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## **From Hunger Levels to Resilience Trajectories: A Dynamic Resilience Framework for Food Security**

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**Abstract.** This article develops a Dynamic Resilience Framework (DRF) to conceptualize hunger and food security as trajectories rather than static conditions. Building on earlier distinctions between one-dimensional (availability-focused) and multi-dimensional (FAO's four pillars) hunger solutions, it argues that existing frameworks largely diagnose levels of food security but do not explain how and why countries move between states of vulnerability and resilience over time. Drawing on resilience theory, research on the informal economy, and critical work on data and humanitarian governance, the DRF conceptualizes food systems as evolving through three interconnected stages: Crisis and Shock Response, Adaptive Recovery, and Transformative Resilience. It positions Adaptive Informal Food Commons (AIFC)-informal markets, neighborhood networks, and community feeding systems- as meso level engines of crisis coping and innovation, and embeds a Bias-Transparency-Trust (BTT) lens to highlight how governance and data practices condition the legitimacy and impact of interventions. The article specifies a conceptual state-transition and determinant model and derives propositions on the roles of infrastructure, digital inclusion, women's financial access, informality, and governance in shaping upward transitions. It concludes with a research agenda and argues that moving from levels to trajectories is essential for designing sequenced, transition-oriented strategies to end hunger.

**Keywords.** Food security; Resilience; Informal economy; Dynamic Resilience Framework (DRF); Adaptive Informal Food Commons (AIFC)

### **Chapter 1. Introduction: From Static Indicators to Dynamic Systems**

Global debates on hunger and food security have become more urgent as multiple crises accumulate and interact. Climate change has intensified droughts, floods, and heatwaves; globalized markets transmit price shocks across continents; pandemics such as COVID-19 disrupt labour, logistics, and incomes; and armed conflicts continue to destabilize entire regions.

In this turbulent context, the longstanding goal of Sustainable Development Goal 2 (SDG 2)-“Zero Hunger”-remains distant.

Conventional approaches to food security have generated an impressive arsenal of indicators, indices, and monitoring frameworks. These include FAO’s measures of undernourishment and the four pillars of food security (availability, access, utilization, stability), as well as composite indices such as the Global Food Security Index (GFSI) produced by the Economist Intelligence Unit. These tools are invaluable for providing static snapshots: they characterize the level and multidimensional nature of food insecurity at a particular point in time and allow comparisons across countries and years (FAO, 2008; Economist Intelligence Unit, 2024). Yet, there is a critical limitation in how these frameworks are typically used. Most existing measures are interpreted as levels rather than trajectories. They tell us how food secure a country is *now*, or how an index has moved between one year and the next, but they rarely analyze state transitions systematically. As a result, policy dialogue often revolves around questions like:

What is the current prevalence of undernourishment?

How does Country A rank relative to Country B on the GFSI?

By contrast, far less attention is given to inherently dynamic questions:

Why do some countries move from low to medium food security while others remain stuck in chronic vulnerability?

Why do some countries experience repeated reversals-moving into higher food-security states only to fall back during crises?

Which combinations of structural investments, informal practices, and governance reforms shift countries onto more resilient pathways?

Earlier work on “Hunger Solution: One-Dimensional and Multi-Dimensional Food Security Programs” drew a crucial conceptual distinction between one-dimensional hunger solutions-focused primarily on food availability-and multi-dimensional solutions that incorporate access, utilization, and stability. That work showed that addressing hunger requires moving from a narrow, production-centered paradigm to a richer, multi-dimensional understanding aligned with FAO’s pillars and Sen’s entitlement approach (Sen, 1981; Maxwell & Smith, 1992).

However, even multi-dimensional models are commonly treated as static. They extend what we measure, but not *how* we theorize change. In many analyses, food security becomes an outcome to be achieved and maintained, rather than a process of movement through changing states of vulnerability and resilience.

This article argues that such static thinking is no longer adequate. As climate change, pandemics, and geopolitical disruptions become recurrent and interacting, resilience must be understood as a dynamic property of food systems: the capacity to absorb shocks, adapt, and transform over time (Holling, 2001; Folke, 2016; Walker, Holling, Carpenter, & Kinzig, 2004). Hunger reduction is therefore not simply a matter of reaching a certain level of food security; it is a matter of shaping trajectories-pathways through which societies move out of, remain in, or fall back into hunger.

To address this conceptual gap, the article develops a Dynamic Resilience Framework (DRF) for food security. The DRF brings together three strands of literature:

Resilience and complex adaptive systems, which stress adaptive cycles, non-linearity, and feedbacks.

Informal economy and informal food systems, reframed as Adaptive Informal Food Commons (AIFC) that act as meso-level infrastructure for crisis coping and innovation.

Data and humanitarian governance, through the Bias-Transparency-Trust (BTT) model, which highlights how data practices and power relations condition the legitimacy and effectiveness of digital tools and predictive analytics (Madianou, 2019; Burns, 2015).

The DRF conceptualizes food systems as evolving through three interconnected stages: Crisis & Shock Response - emergency stabilization of access and availability.

Adaptive Recovery - local and institutional learning, reorganization, and diversification.

Transformative Resilience - structural and institutional changes that embed anticipatory capacity.

Each stage is shaped by interactions between structural investments (infrastructure, digital connectivity), informal systems (AIFC), and governance norms (BTT). The framework is deliberately theoretical: it does not present estimated models or case statistics, but rather develops a set of propositions that can guide empirical research and policy analysis, and illustrates how the DRF could, in principle, be operationalized through state-transition and determinant models.

The article proceeds as follows. Chapter 2 reviews one-dimensional and multi-dimensional hunger solutions and identifies the missing dynamic dimension that current models overlook. Chapter 3 outlines the conceptual foundations of the Dynamic Resilience Framework (DRF), drawing on resilience theory, informal economy research, and governance ethics. Chapter 4 presents the DRF in detail, describing its stages, mechanisms, and feedback loops. Chapter 5 introduces the theoretical state-transition and determinant model and derives propositions that explain upward and downward mobility within food-security systems. Chapter 6 synthesizes the policy implications of the DRF, emphasizing transition-oriented hunger solutions, the sequencing of interventions, the role of informal food systems, and the enabling function of governance and data ethics. Chapter 7 offers a forward-looking research agenda and articulates the broader conceptual shift from static indicators to trajectory-based thinking necessary for shaping resilient food systems.

## **Chapter 2: Existing Hunger Solutions: One-Dimensional and Multi-Dimensional Approaches**

### **2.1 One-Dimensional Hunger Solutions**

Historically, many development policies framed hunger primarily as a problem of insufficient aggregate food supply. The implicit model was linear: low production → insufficient supply → hunger. Solutions then focused on raising output through agricultural intensification, expansion of cultivated land, adoption of improved seeds and fertilizers, or imports and food aid.

This one-dimensional hunger solution is grounded in an “availability first” logic. Its strengths are clear:

It is intuitive and operationally straightforward.

It is indispensable in acute crises where physical shortages are imminent.

It fits within agricultural planning models that aim to meet projected calorie needs.

However, by focusing on availability alone, one-dimensional approaches overlook critical elements of hunger that stem from access, entitlements, and inequality. Sen (1981) famously showed that famines can occur without any decline in aggregate food availability: people starve because they lose their *entitlements*—their legally and economically recognized means of commanding food, such as employment, wages, or social transfers.

Subsequent research has shown that one-dimensional models:

Underestimate the role of poverty, prices, and market failures (Barrett, 2010; Headey & Ecker, 2013).

Neglect intra-household distribution, gender relations, and nutrition quality (Ruel, Quisumbing, & Balagamwala, 2018).

Offer little guidance for understanding institutional and governance failures that contribute to chronic food insecurity.

From a dynamic perspective, one-dimensional models are also atemporal. They may consider trends in yields or production but do not conceptualize the structure of transitions between different states of food security or vulnerability. They can therefore respond to immediate shortages but do not, by themselves, explain why some societies repeatedly fall back into crisis while others progressively build resilience.

Within the DRF, one-dimensional solutions are thus reinterpreted as stage-specific tools-appropriate in the Crisis & Shock Response phase but not sufficient for sustained resilience.

## **2.2 Multi-Dimensional Hunger Solutions**

In response to the limitations of one-dimensional approaches, the field progressively adopted multi-dimensional conceptions of food security. FAO's widely cited definition views food security as existing "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2008).

This definition is operationalized through the four pillars:

Availability - sufficient quantities of food of appropriate quality.

Access - adequate resources to obtain appropriate foods for a nutritious diet.

Utilization - appropriate use of food, based on knowledge of nutrition and care, as well as access to clean water and sanitation.

Stability - the ability to maintain access to adequate food over time, without unacceptable risks.

Multi-dimensional approaches are reflected in national food-security strategies, academic studies, and international indices. The Global Food Security Index (GFSI), for example, includes indicators covering affordability, availability, quality and safety, and-more recently-resilience and natural resources (Economist Intelligence Unit, 2024). Likewise, various composite measures of nutrition, poverty, and governance capture multiple aspects of food insecurity (Headey & Ecker, 2013; Béné et al., 2014).

These frameworks mark a conceptual shift from "more food" to "adequate, accessible, and stable food systems." They highlight structural drivers such as poverty, infrastructure, social protection, and governance. Yet, in practice, they are often used as static measurement tools:

Index scores are computed annually and compared across countries.

Progress is quantified as changes in levels ("Country X improved its GFSI score by 5 points over a decade").

Less attention is given to the paths countries travel-e.g., whether they experienced long periods of stagnation, rapid transitions, or cycles of rise and decline.

As a result, policy debates remain centered on levels ("high", "medium", "low" food security) rather than on mobility ("transition probabilities", "resilience traps", "resilience

plateaus”). Multi-dimensionality improves diagnosis but does not necessarily embed dynamic systems thinking.

### **2.3 The Missing Dynamic**

The core argument of this article is that hunger solutions require not only multi-dimensional diagnosis but also a theory of change over time. The question is not just what constellation of factors defines food security at a given moment, but how those constellations evolve under the influence of shocks, interventions, and institutional transformation.

In this sense, both one-dimensional and multi-dimensional frameworks lack an explicit transition mechanism. They say little about:

How crises alter the structure of food systems beyond their immediate impacts.

How informal economies and local practices mediate or amplify shocks.

How investments in infrastructure, digital tools, or social protection alter resilience trajectories.

How governance and data practices shape which groups benefit from or are harmed by interventions.

The Dynamic Resilience Framework (DRF) proposed here aims to fill this conceptual gap by integrating resilience theory, informality, and governance ethics into a unified dynamic model of food-security trajectories.

## **Chapter 3: Conceptual Foundations: Resilience, Informality, Governance Ethics**

### **3.1 Resilience Theory and Complex Adaptive Systems**

Resilience theory provides a natural starting point for thinking about food security as a dynamic process. In ecological and social-ecological models, resilience refers to the capacity of a system to absorb disturbance and reorganize while undergoing change so as to retain essentially the same function, structure, identity, and feedbacks (Folke, 2016). Holling (2001). Adaptive cycle framework suggests that systems pass through phases of growth, conservation, collapse, and reorganization, with resilience involving not only resistance to shocks but also the capacity for creative renewal.

Applied to food systems, resilience thinking implies that:

Food systems are complex adaptive systems involving interactions among ecosystems, economies, technology, and social institutions.

Disturbances (droughts, price spikes, conflicts, pandemics) can push systems across thresholds, triggering qualitative shifts.

Resilience is about learning, adaptation, and transformability, not mere return to the pre-shock state (Walker et al., 2004; Walker, Salt, & Reid, 2020).

For example, a country facing repeated droughts may respond by: Short-term emergency imports (crisis response); Medium-term adoption of drought-tolerant crops and new water-management practices (adaptive recovery); Long-term transformations in land use, infrastructure, and governance that embed climate resilience (transformative resilience). This sequence is not automatic ; it depends on governance, social learning, and power relations. Resilience theory urges analysts to look beyond the level of food security at time  $t$  to the trajectory of system reconfiguration.

The DRF builds on these ideas by explicitly structuring food-security dynamics around three stages - Crisis and Shock Response, Adaptive Recovery, and Transformative Resilience- and examining the feedbacks among them.

### **3.2 Informal Economies and the Adaptive Informal Food Commons (AIFC)**

A second pillar of the DRF is the literature on informal economies, particularly in low- and middle-income countries where a large share of employment, trade, and services operates outside formal regulatory systems (Hart, 1973; Chen, 2012). Informal markets and networks play critical roles in food systems: They connect small-scale producers to urban consumers. Also offer flexible quantities, bargaining, and credit, often in small denominations. As well they function in settlements and territories where formal retail and public services are scarce or absent. Despite their centrality to food access, informal actors are often excluded from policy design or treated as obstacles to modernization. Formalization programs may seek to regulate or replace informal vendors without recognizing their adaptive contributions, particularly during crises.

The concept of Adaptive Informal Food Commons (AIFC) reframes these systems as commons-like arrangements where food and related resources flow through networks governed by trust, reciprocity, and social norms. AIFC can include:

Street vendors and community markets that continue operating during shocks.

Informal women's savings groups that mobilize and redistribute resources.

Religious or community kitchens that provide meals based on donations and voluntary labour.

Digital neighbourhood groups (e.g., messaging apps, local platforms) that coordinate food-sharing, deliveries, or mutual aid (Moreira, 2020).

In crises, AIFC can act as last-mile infrastructure when formal supply chains are disrupted. In recovery phases, they can serve as laboratories for innovation, experimenting with new forms of coordination, procurement, or distribution. However, their contribution to resilience is conditional:

When public policies are supportive and governance is inclusive, AIFC can connect to formal systems and enhance resilience.

When informality is criminalized, over-policed, or systematically excluded from decision-making, it can become a trap that reproduces precarious livelihoods and blocks upward mobility (Bromley, 1989; Chen, 2012).

The DRF therefore positions AIFC as a meso-level engine of crisis response and adaptive recovery, whose role must be understood in interaction with formal institutions and structural investments.

### **3.3 Data Governance and the BTT Model**

The third foundation concerns the governance of data, digital technologies, and predictive analytics in humanitarian and development practice. Innovations in satellite imagery, mobile-data analytics, and machine learning have created new possibilities for early-warning systems, targeting, and anticipatory action. However, scholars have documented significant risks associated with these practices.

Madianou (2019) describes “techno colonialism” in the context of refugee crises, where digital humanitarian projects may reinforce existing inequalities, extract data without consent, and impose top-down solutions. Burns (2015) examines “data infrastructures for humanitarian governance,” showing how data systems can reconfigure power relations and accountability among agencies and affected communities.

These critiques suggest that resilience analytics and digital tools are not neutral. They are embedded in decisions about: Which indicators are collected, at what scale, and for whom;

How uncertainties and model limitations are communicated; Who participates in the design, interpretation, and use of data systems.

To address these governance challenges, the article adopts the Bias-Transparency-Trust (BTT) model as a normative lens:

**Bias** - Acknowledging and addressing systematic distortions in what is measured, who appears in datasets, and whose experiences inform predictions. For example, informal sectors or marginalized regions may be underrepresented in official statistics.

**Transparency** - Making methods, assumptions, and uncertainties of indices and predictive models intelligible and accessible. This includes open documentation, explainability, and clarity about how outputs inform decisions.

**Trust** - Building and maintaining legitimacy through participation, accountability, and responsiveness to the concerns of affected people. Without trust, digital tools may be resisted or ignored, undermining their effectiveness.

Within the DRF, BTT operates as an enabling or constraining envelope around resilience interventions. Even well-designed infrastructure or digital investments may fail to produce upward trajectories if governance is opaque, biased, or untrusted. Conversely, strong BTT practices can amplify the benefits of structural investments and AIFC innovations.

, Stages of the Dynamic Resilience Framework (DRF), *the schematic illustrates the three stages through which food systems evolve: Crisis and Shock Response, Adaptive Recovery, and Transformative Resilience. The arrows represent transition pathways-showing how short-term stabilization can lead to reorganization and ultimately to structural transformation and anticipatory capacity.*

**Figure 1: Stages of the Dynamic Resilience Framework (DRF)**



#### **Chapter 4: The Dynamic Resilience Framework (DRF)**

Having outlined its conceptual foundations, we now present the Dynamic Resilience Framework itself. The DRF is a theoretical lens that structures how we think about hunger and food security as evolving systems.

The DRF begins with the recognition that food systems can be described in terms of discrete states of food security. For analytical convenience, we can classify these states as:

**Low food security** - High prevalence of hunger and malnutrition; weak infrastructure; limited buffers; fragile livelihoods; high vulnerability to shocks.

**Medium food security** - Partial improvements in availability, access, and utilization; some safety nets and infrastructure; yet persistent vulnerabilities and exposure to shocks.

**High food security or resilience** - Broad and stable access to sufficient, safe, and nutritious food; strong buffers; adaptive institutions; diversified livelihoods and markets.

These categories are ideal types. In practice, thresholds could be defined using combinations of indicators (e.g., GFSI scores, undernourishment rates, resilience indices such as UNDP-World Bank's State Resilience Index). The key point is not the precise cut-offs but the existence of qualitatively different states with different dynamics and risks.

Food systems transition between these states over time. Such transitions can be:

Upward - moving from low to medium, or medium to high food security;

Downward - dropping from medium to low or from high to medium;

Stable -remaining in the same state for extended periods.

These transitions are shaped by feedback mechanisms-reinforcing or balancing loops generated by interactions among infrastructure, markets, informal systems, governance, and ecological conditions. For example: A positive feedback might occur when improvements in infrastructure lower transportation costs, enabling better market integration, which in turn increases incomes and justifies further investments. A negative feedback might arise when price spikes undermine household purchasing power, leading to reduced investment in productive assets and education, thereby reinforcing vulnerability. The DRF is interested in how these feedbacks accumulate across time, producing patterns such as “vulnerability traps” (persistent low-level food security) and “resilience plateaus” (sustained high-level food security with limited risk of reversal).

#### **4.1 Three Stages and Feedback Loops in the DRF**

The DRF organizes system evolution into three conceptual stages: Crisis and Shock Response, Adaptive Recovery, and Transformative Resilience. These stages are not strictly sequential, they can overlap and recur. However, distinguishing them clarifies how different kinds of interventions and actors influence trajectories. In the Crisis and Shock Response stage, acute disturbances-such as droughts, floods, pandemics, or wars-threaten immediate food access. The system faces the risk of sudden downward transitions: for example, moving from medium to low food security.

The central objective is stabilization. Instruments include: Emergency food distributions and nutritionally targeted programs; Cash or voucher schemes enabling households to purchase food locally; Temporary adjustments to trade policies and price controls; Support to critical supply chains, including those involving informal markets.

From a DRF perspective, crisis response should not only alleviate immediate suffering but also preserve the basis for recovery. That means protecting: Productive assets (land, tools, livestock); Social capital and trust networks; Key nodes of AIFC that deliver food to vulnerable groups.

One-dimensional hunger solutions (focused on availability) are appropriate in this stage but must be implemented in ways that do not undermine local systems or create dependencies that block adaptive recovery.

Once the shock’s acute phase has passed, food systems enter an Adaptive Recovery phase. Here, the emphasis shifts from “keeping people alive” to restoring and improving livelihoods.

This stage is characterized by:

Experimentation - households and communities rearrange activities, diversify income sources, and explore new markets.

Reorganization - value chains are rebuilt; new partnerships emerge; social protection is reoriented toward longer-term support.

Learning - actors internalize what worked or failed during the crisis and adjust accordingly.

Key instruments for adaptive recovery include:

Digital tools - such as mobile market platforms, early-warning systems, and digital payment channels that facilitate information flows and financial transfers (Aker, 2010; Suri & Jack, 2016). Expanded social protection - predictable cash transfers, public works, or insurance mechanisms that stabilize incomes and support investment (Hoddinott, Gilligan, & Taffesse, 2012).

Support to AIFC structures - recognition and assistance for informal traders, community kitchens, cooperatives, and women's groups that played critical roles during the crisis.

In this phase, informal food systems become particularly important. They often recover faster than formal systems, offering flexibility and innovation. However, whether they contribute to upward trajectories depends heavily on governance: are they treated as partners, or as targets of punitive enforcement?

The third stage, Transformative Resilience, concerns the institutionalization of learning and structural change. The goal is to embed resilience in the architecture of food systems, such that future shocks are absorbed with less disruption.

Transformative resilience involves:

Infrastructure deepening - systematic investment in roads, storage, processing, irrigation, and energy that reduces structural bottlenecks (Gollin & Rogerson, 2014; World Bank, 2024).

Institutional reforms - governance changes that improve predictability, accountability, and inclusion (e.g., land rights, regulatory reforms, participatory planning).

Resilience mainstreaming - integration of risk management and climate adaptation into national budgets, planning frameworks, and sectoral policies (Béné et al., 2014).

Formal recognition of AIFC elements - where effective informal practices are selectively formalized or institutionalized in ways that preserve their adaptive flexibility while providing legal protection.

Crucially, transformative resilience is not a static endpoint. It implies an enhanced anticipatory capacity: the ability of institutions and communities to foresee emerging risks, trigger early responses, and adjust development trajectories proactively. This stage is intimately tied to BTT practices, since anticipatory governance hinges on transparent data systems and trust between authorities and populations.

The DRF emphasizes three sets of feedback loops:

Stabilization Feedback- Effective crisis responses reduce asset destruction and social fragmentation, preserving the capacity for recovery. Poorly designed responses (e.g., those that displace local markets or reinforce social exclusion) can weaken this feedback.

Learning Feedback- Adaptive recovery generates innovations in arrangements, technologies, and institutions. If these innovations are documented, discussed, and integrated into policy, they can shape long-term transformation. If learning is lost or suppressed, the system remains vulnerable to repeating the same failures.

Transformative/Anticipatory Feedback- Structural changes and improved governance feed back into how future shocks are managed. For example, better infrastructure and social protection systems make emergency responses more effective and less disruptive. Over time, this can elevate the entire trajectory of the food system.

These feedbacks mean that interventions in any stage can have long-run consequences far beyond their immediate goals. The DRF therefore argues for transition-aware policy design-policies that are explicitly evaluated in terms of their effects on trajectories, not only static indicators.

## **Chapter 5: Theoretical Model and Propositions**

To translate the DRF into a more explicit theoretical structure, this section presents a conceptual state-transition model and derives five propositions regarding the determinants of upward food-security transitions.

### 5.1 State Transitions as a Conceptual Markov Process

Conceptually, one can represent food-security transitions using the language of Markov processes, where the probability of moving from one state to another depends on the current state and a set of structural variables.

$S_t$  define each country or region at time  $t$  be in a food-security state:

$$S_t \in \{Low, Medium, High\}$$

At time  $t+1$ , the system may remain in the same state or transition to another. The transition probabilities can be organized in a matrix:

$$P = \begin{bmatrix} P_{LL} & P_{LM} & P_{LH} \\ P_{ML} & P_{MM} & P_{MH} \\ P_{HL} & P_{HM} & P_{HH} \end{bmatrix}$$

where, for instance,  $P_{LM}$  is the probability of moving from Low to Medium, and  $P_{HH}$  is the probability of remaining in High. Each row sums to one.

Although this article does not estimate such a matrix, it uses this conceptual construct to emphasize two ideas:

Persistence - diagonal elements (e.g.,  $P_{LL}$ ,  $P_{MM}$ ,  $P_{HH}$ ) tend to be large, reflecting the difficulty of escaping vulnerability or losing resilience.

Mobility - off-diagonal elements (e.g.,  $P_{LM}$ ,  $P_{MH}$ ,  $P_{HM}$ ) capture upward and downward movements, which may be rare but crucial for long-term trajectories.

The central analytical question becomes: what factors influence these transition probabilities, especially upward movement from Low to Medium and Medium to High?

### 5.2 Conceptual Determinant Model

The DRF proposes that the probability of **upward transition** is shaped by a set of structural and governance variables. Without specifying a particular functional form, one can express the conceptual relationship as:

where:

$$U_p = f(\text{Infra}, \text{Digital}, \text{Informal}, \text{GenderFin}, \text{Gov}, \text{ResCap})$$

$U_p$  is the conceptual probability of upward transition between  $t$  and  $t+1$ ;

Infra represents infrastructure intensity and quality;

Digital captures digital inclusion and connectivity;

Informal measures the scale and governance of informal employment and AIFC structures;

GenderFin reflects women's access to financial services;

Gov represents governance quality, transparency, and inclusiveness;

ResCap indicates resilience capacity (e.g., institutional strength, social cohesion, environmental resilience).

The DRF suggests that:

$\partial U_p / \partial \text{Infra} > 0$  - better infrastructure supports upward transitions.

$\partial U_p / \partial \text{Digital} > 0$  - digital inclusion improves coordination and adaptive capacity.

$\partial \text{Up} / \partial \text{GenderFin} > 0$  - women's financial inclusion enhances household resilience and investments.

$\partial \text{Up} / \partial \text{Gov} > 0$  - good governance makes interventions more effective and legitimate.

$\partial \text{Up} / \partial \text{ResCap} > 0$  - higher resilience capacity supports sustained improvements.

$\partial \text{Up} / \partial \text{Informal}$  may be positive or negative depending on context, reflecting the dual role of informality.

Additionally, interaction effects are likely:

Digital  $\times$  ResCap - digital tools are more effective in contexts with higher institutional resilience.

Infra  $\times$  GenderFin - infrastructure benefits are amplified when women can leverage them economically.

Informal  $\times$  Gov - supportive governance enhances the positive contributions of AIFC, while hostile governance tends to convert informality into a trap.

From this theoretical structure and the DRF's conceptual logic, we can derive the following propositions:

Proposition 1: Infrastructure as Backbone of Upward Transition- Countries or regions with higher levels of infrastructure intensity and quality-particularly in transport, storage, and energy-have a greater probability of transitioning from lower to higher food-security states. Infrastructure reduces transaction costs, connects rural producers to urban consumers, and enhances the physical robustness of food systems (Gollin & Rogerson, 2014; World Bank, 2024).

Proposition 2: Digital Inclusion as Coordination Amplifier-Greater digital inclusion, including access to mobile networks, internet connectivity, and digital payment systems, improves coordination, information flows, and the delivery of social protection and early-warning services. This, in turn, raises the likelihood of upward transitions, particularly in the Adaptive Recovery stage (Aker, 2010; Suri & Jack, 2016).

Proposition 3: Women's Financial Inclusion as Resilience Multiplier- Higher levels of women's financial inclusion-measured by their access to formal bank accounts, mobile money, savings, and insurance-multiply the resilience benefits of infrastructure and digital investments by strengthening household risk management, consumption smoothing, and nutrition-focused spending (Dupas & Robinson, 2013; Quisumbing & Maluccio, 2003).

Proposition 4: AIFC as Conditional Adaptive Infrastructure- Where informal food systems and AIFC structures are recognized, protected, and linked to formal policies, they function as adaptive infrastructure that stabilizes access in crises and fosters innovation in recovery. Where they are marginalized or criminalized, the same informality can contribute to structural traps that impede upward transitions (Hart, 1973; Chen, 2012; Moreira, 2020).

Proposition 5: Governance and BTT as Enabling Envelope- Governance quality, transparency, and inclusive data practices-as expressed in the Bias-Transparency-Trust (BTT) model-condition the effectiveness of all other investments. Similar levels of infrastructure or digital connectivity may yield different trajectories depending on whether institutions are perceived as legitimate, accountable, and responsive (Madianou, 2019; Burns, 2015; UNDP & World Bank, 2022).

These propositions provide a theoretical agenda for empirical research and a conceptual bridge between resilience theory and policy design.

**Error! Reference source not found.** below provides a visual synthesis of the theoretical model, illustrating how food systems transition between low, medium, and high food-security states and identifying the key determinants that influence upward and downward

mobility.

**Figure 2: Theoretical Model of State Transitions in the Dynamic Resilience Framework (DRF)**



**Downward Mobility**

The diagram depicts three food-security states-low (vulnerable), medium (transitional), and high (resilient)-linked by upward and downward transition pathways. It highlights five determinants shaping these transitions: infrastructure, digital inclusion, women’s financial access, adaptive informal food commons, and governance aligned with bias-transparency-trust principles.

**Chapter 6: Implications for Hunger Solutions and Policy Design**

The Dynamic Resilience Framework (DRF) offers a fundamental shift in how hunger solutions should be conceived, evaluated, and implemented. Rather than treating food insecurity as a static condition measured through levels or index scores, the DRF positions hunger reduction as a transition process, shaped by crisis responses, adaptive learning, and long-term structural change. This shift from *levels* to *trajectories* has profound implications for the design, sequencing, and governance of hunger interventions.

First, the DRF reframes existing paradigms. Traditional one-dimensional hunger solutions, focused primarily on food availability, remain indispensable during the Crisis and Shock Response stage, where immediate stabilization of access is essential. However, their effectiveness depends on whether they protect the foundations for recovery-local markets, AIFC networks, productive assets, and social trust. Multi-dimensional solutions, rooted in the FAO pillars and indices such as the GFSI, provide a richer diagnosis of constraints, but their greatest value emerges in the Adaptive Recovery and Transformative Resilience stages, where structural bottlenecks must be addressed. The DRF thus clarifies that neither paradigm is sufficient alone; each is part of a stage-specific toolbox within a broader mobility system.

Second, the DRF underscores the importance of sequencing and bundling interventions. Effective hunger policy cannot be built from isolated projects. Instead, interventions must be organized along transition pathways:

In the short term, crisis measures should stabilize access without undermining local systems or creating new vulnerabilities.

In the medium term, policies should enable adaptive recovery by strengthening digital inclusion, social protection, women’s financial access, and the coordination capacities of local and informal actors.

In the long term, structural reforms-especially investments in infrastructure, governance quality, and anticipatory institutions-must consolidate learning and reduce the likelihood of future downward transitions.

This approach clarifies why similar interventions produce starkly different results across countries: their impact depends on the stage at which they are implemented and the feedback loops they activate.

Third, the DRF elevates the role of the Adaptive Informal Food Commons (AIFC). Instead of viewing informal markets, neighborhood networks, and community feeding systems as marginal or temporary, the DRF recognizes them as critical adaptive infrastructure, especially during crises. Their ability to reorganize supply chains, maintain distribution, and innovate under pressure makes them essential partners. Policy should therefore protect and leverage these systems-not replace them-while ensuring that their inclusion does not reinforce exploitation or perpetuate structural inequalities.

Fourth, the DRF positions governance and data ethics-captured by the Bias-Transparency-Trust (BTT) model-as central determinants of policy effectiveness. Infrastructure and digital interventions will not generate upward transitions if governance systems are opaque, unaccountable, or exclusionary. Transparent data practices, participatory decision-making, and mechanisms for accountability shape whether interventions gain legitimacy among affected communities. In this sense, BTT is not a peripheral ethical concern but a core enabling condition for resilience.

Finally, the DRF has clear implications for global, national, and local actors. International organizations such as FAO, WFP, and UNDP can incorporate transition metrics-such as probabilities of upward or downward mobility-into monitoring systems alongside static indicators. Governments can use DRF-informed diagnostics to identify where their food systems lie in the resilience cycle and which drivers have shaped their historical transitions. Local actors, including informal traders, religious groups, and community networks, can be recognized as co-producers of resilience rather than passive beneficiaries.

Collectively, these implications call for a transition-oriented policy architecture-one that aligns emergency response, adaptive learning, and structural transformation into a coherent strategy. Such an approach not only improves the effectiveness of interventions but also enhances the capacity of societies to navigate future shocks. In this way, the DRF supports the development of hunger solutions that are not only multi-dimensional but also explicitly dynamic, capable of shifting systems toward more resilient and equitable food-security trajectories.

### **Chapter 7: Summary and Toward Transition-Oriented Hunger Solutions**

The analysis presented in this article argues that ending hunger requires moving beyond static measures of food insecurity toward a deeper understanding of how food systems evolve through states of vulnerability, adaptation, and resilience over time. Traditional one-dimensional and multi-dimensional models remain indispensable for identifying constraints and assessing levels of food security, yet they do not explain the mechanisms of movement-the pathways through which societies escape, remain trapped in, or relapse into hunger.

The Dynamic Resilience Framework (DRF) introduces this missing temporal dimension. By integrating resilience theory, the Adaptive Informal Food Commons (AIFC), and the Bias-Transparency-Trust (BTT) governance lens, the DRF conceptualizes food security as a trajectory shaped by crisis response, adaptive recovery, and transformative resilience. This approach highlights that hunger is not merely a condition to be measured, but a transition process that unfolds through interactions among structural investments, informal economies, and governance systems.

Thinking in terms of transitions offers several advantages. It clarifies why similar interventions produce different outcomes across contexts; it illuminates the reinforcing or self-limiting feedback loops that determine long-term mobility; and it underscores the importance of sequencing policies so that emergency responses, system reorganization, and structural reforms build upon one another rather than operate in isolation. Transition-oriented policy design prioritizes interventions that not only improve static indicators but also increase the probability of upward movement toward resilience.

This perspective also reframes the role of informal systems: instead of being treated as marginal or temporary, AIFC become visible as crucial adaptive infrastructure, capable of stabilizing access during crises and pioneering innovations in recovery. Likewise, governance and data practices-captured by the BTT model-are understood not as peripheral concerns but as core determinants of whether resilience investments gain social legitimacy and produce sustained change.

Finally, adopting a transition-oriented framework points toward a broader research agenda. Future empirical work may estimate state-transition probabilities, test the DRF's propositions, and explore how structural factors, gendered finance, digital inclusion, and governance shape resilience trajectories at national and subnational levels. Such research can help policymakers anticipate downward risks, identify resilience plateaus, and design interventions that actively shift systems onto more equitable and resilient paths.

In sum, the DRF calls for a paradigm shift: from viewing hunger as a static level to understanding it as a dynamic journey. This conceptual move enables scholars, practitioners, and global institutions to align strategies with the temporal realities of change, paving the way for transition-oriented solutions that can finally move the world closer to ending hunger.

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