitoring and risk assessment to proactively protect public health.	
	D - Trade: Implement rigorous border controls for food safety, including inspection, quarantine, and international notification protocols.	
	F - Investment: Accelerate investment in advanced food safety capabilities, including testing, purification, and production infrastructure, to ensure product integrity.	
	G - Subsidy: Provide financial subsidies to incentivize the adoption of sustainable agricultural practices and certified safe production systems.	
	M - Eater Self Check:	Promote the consumption of certified organic and sustainably produced foods to reduce exposure to agricultural contaminants.
	A - Legislation: Implement and enforce national nutritional standards to mitigate the public health burden of diet imbalance-related illnesses.	
	K - Education: Prioritize nutrition literacy and the development of healthy dietary habits from an early age.	Implement a comprehensive dietary guide covering stages before, during and after eating. Complement this with food education courses that emphasize the concept of body-food coupling.
16. Prevalence of Eating Related Illnesses **Prevalence of Diseases from Dietary Imbalance** **[SI-1223000]**	N - Healthcare: Establish accessible care pathways for the early intervention and management of diet imbalance-related conditions.	
	B - Policy: Formulate and implement policies that actively encourage balanced diets and nutritional diversity.	
	I - Technology: Advance the development of nutrient-fortified and texture-modified food products to meet specific dietary needs.	
	J - Digitalization: Develop digital platforms for real-time nutrition monitoring and personalized dietary guidance.	Build innovative digital tools that empower individuals to track and optimize their daily nutrition.
	D - Trade: Diversify the national food supply by facilitating the import of a wider variety of food products.	
	E - Pricing: Implement measures to stabilize the prices of vegetables, fruits, and other nutrient-dense foods.	
	F - Investment: Prioritize investments in diversified agriculture and the functional food sector to directly increase consumer access to a wider variety of nutritious foods.	
	G - Subsidy: Expand and enhance school feeding programs while implementing subsidy schemes to support diverse and nutritious family diets.	
	M - Eater Self Check:	Foster the adoption of diverse diets by implementing hands-on cooking workshops, establishing interactive nutrition education centers, and facilitating community-wide engagement activities.

Issue	Existing Solutions	Supplementary Solutions
17. Prevalence of Eating-Related Illnesses **Prevalence of Overeating Diseases** **[SI-1224000]**	A - Legislation: Formulate and implement stringent regulations on the marketing of unhealthy foods and enhance mandatory labeling for products high in sugar, fat, and salt.	
	B - Policy: Implement and enforce national guidelines for obesity prevention and healthy diets.	
	K - Education: Implement a nationwide public education campaign on nutrition and obesity prevention.	Implement a comprehensive dietary guide covering stages before, during and after eating. Complement this with food education courses that emphasize the concept of body-food coupling.
	N - Healthcare: Ensure access to early intervention and evidence-based treatment for patients with overeating diseases.	
	D - Trade: Impose restrictions on the importation and domestic sale of energy-dense, nutrient-poor food products.	
	E - Pricing: Reform food pricing structures to ensure that healthy options are more affordable than less healthy alternatives.	
	F - Investment: Incentivize capital allocation to companies developing and commercializing nutritious, lower-calorie food products as a catalyst for a healthier food industry.	
	G - Subsidy: Implement subsidy programs to improve the affordability and accessibility of nutritious foods, including fruits, vegetables, and whole grains.	
	H - Taxation: Implement a tiered tax on sugary drinks, high-sugar foods, and ultra-processed products to reduce consumption.	
	I - Technology: Accelerate the innovation and formulation of reduced-sugar, reduced-fat food products and evidence-based functional foods.	
	J - Digitalization: Develop integrated digital health platforms for real-time dietary tracking and personalized health management.	Build innovative digital tools that empower individuals to track and optimize their daily nutrition.
	M - Eater Self Check:	Promote active engagement in experiential healthy eating programs, including instructional cooking classes and slow-food community initiatives.
18. Prevalence of Eating-Related Illnesses	A - Legislation: Strengthen regulatory frameworks for accurate allergen disclosure and robust food safety management systems.	
	K - Education: Strengthen public education on allergen risks and essential food safety protocols.	Implement a comprehensive dietary guide covering stages before, during and after eating. Complement this with food education courses that emphasize the concept of body-food coupling.
	N - Healthcare: Ensure rapid access to diagnosis, management plans, and emergency care for individuals with food allergies.	

Issue	Existing Solutions	Supplementary Solutions
Prevalence of Food Sensitivity Diseases [SI-1225000]	I - Technology: Accelerate the development of technologies for rapid allergen detection, effective removal processes, and alternative ingredient formulations.	
	J - Digitalization: Develop integrated information systems to enhance food traceability and safety for consumers with food allergies.	Build innovative digital tools that empower individuals to track allergen exposure and manage their dietary safety.
	B - Policy: Implement and enforce comprehensive allergen management policies within a robust food safety supervision system.	
	D - Trade: Strengthen border inspection protocols and mandatory notification requirements for major food allergens in imported and exported goods.	
	F - Investment: Accelerate investment in the development and validation of allergen-free food products and related safety testing technologies.	
	G - Subsidy: Subsidize allergen-free food manufacturing and allergen-free school meal programs to improve food safety.	
	H - Taxation: Provide tax incentives for companies that develop and manufacture low-allergen or allergen-free food products.	
	M - Eater Self Check:	Improve public understanding of food safety through hands-on cooking workshops and interactive safe food handling demonstrations.
19. Prevalence of Eating-Related Illnesses **Prevalence of Appetite Deficiency Diseases [SI-1226000]**	A - Legislation: Enact integrated legislation that supports mental health services and promotes evidence-based dietary interventions.	
	K - Education: Implement public awareness campaigns to improve literacy on mental well-being, and the early signs of appetite deficiency diseases.	Implement a comprehensive dietary guide covering stages before, during and after eating. Complement this with food education courses that emphasize the concept of body-food coupling.
	N - Healthcare: Provide timely support to patients with anorexia.	
	B - Policy: Foster cross-sectoral policies that bridge public health nutrition and mental healthcare systems.	
	I - Technology: Develop evidence-based nutritional supplements and low-energy-density foods to enhance the efficacy of dietary and therapeutic interventions.	
	J - Digitalization: Develop integrated digital health platforms for tracking nutritional intake and delivering personalized dietary interventions.	Build innovative digital tools that empower individuals struggling with appetite loss to monitor their nutritional intake and manage dietary adequacy.
	F - Investment: Prioritize and expand funding for integrated mental health and nutrition services.	
	G - Subsidy: Allocate subsidies to integrated medical and nutritional care programs.	
	H - Taxation: Authorize tax deductions for out-of-pocket expenses related to mental health treatment.	

Issue	Existing Solutions	Supplementary Solutions
20. Eating Aesthetics Issues **Dual-Aesthetics Imbalance** **[SI-1231000]**	B - Policy:	Integrate the principle of dual aesthetics throughout the three-stage dietary guide.
	E - Pricing:	Implement pricing incentives to make healthier options more affordable and encourage consumers to choose products that are both healthy and appealing.
	G - Subsidy:	Subsidize businesses that produce and distribute healthy, palatable food options to improve consumer access.
	H - Taxation:	Implement a health-related tax on products with low nutritional value, particularly those with excessive levels of added sugars, salt, and unhealthy fats.
	I - Technology:	Formally incorporate the principles of eating aesthetics into the contemporary aesthetic framework to guide the development of foods that achieve an optimal synthesis of palatability and health.
	J - Digitalization:	Develop digital platforms that empower consumers to make informed food choices by balancing taste preferences with health goals when ordering food.
	K - Education:	Reframe food education courses around the principle of dual aesthetics to promote a more holistic and responsible definitions of gourmet experts.
21. Eating Aesthetics Issues **Five-Sense Aesthetic Bias** **[SI-1232000]**	B - Policy:	Integrate the holistic framework of five-sense aesthetics into national dietary and cultural policies.
	G - Subsidy	Provide subsidies to incentivize food R&D and catering services that pioneer methods for achieving balanced five-sense engagement.
	H - Taxation:	Introduce taxes on food products that exhibit significant sensory imbalances, such as those relying on excessive artificial coloring or flavor enhancers.
	I - Technology	Foster multi-sensory food R&D and utilize immersive wearable technology (e.g., VR) as an educational tool to help the public appreciate and demand a balanced sensory experience in their food choices.
	K - Education	Integrate the framework of five-sense aesthetics into both food and aesthetic education curricula to systematically cultivate students' holistic dietary awareness and appreciation.

Table 6-11. Issue –Solution Mapping: Eater Sustainability

Issue	Existing Solutions	Supplementary Solutions
22. Intra-Human (Internal) Conflict Public Administration Issues in the Food Systems [SI-1311000]	A - Legislation: Enact a comprehensive food safety law that establishes clear, distinct mandates for risk assessment, supply chain traceability, and rapid alert systems. This will create a unified, coherent, and effective national regulatory framework to protect public health.	
	B - Policy: Establish a high-level National Council for Food and Nutrition Security, directly led by the highest levels of government and empowered to coordinate all relevant ministries, eliminate policy silos, and ensure a unified national strategy. Integrate the food system into the national development strategy to ensure policy continuity. Build multi-stakeholder platforms engaging government, industry, academia, and civil society to institutionalize participatory decision-making and co-governance. Utilize self-assessment and third-party evaluations to identify governance gaps, and adopt international standards and voluntary certifications to address them.	Establish a unified National Food System Authority by consolidating the currently fragmented regulatory responsibilities of agencies for agriculture, health, commerce, food and drugs, and quality supervision. This integrated, national-level institution will enable seamless, full-chain governance from farm to table, and back to the farm. Create a World Food System Council, co-convened by the FAO and WHO. This high-level body would leverage Codex Alimentarius standards to enhance global coordination on food security, transboundary contamination, and trade disputes.
	C - Population: Integrate demographic trends and the specific needs of vulnerable groups into food system policies to ensure nutrition security and equity through targeted social protection, fiscal support, and priority funding.	Advance voluntary family planning programs, recognizing its role in moderating rapid population growth.
	I - Technology: Enhance the capacity and effectiveness of government administration by integrating cutting-edge research from relevant disciplines, including public policy, organizational management, and data analytics, into decision-making processes.	Establish Food Systems Administration as a core academic discipline within universities to build a professional pipeline for public sector expertise.
	J - Digitalization: Leverage modern technologies—including blockchain, AI, big data, and the Internet of Things (IoT)—to automate oversight, enhance predictive capabilities, and strengthen the resilience of administrative systems.	Build a global big data platform for collaborative food system governance—internet of the food system—that interconnects producers, consumers, and tools. This platform will enable the real-time monitoring and intelligent regulation of food production, distribution, and consumption.
	K - Education: Strengthen governmental management and decision-making capabilities by cultivating a pipeline of relevant talent through targeted academic exchanges and professional training programs.	

Issue	Existing Solutions	Supplementary Solutions
23. Intra-Human (Internal) Conflict **Gaps in Laws and Standards for the Food System** **[SI-1312000]**	A - Legislation: Utilize internationally recognized standards and certification schemes to address critical regulatory gaps. Systematically document and codify successful local and national food system transformations, integrating these proven experiences into formal legal and policy frameworks. Implement systematic, evidence-based review mechanisms to ensure national legislation and standards are dynamically updated in response to new scientific findings. Enact a cross-sectoral framework law that integrates policies for agriculture, food safety, nutrition, and the environment into a coherent legal system to eliminate fragmentation and close regulatory gaps. Advance cross-border coordination by systematically integrating food system provisions into international trade agreements and multilateral frameworks. This will facilitate regulatory convergence and mutual recognition of standards.	Utilize the holistic knowledge system of Shiology to construct an integrated food system code that unifies the domains of production, processing, distribution, consumption, and governance into a single, coherent system.
	I - Technology: Strengthen legislative capacity by integrating evidence-based research from relevant legal disciplines into the law-making process.	Establish Food-System Law as a distinct academic discipline to build expertise in the legal framework.
24. Intra-Human (Internal) Conflict **The Failure of Education, Scientific and Cultural to Address Food System Unsustaina-bility** **[SI-1313000]**	A - Legislation: Enact national legislation to mandate food education and institutionalize its integration into school curricula.	
	B - Policy: Establish a vocational education and qualification system for food and nutrition professions, using legislation and industry standards to define mandatory training and certification requirements for food safety managers, dietitians, and catering personnel.	Formally define food education within national policy as a dual system integrating general education with specialized professional training.
	F - Investment: Increase state-level investment in scientific research.	Foster interdisciplinary collaboration by establishing dedicated schools of food systems.
	I - Technology: Establish a global network for scientific research cooperation.	Establish dedicated food education research centers to generate the theoretical support needed for curriculum development, teacher training, and policy design.
	K - Education: Implement vocational skills enhancement and continuing education programs for farmers, food processors, and retail workers, to address the critical shortage of skilled grassroots talent. Leverage public advocacy and cultural communication to foster a cultural shift away from unsustainable and detrimental practices, while preserving and promoting traditional food cultures. Implement and disseminate the National Guidelines for Healthy Eating to foster a healthier populace.	Integrate food education into the compulsory education curriculum and accord it the same importance as fundamental subjects, such as mathematics, to cultivate citizens' comprehensive competence. Establish two parallel and complementary education systems—one for eaters and one for food industry workers—under the guiding framework of Shiology. Institute the practice of AWE at the Table as a global pre-meal ritual, inspiring a universal commitment to revere and cherish food.

Issue	Existing Solutions	Supplementary Solutions
25. Intra-Human (Internal) Conflict **External Shocks and Geopolitical Risks to the Food System** **[SI-1314000]**	A - Legislation: Enhance the regulatory framework for national food reserves and emergency response mechanisms.	
	B - Policy: Establish robust national and regional food reserves, complemented by early warning systems, to bolster societal resilience against existential threats including armed conflict, trade disruptions, and pandemics. Enhance intergovernmental cooperation on global food systems.	Establish a World Food System Council to address and coordinate critical global challenges, including food security, transboundary contamination, and international trade disputes.
	D - Trade: Diversify food import channels while establishing regional food mutual-aid mechanisms.	
	E - Pricing: Implement calibrated food price controls and temporary subsidies during crises to mitigate price gouging.	
	F - Investment: Boost investment in strategic food reserves and essential food supply chain infrastructure.	
	J - Digitalization: Develop digital monitoring and early warning systems to enhance preparedness for food supply chain disruptions.	Establish a global digital platform for the food system—internet of the food system— to enable real-time monitoring and regulation.
	K - Education: Integrate public education on diet and health, with a specific focus on crisis preparedness.	Promote public understanding of food as a fundamental necessity for survival, not merely a commodity.
	L - Donation: Strengthen international aid and food bank mechanisms to guarantee minimum food security for vulnerable and disaster-affected countries during geopolitical conflicts and natural disasters.	
26. Intra-Human (Internal) Conflict **Economically Unsustainable Development of the Food System** **[SI-1315000]**	A - Legislation: Establish and enforce legal frameworks to guarantee market competition, uphold consumer rights, and ensure fairness in resource allocation.	Enact legislation that codifies the right to food, guaranteeing universal access to adequate food.
	B - Policy: Steer economic structural transformation via coherent national strategies and targeted industrial policies.	Clearly define the scope of the food industry and establish its status as a strategic national priority.
	D - Trade: Diversify international trade channels while strengthening regional cooperation frameworks.	
	E - Pricing: Establish a sound price formation and market early-warning mechanism.	
	F - Investment: Promote long-term investment in agriculture and food systems.	
	G - Subsidy: Provide targeted subsidies to vulnerable producers to balance income distribution and incentivize green production practices.	

Issue	Existing Solutions	Supplementary Solutions
	H - Taxation: Implement differentiated tax policies, such as levies on high-pollution foods and reductions for healthy options, to steer consumer markets toward healthier outcomes.	
	I - Technology: accelerate the adoption of smart agriculture to increase farmers' profitability.	
	J - Digitalization: Develop digital market information platforms that integrate real-time data on supply, demand, prices, and trade.	
	K - Education:	Incorporate the understanding of food as both a commodity and a survival necessity into public and industry education to counteract consumer biases that lead to market imbalances. Promote the adoption of a "survival-oriented industrial classification system" to prioritize sectors essential for food security.
27. Human-Environment (External) Conflict **Structural Ecosystem Degradation (Caused by Food-System Activities)** **[SI-1321000]**	A - Legislation: Enact stringent laws to enforce ecological protection redlines, regulate land use, and safeguard biodiversity.	
	B - Policy: Leverage national strategies and international conventions to prohibit destructive practices and safeguard critical ecological frameworks.	Establish a comprehensive food-System administration authority to consolidate all food-related ecological protection functions under a single regulatory body.
	F - Investment: Increase investment in ecological restoration—including wetland recovery, soil improvement, and watershed management—to enhance ecosystem resilience.	
	G - Subsidy: Provide financial incentives for eco-friendly practices in agriculture, fisheries, and forestry.	
	H - Taxation: Levy ecological taxes on food industries that have high energy consumption and emissions detrimental to ecosystems.	
	I - Technology: Deploy innovative technologies to enhance environmental monitoring, accelerate ecosystem restoration, and promote eco-friendly productivity.	
	J - Digitalization: Develop a global ecological data platform to monitor environmental changes and inform conservation efforts.	
	K - Education:	Integrate the concept of the food ecosystem as a core component of both food education and ecological education.
	L - Donation: Strengthen ecological protection in less developed countries through targeted international aid and NGO funding.	

Issue	Existing Solutions	Supplementary Solutions
28. Human-Environment (External) Conflict **Non-structural Ecosystem Degradation (Driven by Food-System Emissions and Loads)** **[SI-1322000]**	A - Legislation: Strengthen laws governing air, water, and soil pollution by establishing binding emission caps and robust penalty mechanisms.	
	B - Policy: Establish an inter-departmental coordination mechanism for agriculture, industry, environmental protection, and health sectors.	Establish a comprehensive food-system administration authority through the consolidation of food-related ecological protection functions under a centralized national body.
	D - Trade: Integrate environmental standards into international trade agreements to restrict the trade of highly polluting food products.	
	E - Pricing: Implement environmental pricing reforms, such as carbon pricing and water resource fees.	
	F - Investment: Boost investment in clean agriculture, green energy, and pollution control technologies.	
	G - Subsidy: Provide subsidies to farmers and enterprises that adopt eco-friendly practices such as organic farming, water-efficient irrigation, and reduced pesticide use.	
	H - Taxation: Implement taxes on pollution and emissions, while providing tax incentives for green products.	
	I - Technology: Accelerate the adoption of precision agriculture and advanced pollution monitoring technologies.	
	J - Digitalization: Develop an integrated digital platform for real-time pollution monitoring and early warning systems.	
	K - Education	Integrate the concept of the food ecosystem as a core component of both food education and ecological education.
	L - Donation: Provide financial and technological assistance to developing countries for pollution control, water quality improvement, and cultivated land enhancement.	



Toward a Community with a Shared Future for Human Food Systems

Food-system issues rank among the most complex challenges confronting humanity. Yet complex does not mean intractable. By building the Food-System Issue Framework and its hierarchical coding system, we bring structure and clarity to that complexity. By applying the Shiology knowledge system together with country–issue mapping and dual integrative governance—(the Eater–Food–Food-System Order triad and the global scope of 193+2 countries)—we can comprehensively cover, and begin to address, problems that once seemed unsolvable.

7-1 A community with a shared future for human food systems

We propose the concept of a Community with a Shared Future for Human Food Systems, grounded in empirical observation. It recognizes that, through the basic facts of eating and nourishment, the world forms an interconnected and interdependent community of fate. Within this community, food, eaters, and food-system order are tightly coupled; the health, safety, and well-being of every person are linked; and all countries—developed, developing, and least developed—are bound together.

Four core dimensions

1. Biological and Health Dimension

Food is the fuel of life—the common foundation of survival and health. Regardless of race, nationality, or class, all people must eat to sustain life, obtain nutrients, maintain health, and extend longevity.

2. Economic and Supply-Chain Dimension

In today's deeply interconnected world, complex global supply chains intertwine our tables. No country can remain fully self-sufficient. Prosperity and adversity are shared: war or natural disaster in a major food exporter can trigger global price shocks and supply stress, threatening distant poor populations; likewise, demand shifts in major

importers reshape suppliers' food economies.

3. Ecological and Environmental Dimension

We share a fragile planet. Food systems are both a significant source of greenhouse-gas emissions and a major victim of climate change. Modes of production and consumption directly shape climate trajectories. Over-exploitation of resources leads to ecosystem degradation and biodiversity loss—costs ultimately borne by all.

4. Cultural and Ethical Dimension

Culinary exchange makes food a universal cultural ambassador. Sushi, pizza, tacos, and hotpot cross borders and become shared cultural assets, deepening mutual understanding. At the same time, consumer choices are reshaping agri-food production worldwide; what people eat in one place influences the livelihoods and practices of producers far away, entailing ethical responsibilities along the value chain.

7-2 A call for joint action

The pressures we face are common and cannot be solved by any single country. Confronted with recurrent food-system challenges, all nations—and all people—must act together.

7-2.1 Principles for building this community

1. Sovereign equality

All countries—regardless of size, strength, or wealth—should participate in, decide on, and benefit from global food-system governance on an equal footing. Representation and voice of developing and least developed countries should be strengthened while international food relations should be democratized.

2. International rule of law

Fully uphold the purposes and principles of the UN Charter and universally recognized norms of international relations. Ensure equal and uniform application of international law and rules; avoid double standards or imposing the "house rules" of a few upon others.

3. Multilateralism

Embrace consultation, co-construction, and shared benefits in the face of food-system disputes. Strengthen solidarity and cooperation, oppose unilateralism, safeguard

the United Nations' role and authority, and reinforce its irreplaceable function in global food-system governance.

4. People-centered orientation

In the triad of food, eaters, and food-system order, keep the eater at the center. Without the eater, food and order lose meaning. An eater-centered approach binds the triad into a coherent whole and aligns governance with the ultimate end of human health and well-being.

7-2.2 A Ten-Point Roadmap

1. Clarify the vision and objectives

Articulate a shared vision of a fair, sustainable, healthy, and safe global food system in which everyone has access to sufficient, nutritious food. Core objectives include ending hunger and malnutrition, improving the sustainability of production, reducing environmental externalities, enhancing supply-chain transparency and fairness, and strengthening food safety and public-health management worldwide.

2. Strengthen global governance mechanisms

Build a robust governance architecture to organize international cooperation in food systems. Reinforce the roles of FAO, WFP, and IFAD as central platforms; advance legally binding multilateral agreements (e.g., a Global Food Security Convention defining responsibilities in production, trade, and assistance); and institute regular assessments and reporting, including a global food-status monitoring system.

3. Promote technology and knowledge sharing

Accelerate diffusion of innovations (precision farming, gene editing, water-saving irrigation), safeguard crop diversity with global seed banks, and apply digital tools (AI, blockchain, big data) to optimize production and supply chains.

4. Advance fair trade and market cooperation

Use trade mechanisms to improve equitable distribution: pursue WTO-related reforms, lower tariff and non-tariff barriers in agri-food trade, expand South–South and triangular cooperation, and develop global grain reserves and emergency mechanisms to buffer shocks.

5. Foster sustainable production and consumption

Scale green, organic, ecological, and circular agriculture; curb excessive fertilizer

and pesticide use; reduce food loss and waste from farm to fork via policy and education; and promote healthy diets, including the "seven couplings between food and the human body," encouraging balanced intake and curbing excessive sugar and fat consumption.

6. Strengthen food safety and hygiene management

Harmonize food-safety standards applicable in international trade; enhance cross-border cooperation on monitoring, early warning, and emergency response; and combat illicit production and counterfeit food through coordinated international action.

7. Promote cultural exchange and shared values

Encourage dialogue that respects culinary diversity while converging on health and sustainability. Share culinary knowledge and techniques so that "each culture shines, and all cultures shine together." Develop and publish food-education (Shoku-iku) general-education materials with both global and local characteristics; integrate eater education into schools and communities.

Figure 7-1. Published children's food-education textbooks



8. Establish global financing mechanisms

Create a dedicated international food-system assistance fund to support agricultural modernization and food-security projects in developing and least-developed countries; mobilize diverse capital (multinationals, foundations, individual investors); and provide debt relief and technical assistance to build sustainable production capacity.

9. Address global systemic risks

Confront climate change, unmanaged population growth, and resource scarcity with

integrated measures: climate-adapted agriculture (drought-/salinity-tolerant varieties), strengthened water-resource management through international cooperation, and energy transitions in the food sector (e.g., biomass and other renewables) to reduce reliance on fossil fuels.

10. Mobilize society and engage the public

Elevate awareness and participation through civic education on food safety and sustainability; enable NGOs and volunteer groups to implement food-system initiatives; and use media to disseminate evidence-based messages, discourage harmful food customs, and promote healthy, sustainable lifestyles.

7-3 Epilogue: Envisioning a Food-System Civilization

Looking beyond problem-solving, we envision a Food-System Civilization—a higher-order stage of human development distinguished from today's industrial civilization by six defining features:

1. A holistic civilization

Industrial civilization has often prioritized **national** over **humanity-wide** interests, inadvertently exacerbating food-system risks. A food-system civilization applies **whole-of-humanity cognition and governance** to food, aiming to resolve deprivations in **every** corner of the planet and to align policies with shared, global welfare.

2. A sustainable civilization

Pursuit of profit sustainability without **resource sustainability** has driven land- and yield-intensity close to their ecological ceilings. Without sustainable food supply, there is no sustainable humanity. A food-system civilization reconciles the human–nature nexus of food, enabling **harmonious co-existence** and long-run viability of ecosystems and livelihoods.

3. A longevity civilization

Industrialization increased food quantity and improved medical care, raising life expectancy—but environmental pollution and imprudent use of some additives have also undermined **health quality**. A food-system civilization makes **fully realized human longevity**—healthier, longer lives grounded in safe diets and clean environments—an ultimate performance objective.

4. A leisure civilization

Industrial gains in productivity have often coincided with heightened **time stress**, compressing leisure and turning people into "bodily machines." In a food-system civilization, productivity gains are paired with **higher social efficiency**—intuitively, more desired outcomes per unit of collective labor—so that aggregate **leisure time** expands while food output remains secure and resilient.

5. A civilization of restrained desire

As Gandhi is widely paraphrased: "The Earth provides enough to satisfy every person's need, but not every person's greed." Human desires are **unbounded**; planetary resources are **finite**. A food-system civilization distinguishes **essential** from **non-essential** wants: sustaining essential needs and industries; curbing desires and activities that threaten survival; and phasing out industries that imperil collective well-being.

6. An Earth civilization

Faced with population pressure and finite resources, some advocate off-planet migration. Regardless of technological feats for individuals, **large-scale species relocation is not a realistic governance premise**. Food is Earth-bound; stewardship of this planet is therefore non-substitutable. A food-system civilization is an **Earth civilization**, not an extraterrestrial one.

Food is foundational to survival, to flourishing, and to the continuity of our species. The **Food-System Civilization** envisaged here is not utopian rhetoric; it is a normative horizon toward which the evidence and ethics of this report both point—and it is already coming into view.

APPENDIX

Shiology Terminology

This appendix provides a glossary of key terms from Shiology, the emerging discipline that offers an integrated theoretical framework for understanding food systems. Readers should note that the terminology used in the main body of this Report has been adapted for accessibility and readability in an international policy context. As such, some wording in the glossary may differ from expressions in the Report's chapters.

1. Shiance

The phenomena and activities of human food acquisition and utilization. It encompasses the phenomena and activities surrounding survival and health behaviors (e.g., drinking, eating), those related to wild food acquisition, food domestication, processing and distribution, as well as those related to laws, economy, administration and education so as to maintain shi-order.

In this sense, Shiance is the foundational and central activity set of human civilization, serving as the starting point for understanding and governing the entire food system.

1.1. Cognition of shiance; shiance knowledge

The human perception and understanding of shiance objects.

It operates on both the knowledge level and the practical level.

1.2. Shiance administration

The exercise of state authority over food acquisition, utilization, and related sectors. It encompasses regulatory power in agriculture, food industry, food service, dietetic therapy, etc.

Shiance administration ensures food security, health, and social order, and is a key mechanism for sustainable and fair food systems.

1.3. Shiance behavior

Human activities related to acquiring and utilizing foods. It encompasses wild food acquisition, food domestication, processing, distribution, regulation and eating practices.

It encompasses both individual choices and social/institutional behaviors, such as collective eating habits, public dining management, and market participation.

1.4. Shiance disaster

Large-scale harm and suffering in shiance caused by natural or human factors. It is classified into natural shiance disasters and anthropogenic shiance disasters.

Shiance disasters affect social stability and individual survival, serving as key indicators of food system resilience and governance effectiveness.

1.5. Shiance economy

The comprehensive system encompassing all material and non-material resources related to

societal food production, distribution, allocation, and consumption. It comprises three tiers: micro shiance economy, macro shiance economy and global shiance economy.
Shiance economy measures efficiency, equity, and sustainability within the food system.

1.6. Shiance efficiency

The ratio of useful work output to the total work input invested in the acquisition and utilization of food by humans. It includes food production efficiency, shiance labor efficiency, and food utilization efficiency. Food utilization efficiency is the core of shiance efficiency.

1.7. Shiance industry

The social system formed by individuals and legal entities engaged in shiance activities. It encompasses all shiance-related industries, including agriculture, food industry, food service, dietetic therapy and those aimed to maintain shi-order.
The shiance industry not only provides food and services but also carries social, cultural, and ecological responsibilities, serving as a key bridge between eaters, food, and Shiance order.

1.8. Shiance internet

A computer network system composed of food, eaters, shiance industry workers and shiance tools, referred to as shi-internet for short.
It uses information technologies (Internet, big data, blockchain) to link the entire Shiance activity chain, enabling information sharing, supply optimization, and behavior monitoring.

1.9. Shiance issue

The complex dilemmas and contradictions arising from human and external factors on food acquisition and utilization. These extend beyond mere sustenance to multidimensional tensions—ensuring food security, nutritional health and sustainable resilience.

1.10. Shiance law

The comprehensive body of rules governing shiance behaviors, enacted by legislative or state authorities and enforced by state power. Also termed “shiance behavior law", it covers legal frameworks addressing eater needs, food acquisition and shi-order.
Shiance law underpins shiance order and social stability, serving as a critical tool for food system governance.

1.11. Shiance tool

The implements designed to enhance shiance behavior efficiency. Also termed "shiance behavior tool", it is categorized into manual tools, powered tools and digital tools.
Shiance tools form the foundation for shiance efficiency and support modern food management and innovation.

2. Shiology

A unified knowledge system that reveals objective laws governing shiance; addresses its systemic challenges; deciphers relational dynamics between humans and food; and explores evolutionary patterns of shiance behaviors across history.

2.1. Shiology education

The systematic transmission of accurate knowledge systems about shiance. It encompasses two dimensions: education for shiance industry workers, and education for eaters.

Shiology education aims to enhance society-wide shiance awareness and practice, addressing both industry professionals and general consumers.

2.2. Shiology mission

The fundamental responsibilities borne by shiology, namely: to holistically resolve humanity's shiance challenges. Core mandates include extending individual lifespans, optimizing social order, and ensuring the sustainability of the human species.

Shiology mission addresses challenges from individual health to social order and ecological sustainability.

2.3. Shiology principle

Fundamental, universal laws governing shiance, structured across three domains of eater needs, food acquisition and shi-order. Eater needs principles include “human body transformed from food”, “body-food coupling”, “eating can cause disease”, “eating can cure disease”, and “five-sense aesthetics". Food acquisition principles include “photosynthesis”, “diversity symbiosis”, and “yield limits”. Shi-order principles include “shiance breeds civilization”, “shiance triangle", “shiance priority", “shiance behavior follows food ecosystem and food conversion system”, and “shi-order as the foundation of human social order”.

2.4. Shiology system

The hierarchical and parallel relational architecture within shiance cognition, representing the structured way shiance knowledge is organized and interconnected.

2.5. Shiology teaching material

The educational resources designed to instruct shiology content, including but not limited to textbooks, lecture notes, visual aids and syllabi.

2.6. Shiology term

A standardized lexical unit describing phenomena, entities, processes, methodologies, and technologies within the shiance domain.

2.7. Shiology triangle

The core framework of shiology, structured as a tripartite model integrating eater needs, food acquisition and shi-order.

3. Shi-order

The structural coherence and functional continuity of human shiance behaviors, formally termed "Shiance Order". As the foundation of social stability, its collapse triggers systemic societal disintegration, while its refinement accelerates civilizational progress.

3.1. Cognition of shi-order; shi-order knowledge

The human perception and understanding of shi-order as an objective system.

3.2. Reform in shi-order

The systematic modification of outdated or dysfunctional elements within shi-order, replacing them with new, context-adapted practices to enhance societal resilience and sustainability.

3.3. Shi-order harmony

A state of balanced coordination making consistency within the shi-order.

It describes a state where all elements of shiance order—eaters, food, and shiance industry—are coordinated and functioning smoothly.

3.4. Shi-order issue

The complex dilemmas and contradictions arising in the pursuit of harmonious shi-order.

3.5. Shi-order optimization

The systematic improvement of shi-order through targeted interventions.

It involves adjusting, improving, or selecting best practices to enhance the overall efficiency, healthfulness, and sustainability of shiance order.

4. Eater

Humans conceptualized through the lens of dietary needs, including all humans dependent on food, irrespective of age, gender, occupation, etc.

4.1. Eater cognition

The mental processes through which eaters acquire, process, and apply knowledge.

4.2. Eater constitution

The physiological constitution of eaters, comprising nine core systems: digestive system, musculoskeletal system, respiratory system, urinary system, reproductive system, endocrine system, immune system, nervous system and circulatory system.

4.3. Eater health

A state of optimal physical and mental well-being assessed through the lens of dietary influences.

4.4. Eater issue

Contradictions and challenges encountered in optimizing health and longevity through eating practices.

4.5. Eater need

Human requirements for survival, health, and socio-systemic harmony through shiance, encompassing needs for survival, health and longevity, as well as those for food distribution equity and supply security.

4.6. Eater physiological nature

The innate somatic nature of individuals, classified into nine types: plain conditions, qi-deficient conditions, yang-deficient conditions, yin-deficient conditions, phlegm-damp conditions, damp-heat conditions, qi-stagnation conditions, blood-stasis conditions, and special conditions.

4.7. Eater preference

An individual's or group's systematic inclination toward specific foods.

4.8. Education for eaters

A targeted pedagogical framework to equip all individuals with lifelong competencies in self-awareness, food intelligence, eating methodology, eating aesthetics, eating disorders, dietary therapy, etc.

Educating eaters improves individual dietary literacy and health management capability.

5. Food

Any edible substances, classified into animal-based foods, plant-based foods, fungal foods, mineral foods, and artificial foods.

5.1. Food acquisition

Human activities to obtain foods, including wild food acquisition, food domestication, processing, distribution, etc.

Understanding acquisition processes helps optimize supply chains and ensure food safety.

5.2. Food conversion

The holistic process by which ingested food is metabolized into bodily structures, energy, signaling molecules, and waste products.

5.3. Food domestication

The intentional human-directed breeding and cultivation of wild food species to enhance desirable traits, implemented through cultivation, breeding and fungiculture.

5.4. Food nature

The inherent characteristics of food that influence its physiological and energetic effects on the human body, categorized as neutral nature and partial nature. Also called “food character”. Subtypes of partial nature includes cold, hot, warm and cool.

5.5. Food quality

The measurable and perceived characteristics of food.

5.6. Food quantity

The measurable amount of food.

5.7. Food system

A closed-loop ecosystem encompassing the entire lifecycle of food, from production to post-consumption recycling, structured as: crop growth, animal rearing, processing, distribution, consumption... and back to earth, crop growth and animal rearing. It is also termed “from farm to farm”.

5.8. Food utilization

The process by which food exerts its functional effects within the human body, as well as the results thereof.

5.9. Wild food acquisition

Human procurement of undomesticated food, also termed “direct food acquisition”, encompassing fishing, gathering, picking, and hunting.

6. Eatance

The phenomena and activities of food intake by humans, as a part of shiance. For instance, farming, cooking, having a meal and drinking tea belong to shiance, and having a meal and drinking tea are eatance.

6.1. Eatance aesthetics

The multisensory experience of deriving psychological and physiological pleasure from eating.

6.2. Eatance education

The systematic transmission of knowledge and skills to establish correct eating practices.

6.3. Eatance methodology

A structured approach to food intake designed to meet the demands of the food conversion system. It consists of three phases centered on optimizing the coupling between the body and food: Three Assessments Before Eating, Seven Couplings During Eating, and Two Evaluations After Eating.

6.4. Eatance pace

The rate of food intake, one of the "Seven Couplings" in eating practices.

6.5. Eatance phase

The chronologically segmented stages of eating practices, comprising three distinct phases: Pre-Eating Phase, Eating Phase, and Post-Eating Phase.

6.6. Eatance preference

Consistent and deliberate favoritism toward specific eating practices.

6.7. Eatance-related disorder

Abnormal physiological states caused by food or improper eating methods, classified into: under-eating disorders, food-borne disorders, disorders from dietary imbalance, overeating disorders, sensitivity disorders, and appetite deficiency disorders.

6.8. Eatance right

The fundamental human right of every individual to access food for survival. It includes the right to adequate food intake in terms of quantity, quality and variety.

6.9. Eatance sequence

The strategic sequencing of food intake, recognized as one of the "Seven Couplings" in eating practices.

6.10. Therapeutic eatance

The targeted use of eating practices to treat diseases.

7. Eatology

A knowledge system studying the causal relationships between eatance and health/longevity, also termed “Food Conversion Science”, comprising Eatance Methodology, Eatance Aesthetics, Science of Eatance-related Disorders and Eatance Therapuetics.

7.1. Eatology education

The systematic transmission of accurate knowledge systems about eatance.

7.2. Eatology mission

The fundamental responsibility of eatology to guide humanity toward optimal eating practices that prevent and reduce eatance-related diseases and extend healthspan.

7.3. Eatology system

The hierarchical and parallel relational architecture within eatance cognition.,representing the structured way eatance knowledge is organized and interconnected

7.4. Eatology teaching material

The educational resources designed to instruct eatology content, including but not limited to textbooks, lecture notes, visual aids and syllabi.

7.5. Eatology term

A standardized lexical unit describing phenomena, entities, processes, methodologies, and technologies within the eatance domain.

8. Eatings

Food substances in the immediate context of eating—being ingested or about to be ingested, such as the dishes on the dining table or snacks about to be put into the mouth, representing a subcategory of food. Items such as food products on store shelves and wheat do not qualify as eatings. Food includes eatings.

8.1. Eatings doneness

The degree to which eatings have been thermally processed.

8.2. Eatings group; type of eatings

Different kinds of eatings.

8.3. Eatings issue

Contradictions and obstacles in ensuring adequate quantity, nutritious quality, and diverse variety of eatings.

8.4. Eatings quality

The measurable and perceived characteristics of eatings.

8.5. Eatings temperature

The measurable heat/cold level of eatings, recognized as one of the "Seven Couplings" in eating practices.

9. Shiology Principles

9.1. Body Transformed from Food

One of the shiology principles: The human body is transformed from food, including bones, blood, internal organs, muscles, the brain, skin, hair, and so forth. This is a complex process of transformation—without food, there is no body; without food, there is no life.

9.2. Eating Can Cause Disease

One of the shiology principles: Eatance is a source of human disease. Improper food choices and incorrect eating methods can trigger illness and threaten physical health. Conversely, correct eatance can prevent the onset of disease.

9.3. Eating Can Cure Disease

One of the shiology principles: Eatance is an important form of disease treatment. By leveraging the digestive and absorptive systems to intervene in bodily imbalances, it represents an ancient discovery and application. Eatance can not only treat illnesses caused by improper food or eating practices but also help alleviate diseases arising from other causes.

9.4. Five-Senses Eating Aesthetic

One of the shiology principles: the appreciation of taste, smell, touch (oral texture), vision, and hearing during the act of eating.

9.5. Body-Food Coupling

One of the shiology principles: Each person's body is unique and constantly changing. Only by clearly recognizing this variability, and selecting the most suitable way of eating based on the specific needs of one's body at a given time, can the optimal coupling between food and the body be achieved, thereby promoting health. Conversely, failure to do so may lead to disease and threaten physical well-being.

9.6. Shiance Behavior Follows Food Ecosystem and Food Conversion System

One of the shiology principles: Human shiance must align with the operational principles of the food conversion system to achieve health and longevity, and must adhere to the operational principles of the food ecosystem to ensure sustainability.

9.7. Shiance Breeds Civilization

One of the shiology principles: shiance predates civilization, and shiance breeds civilization. Shiance forms the foundation of civilization, sustains its continuity, and improper shiance behaviors may threaten its enduring existence.

9.8. Shi-order as the Foundation of Human Social Order

One of the shiology principles: The order of human society originates from the distribution of food and the control of food resources. Shi-order is synonymous with survival order—it predates social order and forms the very foundation of societal structure. Without a stable shi-order, all other social constructs would collapse instantaneously, and civilization itself would crumble.

9.9. Shiance Priority

One of the shiology principles: Addressing shiance issues takes precedence over other matters. Shiance has existed since ancient times, while other human concerns emerged later. Prioritizing shiance ensures stability; neglecting it in favor of secondary pursuits invites disorder.

9.10. Shiance Triangle

One of the shiology principles: A holistic structure composed of three systems—food ecosystem, shiance behavior system, and food conversion system. This framework defines the scope of human shiance and reveals its boundaries.

10. Shiance Efficiency

10.1. Food Production Efficiency

The useful work output generated per unit of space and time. It encompasses both Spatial Food Production Efficiency and Temporal Food Production Efficiency.

10.2. Food Utilization Efficiency

The ratio of an individual's actual healthspan (or lifespan) to the average expected lifespan given the overall coupling between the human body and the food.

10.3. Shiance Labor Efficiency

The useful human shiance work output generated per unit of time.

10.4. Spatial Food Production Efficiency

The useful work output generated per unit of area. This metric primarily applies to the production of plants as food, such as yield per hectare.

10.5. Temporal Food Production Efficiency

The useful work output generated per unit of time. This metric primarily applies to the production of animals as food, such as livestock turnover rate.

11. Five Eater Needs (5E)

11.1. Eating Enough

Ensuring each individual's daily requirement for food quantity is met. The essence is food quantity.

11.2. Eating with Variety

Ensuring the provision of needed food types and categories—grains, meats, vegetables, fruits, and other groups – so people can "eat well." The essence is food variety.

11.3. Food-Safe Eating

Ensuring the quality and safety of what people ingest, with particular attention to the safety of processed foods. The essence is food quality/safety.

11.4. Eating for Longevity

Optimizing body–food coupling. Because bodies differ across individuals, their dietary needs also differ; the quantity and types of foods, eating temperature, degree of doneness (cooking level), frequency, pace, and sequence should be adjusted accordingly to support healthy longevity. The essence is fit/alignment between the body and food.

11.5. Sustainable Eating

Ensuring the sustainable supply of food over time. Major threats arise from intra-human conflict and war on the one hand, and human–environment conflict on the other. The essence is long-term sustainability of food.

12. Others

12.1. Eating Phase

The process of ingesting food, involving seven-dimensional couplings between the human body and food, including quantity of food intake, variety of food intake, eating speed, temperature of food, eating frequency, eating sequence, and degree of doneness. This phase constitutes the core component of eatance.

12.2. Post-Eating Phase

The process of evaluating bodily secretions, excretions and physiological states after eating. This phase is an essential component of eatance.

12.3. Pre-Eating Phase

The process of understanding one's physiological state, food, and seasonal and temporal contexts prior to eating. This phase constitutes an integral part of eatance.

12.4. Seven Couplings During Eating

The seven dimensions of coupling required during eating. These include: quantity of food intake, variety of food intake, eating speed, temperature of food, eating frequency, eating sequence, and degree of doneness.

12.5. Three Assessments Before Eating

Before eating, one must undertake three essential evaluations: appraising one's physiological state, examining food, and considering the seasonal and temporal contexts.

12.6. Two Evaluations After Eating

Following the act of eating, one should assess the suitability of the ingested substances through two key measures: observing the body's secretions and excretions, and monitoring its resultant physiological states.

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