Engaging Donors in Humanitarian Analysis: Case Study of UNICEF Nutritional Products

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ABSTRACT

The treatment of severe acute malnutrition has long been hindered by challenges such as fragmented coordination, volatile funding, and weak national ownership, leaving millions of children without reliable access to ready-to-use therapeutic food. This report begins by investigating these long-standing challenges through industry research, stakeholder engagement, and review of recent developments. We then examine how new frameworks, particularly the Child Nutrition Fund (CNF), aim to address structural barriers by promoting domestic investment, regional production, and more strategic donor alignment. While the CNF represents a promising step forward, it also introduces new planning, budgeting, and coordination demands that many countries and partners are not yet equipped to meet. To explore these dynamics, we applied a modeling and visualization application developed by the MIT Humanitarian Supply Chain Lab in collaboration with UNICEF and the Nigeria Ministry of Health (MoH), to four scenario-based case studies. These case studies revealed how key decisions such as network design, supplier selection, and contingency planning can dramatically influence program outcomes. We find that modeling and visualization can help operationalize the CNF's promise, but they must be accompanied by long-term investment, systems strengthening, and coordination across sectors. Together, these approaches offer a path toward more inclusive, accountable, and resilient nutrition strategies.

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1. Introduction

1.1. Background

The death of one in five children under the age of five globally is attributed to severe wasting disease, otherwise known as Severe Acute Malnutrition (SAM) (UNICEF, 2022b). As the most dangerous form of malnutrition and one of the top threats to child survival, wasting can be fatal if untreated, and those who do survive are susceptible to long-term effects (UNICEF, 2022b).

Ready-to-Use Therapeutic Food (RUTF) is a unique, unrefrigerated, long-lasting, energy-dense, micronutrient paste made using peanuts, sugar, milk powder, oil, vitamins, and minerals. It treats children suffering from wasting and allows for recovery at home, avoiding the need for the impacted to stay in a health facility (UNICEF, 2022b).

The most significant challenges in treating severe acute malnutrition today lie not in the product itself, but in how it is funded, procured, and distributed (Nutrition Cluster, 2023). Ensuring sufficient, efficient, and timely access to RUTF remains a complex challenge that this report seeks to explore.

1.2. Motivation

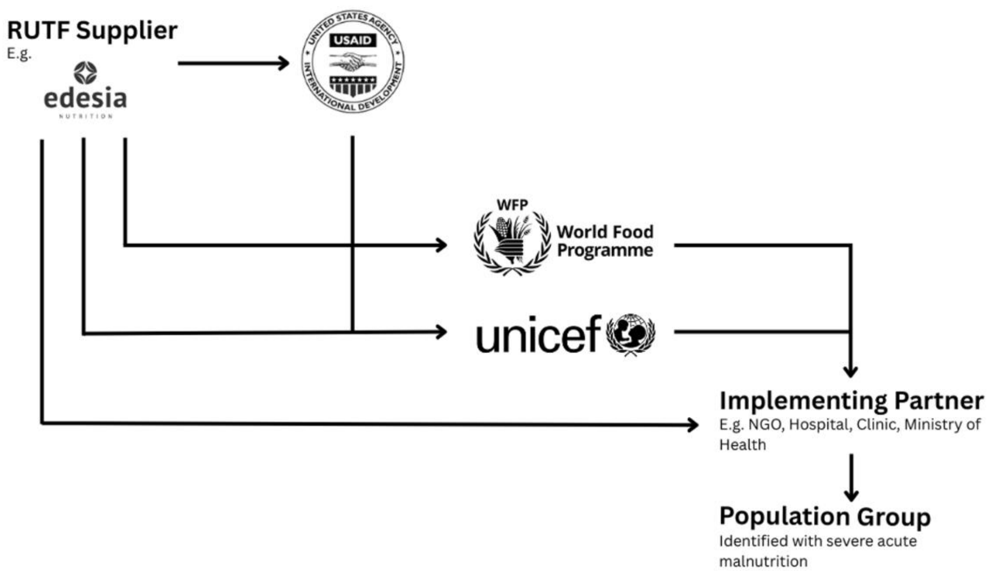
UNICEF is the prominent procurer and distributor of RUTF globally, accounting for 75 to 80 percent of its supply (UNICEF, 2022a). As UNICEF acknowledges, “delivering RUTF to communities where children live is a complex exercise” (UNICEF, 2022a) requiring planning and coordination across financing, procurement, storage, and distribution systems. Challenges include funding constraints, the need for predictable and sustained supply, and the logistical difficulties of reaching children in remote or conflict-affected areas (UNICEF Supply Division, 2023). UNICEF also highlights localization as a critical objective, aiming to strengthen national systems to manage RUTF delivery more independently and sustainably (UNICEF Supply Division, 2023). As part of these broader efforts, the MIT Humanitarian Supply Chain Lab (HSCL) has partnered with UNICEF and the Nigerian Ministry of Health (MoH) to support the transition of nutrition commodity distribution to national systems.

Edesia, a U.S.-based non-profit manufacturer located in Rhode Island, is a leading global supplier of RUTFs for the treatment of SAM (Edesia, n.d.). Suppliers like Edesia provide a valuable case study of how the structural challenges in humanitarian nutrition supply chains impact actors across the system. Despite being a global leader in the production of RUTF, Edesia often faces challenges related to underutilization of production capacity, unpredictability in demand forecasting, and limited visibility into donor-driven procurement cycles. These issues create inefficiencies that affect suppliers and ultimately ripple back through the entire supply chain, contributing to delays, higher costs, and risks of stockouts

(Edesia Nutrition, 2025). Through its partnership with Edesia, the MIT HSCL has benefited from the organization's deep expertise and operational insights, helping to ground this project's analysis in the real-world experiences and perspectives of nutrition suppliers.

Historically, suppliers like Edesia have operated within a structured but complex end-to-end (E2E) demand funnel, where large portions of demand have flowed through international agencies such as UNICEF and the World Food Program (WFP). In many cases, these agencies served as the primary buyers and implementers, but the funding pathways often passed through intermediary entities, most notably the U.S. Agency for International Development's (USAID) nutrition programs. USAID traditionally played a critical role by aggregating funding and forecasting needs, and channeling resources to organizations like UNICEF and WFP, who then managed procurement and distribution to local partners (Edesia Nutrition, 2025).

Figure 1. RUTF E2E Demand Funnel Workflow Example (Edesia Nutrition, 2025).



The humanitarian landscape is now experiencing significant disruption following the dismantling of USAID's core nutrition programs in early 2025, creating urgent gaps in both funding and operational coordination (Standing Together For Nutrition, 2025). Although initiatives like the Child Nutrition Fund (CNF) were already emerging to strengthen long-term nutrition financing, the dismantling of USAID has accelerated the timeline and heightened the importance of these efforts. The CNF "is a UNICEF-led coordination and funding mechanism designed to accelerate the scale-up of sustainable policies, programs and supplies to end child undernutrition in high-need countries"; it "mobilize resources to accelerate the implementation of evidence-based, high-impact actions designed to tackle key nutrition challenges" (UNICEF, 2025, p. 2). The CNF is positioned to help fill immediate funding gaps and address the broader systemic challenges that have historically affected the sustainability and effectiveness of nutrition supply chains (UNICEF, 2025).

With the support of the MIT HSCL, we are uniquely positioned to combine operational feedback from key actors across the RUTF supply chain with management science methodologies and advanced analytical tools. This positioning and approach allow us to develop actionable insights and recommendations to strengthen the funding, deployment, and impact of program activities related to the distribution of RUTF and other specialized nutrition products. We believe these insights will be particularly valuable within emerging frameworks like the CNF, especially given both the growing need for effective interventions and the opportunity to shape stronger, more resilient systems as the humanitarian nutrition sector undergoes major structural change.

1.3. Problem Statement and Key Questions

Despite significant progress, systemic challenges in the humanitarian nutrition landscape have continued to constrain the effective, efficient, and sustainable distribution of RUTF. Emerging mechanisms, such as the CNF, offer more creative approaches for program design and have the potential to address many longstanding challenges. However, they also introduce new complexities, including gaps in visibility, coordination, and decision-making, and a redefinition of responsibilities between donors, implementing partners, and national governments.

These shifts create a need for tools that can clarify trade-offs, bridge operational knowledge gaps, and strengthen shared understanding. Models and visualizations are essential to making complex supply chain decisions more transparent and actionable across a broader range of stakeholders.

In that context, key questions guiding this work include:

1. What are the key issues and challenges facing the treatment of SAM, and the distribution of RUTF today? How do new mechanisms and frameworks, such as the CNF, attempt to address them and what gaps remain, or are created, from these efforts?
2. How can analytical models and visualizations build technical capacity to reimagine how SAM treatment is resourced and delivered? How can countries that struggle to reach every child with wasting treatment leverage such technical capacity to drive effective system reform?

1.4. Project Goals and Expected Outcomes

Building on the guiding questions outlined above, our project goals and expected outcomes are twofold. First, we aim to provide an updated understanding of the persistent challenges facing RUTF distribution. We will assess how emerging mechanisms, particularly the CNF, attempt to address these barriers. We expect that while the CNF represents significant progress in tackling root issues such as funding fragmentation and sustainability, it also introduces new operational gaps, particularly around responsibility hand-offs, capacity demands, and local system readiness. These gaps must be proactively managed to ensure long-term success.

Second, we seek to demonstrate the value of modeling and visualization tools in filling these gaps. We hypothesize that these tools can bridge knowledge and coordination challenges, strengthen strategic planning and decision-making, and enhance storytelling and advocacy efforts by making complex trade-offs and operational realities more accessible to a broad range of stakeholders. To illustrate this, we will present a series of case studies, applying scenario-based modeling analysis to theoretical CNF use cases. The remainder of this report builds on these objectives, examining current challenges, evaluating emerging mechanisms, and exploring the role of modeling and visualization in improving nutrition program delivery.

2. State of the Practice

2.1. Industry Background

The early development of the RUTF industry and its supply chain is well-documented through two foundational case studies, “UNICEF RUTF Supply Chain (1): Crisis in the Horn of Africa,” by Swaminathan (2014), and “UNICEF RUTF Supply Chain (2): Developing a Global Supply Network,” by Goentzel and Swaminathan (2015). These cases apply a unique lens to the industry’s history, considering how UNICEF and its partners responded to escalating global demand for RUTF and how early supply chain strategies shaped the progress and persistent challenges the sector faces today.

Initially, the supply chain was heavily centralized. Production of RUTF was almost exclusively conducted by Nutriset in France, leading to significant supply bottlenecks as global demand rapidly expanded. Limited production capacity, long lead times, heavy reliance on air freight during emergencies, and weak visibility into procurement and delivery planning constrained UNICEF’s ability to respond effectively to growing needs. Donor funding cycles further complicated procurement planning, as irregular and delayed funding releases made it challenging to align production with programmatic demands (Swaminathan, 2014).

In response to these pressures, UNICEF and Nutriset worked to expand global production capacity by developing the PlumpyField Network. This franchise model authorized regional and local manufacturers to produce RUTF using Nutriset's technology. This approach successfully increased capacity, reduced lead times, and geographically diversified the supply base, improving responsiveness during emergencies and supporting local economic development (Goentzel & Swaminathan, 2015).

However, these gains introduced new complexities. Expanding the supplier base raised concerns around maintaining product quality, managing intellectual property associated with the Plumpy'Nut brand, and coordinating procurement across a more fragmented production network. Demand volatility remained a challenge, as did aligning donor funding with production schedules in a way that could minimize disruptions and avoid costly emergency shipments (Goentzel & Swaminathan, 2015). As supply capacity expanded, the system remained highly vulnerable to demand signal distortion and misalignment, a classic case of the "bullwhip effect" (Goentzel, 2025).

These early developments highlight several foundational challenges and lessons that continue to resonate today. Regionalized and diversified supply can improve responsiveness but requires strong systems for quality assurance and coordination. Volatile demand and inconsistent funding can severely strain supply chains. Flexible funding mechanisms, better forecasting, and improved supply chain visibility are critical to supporting more sustainable, resilient nutrition programs (UNICEF Supply Division, 2023).

Many of these challenges persist today and form the foundation for why new frameworks like the CNF are being introduced (UNICEF, 2025). As the sector embraces new approaches, it is essential to learn from these early experiences and recognize that while innovation can drive progress, it also introduces new risks and gaps that must be proactively managed. In particular, as responsibilities increasingly shift toward national actors, the need for stronger integration of wasting treatment into national health systems and government-led planning structures is becoming more urgent – a theme we will return to in Section 2.3.5. Sustained progress will depend on proactively building tools and frameworks that strengthen decision-making, visibility, and coordination across an increasingly complex supply chain.

2.2. Industry Developments & The Child Nutrition Fund

Over the past two decades, the RUTF supply chain has evolved substantially. Early bottlenecks stemming from a centralized supplier model have been reduced through expanded local manufacturing, better procurement practices, and stronger coordination across agencies (Nutrition Cluster, 2023).

Alongside these shifts, the cost of RUTF has fallen significantly, driven by increased supplier competition and improved efficiencies across the market (Van Pelt et al., 2015). However, while supply and affordability have improved, systematic challenges have persisted and new challenges have emerged, highlighting the need for new mechanisms and solutions (UNICEF, 2024a). These challenges will be explored in greater detail in the following sections.

The Child Nutrition Fund was created in 2022 in response to these needs. It is designed to serve as a global financing mechanism to scale wasting prevention and treatment, stabilize supply chains, and build domestic ownership over time (UNICEF, 2025). The CNF operates through three components, which they label as "windows":

- The Programme Window coordinates investments from various global donors, identifying funding gaps and ensuring resources are distributed to countries and activities with the highest impact. Additionally, this window aims to advise and assist countries in implementing their humanitarian programs (UNICEF, 2025).
- The Match Window provides one-to-one financial matching to countries investing in the prevention and treatment of child malnutrition. This incentivizes domestic investment, allowing participating governments to effectively double their investments in nutrition services and products. Matched funds can be used to cover the cost of RUTF, as well as commodities aimed at preventing malnutrition. In addition, handling fees and freight costs are supported up to the point of delivery in country; however, all in-country logistics expenses, including taxes, storage, and distribution, are the responsibility of the national government. To participate, countries must also use UNICEF Procurement Services (PS) to disburse their matched funds and demonstrate that additional investment in RUTF will not come at the expense of other critical nutrition and health interventions (Child Nutrition Fund, 2025a).
- The Supplier Window provides financing tools and support to manufacturers to strengthen local production capacity and resilience. A primary aim of this window is to strengthen regional supply chains so countries can sustainably begin to rely more readily on their own production rather than foreign aid (UNICEF, 2025).

This transition toward more sustainable financing and system strengthening coincides with broader shifts in the humanitarian aid landscape. In early 2025, the dismantling of USAID created significant uncertainty for the SAM treatment ecosystem (Standing Together For Nutrition, 2025). As one of the largest funders and organizers of RUTF procurement and wasting treatment, USAID's sudden dismantling left a significant gap in predictable funding flows and industry structure (Standing Together

For Nutrition, 2025), reinforcing the urgency and opportunity for adoption of new mechanisms like the CNF that promote diversified, multi-source, and country-driven funding models.

2.3. Industry Challenges

2.3.1. Chronic Underfunding and Coverage Gaps

The sector continues to face a fundamental constraint in the chronic underfunding of wasting treatment relative to global needs (UNICEF, 2024a). Historically, financing for wasting treatment has relied on emergency humanitarian aid rather than sustained integration into health and development budgets. As a result, a large population of children in less-publicized, chronic scenarios often go without consistent access to services or RUTF supplies (UNICEF, 2021). UNICEF's Healthy Market Framework (HMF) (2024) explicitly identifies funding, rather than supply or production capacity, as the primary constraint in the RUTF market.

The CNF seeks to narrow this persistent funding gap by mobilizing more sustainable financial flows. Its Programme Window helps align donor contributions with country needs, while the Match Window directly addresses underinvestment by amplifying domestic government spending and creating strong incentives for countries to prioritize nutrition funding (UNICEF, 2025).

While these mechanisms represent critical innovations, it is important to acknowledge that unless total resource mobilization continues to increase and more domestic resources are committed, the global funding gap for wasting treatment will likely persist. The CNF strengthens the architecture of financing, but achieving full coverage will require sustained political will, broader donor commitments, and greater prioritization of wasting within national development agendas (UNICEF, 2024a; UNICEF, 2021).

2.3.2. Volatile Funding Cycles and Supply Instability (A Bullwhip Effect)

In addition to chronic underfunding, the reliance on emergency-based reactive funding drives high volatility in funding cycles and creates instability and inefficiency across the supply chain. When funding is mobilized, it often arrives late or unexpectedly, making it difficult for manufacturers and program managers to plan (UNICEF Supply Division, 2023).

As outlined in the Industry Background, the RUTF supply chain has historically operated, and continues to operate as a push-based system, where production and delivery are driven by centralized forecasting and donor procurement decisions rather than end-user demand (Goentzel, 2025; UNICEF, 2024). As outlined in Cachon & Terwiesch (2019), push systems are particularly susceptible to the "bullwhip effect," in which small fluctuations in demand or funding lead to amplified swings upstream in procurement and production. These dynamics are further intensified in humanitarian settings, where planning visibility is limited and donor timelines are unpredictable.

This pattern was well illustrated by our conversations with Edesia, who have repeatedly experienced the "bullwhip effect". Due to delayed and reactive donor decisions and last-minute budget approvals, Edesia often receives large spikes in orders late in the fiscal year, followed by periods of underutilization (Edesia Nutrition, 2025).

A broader example of this dynamic was particularly prominent from 2022 to 2024. In response to an escalating global nutrition crisis, UNICEF launched the No Time to Waste: Acceleration Plan in late 2022 (UNICEF, 2022c). Backed by nearly $1 billion in mobilized funds, the initiative led to an unprecedented procurement surge of 121,000 metric tons of RUTF in 2022, more than double the previous year. Nearly half of this volume was procured in the final quarter of the year, placing significant strain on the supply base (UNICEF Supply Division, 2023). Many suppliers, previously operating at only ~50% capacity, could not rapidly scale production to meet demand (UNICEF Supply Division, 2023). The result was widespread delays, strained production lines, and longer lead times, a textbook example of the "bullwhip effect" unfolding across the industry (UNICEF Supply Division, 2023). Suppliers like Edesia rapidly worked to meet the funding demand and scaled production operations to a "24/7" schedule (Edesia Nutrition, 2025).

This dramatic spike was short-lived. In early 2023, order volumes began to slow sharply. The earlier surge had largely exhausted donor budgets, and as the product it generated was slowly distributed downstream, uncertainty around future funding made it difficult for agencies to place forward-looking orders (UNICEF Supply Division, 2023). This sudden drop created a second whiplash. After a period of intense strain, manufacturers had to scale production down rapidly. As outlined in a 2023 UNICEF Supply Division market update (2023), suppliers reduced shifts, paused hiring, and faced cash flow challenges just months after the most significant procurement wave in the market's history. Orders were fewer and more unpredictable, reintroducing the instability that had long plagued the market.

By 2024, UNICEF was once again issuing urgent calls for donor support, not simply to increase overall funding, but to avoid imminent stockouts, stabilize the market, and prevent further deterioration (UNICEF, 2024b). Despite earlier investments, the global landscape remained fragile. Conflict, natural disasters, inflation, and supply chain disruptions, compounded by lingering impacts of COVID-19 and the war in Ukraine, continued to drive high levels of need. At the same time, national systems remained heavily reliant on external support (UNICEF, 2024b). In No Time to Waste: Update and Call to Action (2024b), UNICEF emphasized that critical gaps remained in both funding and product availability. Local suppliers, in particular, were at risk. As the report warned: “Without additional capital to procure from local manufacturers, many of them will be forced to close, which in turn will affect the willingness of national governments in these countries to invest domestic resources in essential therapeutic foods and food supplements for children with wasting in the future.” This statement highlights the broader risk that a failure to provide stable, predictable demand jeopardizes not only individual businesses, but also broader efforts to foster national ownership and domestic co-investment.

These events underscore a recurring vulnerability in the global nutrition supply chain. Even high-profile, well-funded initiatives can create instability if not paired with the proper structure, forecasting, planning, coordination, and support. The CNF was introduced in response to this series of events that took place from 2022 to 2024, and its Supplier and Matching Windows were designed to address these risks (UNICEF, 2024b). National funding incentives and supplier financing mechanisms, such as pre-financing, long-term contracts, and volume guarantees smooth demand and weather procurement shocks, maintaining more stable operations and supporting market health (UNICEF, 2025). Together, these measures represent meaningful progress in strengthening market stability and national ownership. Continued success will depend on the successful adoption of these new mechanisms by the donor community and sustained donor responsibility, particularly in a global environment marked by rising volatility, overlapping crises, and intensifying funding pressures.

2.3.3. Supply Chain Constraints and Disruptions

Despite gains in production capacity, the RUTF supply chain remains vulnerable to global and local disruptions. Recent years have seen ingredient shortages, freight delays, and inflationary pressures, from COVID-19 to the war in Ukraine, drive up costs and slow deliveries (UNICEF Supply Division, 2023). According to UNICEF’s Supply Division RUTF Market Update (2023), average RUTF unit costs rose by nearly 9% in 2022 alone, reversing several years of declining price trends, largely due to raw material and transport volatility.

Even when RUTF is procured and delivered nationally, last-mile distribution often breaks down. Field assessments by the Nutrition Cluster (2023) and USAID Advancing Nutrition (2022) stakeholder consultations in Nigeria reveal that stock availability at the central level does not guarantee timely delivery to health facilities. This is particularly true for rural, hard-to-reach, or conflict-affected areas.

Barriers include poor infrastructure, security constraints, staffing shortages, and weak coordination between national and subnational actors (USAID Advancing Nutrition, 2022).

The CNF helps mitigate these challenges by financing local and regional production through its Supplier Window, reducing lead times and import risks (UNICEF, 2025). The Match Window also supports investment in frontline service delivery, helping countries strengthen logistics and workforce capacity (Child Nutrition Fund, 2025a). However, persistent shocks will continue to test the system, and long-term resilience will depend on strategic investment in risk management and local capacity (Nutrition Cluster, 2023). Planning tools that enable governments and donors to evaluate backup supply routes, simulate emergency response models, or compare pre-positioning strategies can be particularly valuable in strengthening preparedness and continuity of care during crises.

2.3.4. Market Composition and Local Production Challenges

While the RUTF supplier base has expanded, with 18 of 21 UNICEF-approved manufacturers now based in countries needing nutrition aid, local producers continue to face structural barriers (UNICEF Supply Division, 2023). Many operate below capacity due to irregular procurement and cash flow constraints, and face challenges like import taxes, limited access to working capital, and higher input costs (Van Pelt et al., 2015; UNICEF, 2024). UNICEF's 2024 market update (2024b) emphasized that without urgent funding to support procurement from suppliers, many face the risk of closure, jeopardizing local production and undermining government confidence and willingness to invest domestic resources in nutrition supply chains. Despite these hurdles, African manufacturers have made progress in becoming cost-competitive, with UNICEF's Supply Division reporting in 2023 that their offering of RUTF was 7–13% cheaper than European suppliers (UNICEF Supply Division, 2023).

The CNF's Supplier Window responds to these challenges by offering tools like pre-financing and concessional loans to help stabilize local production (UNICEF, 2025). In parallel, the Match Window naturally incentivizes governments to procure locally where possible (Child Nutrition Fund, 2025a), aligning domestic investments with regional supply and reinforcing market sustainability. Together, these mechanisms strengthen resilience and reduce import reliance. However, non-financial hurdles, such as regulatory bottlenecks and fragmented procurement processes, remain outside the scope of financing alone and require broader market coordination.

2.3.5. Limited Domestic Ownership and Integration into Health Systems

In many high-burden countries, SAM treatment is still viewed as a humanitarian intervention rather than a core part of national health systems (UNICEF, 2021). This perspective limits domestic budget allocations, planning authority, and long-term sustainability. Consultations in Nigeria, for example, revealed that ministries often lack the institutional mandates, funding streams, and capacity to manage procurement and last-mile delivery without donor support (USAID Advancing Nutrition, 2022). The Global Action Plan on Child Wasting Framework (2021) notes that national governments underfund wasting response, leading to fragmented service delivery and limited integration with broader child health programs.

Several recent developments have created meaningful momentum in transitioning to nationally owned systems. The Codex Alimentarius Commission formally adopted global guidelines for Ready-to-Use Therapeutic Foods (RUTF) in November 2022 (UNICEF, 2022d). These guidelines standardize nutritional and food safety criteria and expand acceptable ingredient options, facilitating greater regional and local production. They also provide a regulatory foundation for countries to classify RUTF as a standard therapeutic product within public health systems and procurement processes (UNICEF, 2022d), enabling supply-side innovation and institutionalizing RUTF within national medical supply chains.

Nigeria has taken a landmark step by including RUTF on its National Essential Medicines List (EML). Finalized in 2020, this milestone followed several years of sustained advocacy and technical engagement by the Federal Ministry of Health, in collaboration with UNICEF and other partners (Nigeria Federal Ministry of Health, 2020a). The process began as early as 2014, with national nutrition stakeholders building clinical consensus and demonstrating cost-effectiveness and public health need (Action Against Hunger, 2018). This inclusion is a significant policy signal of commitment to institutionalizing SAM treatment in routine health service delivery. It enables domestic financing mechanisms, eases public-sector procurement, and integrates RUTF into national health insurance and supply planning frameworks (UNICEF, 2020). Examples like this, unfortunately, remain the exception, not the norm. In many contexts, nutrition programs continue to operate through parallel systems that rely heavily on external funding, outside formal health and procurement architectures (UNICEF, 2022a; UNICEF, 2023a).

The CNF’s Match Window addresses this by incentivizing governments to co-invest in nutrition, which helps secure domestic budgets for RUTF and signals institutional prioritization (Child Nutrition Fund, 2025a). Notably, the Match Window also includes technical support for planning and implementation, which can help governments build the operational and analytical capacity needed to take on these responsibilities (Child Nutrition Fund, 2025a). This support reflects a broader push toward long-term system strengthening, rather than short-term service delivery.

Full integration will require more than financing incentives alone. It will depend on long-term commitment and coordinated investments in policy alignment, health workforce capacity, and supply chain visibility. To create long-term sustainable success, countries must extend their efforts far beyond just funding by structurally embedding nutrition programs into their health systems, policy frameworks, and institutional planning processes.

2.3.6. Fragmented Coordination in Wasting Responses

Child wasting response has long suffered from fragmented coordination between various actors, from donors to UN agencies, NGOs, and national governments. Before the launch of the Global Action Plan (GAP) on Child Wasting, actors often worked in silos without shared strategies, resulting in duplication, funding inefficiencies, and uneven program coverage (UNICEF, 2021). Even with GAP in place, operational alignment remains difficult. The Nutrition Cluster's 10-year review (2023) highlights persistent barriers such as misaligned procurement systems, overlapping mandates, and inconsistent data sharing, which constrain efficient implementation. Consultations in Nigeria echoed this, citing communication breakdowns between agencies and ministries as a major obstacle to scaling treatment (USAID Advancing Nutrition, 2022).

These coordination challenges have grown even more urgent following the dismantling of USAID in early 2025. USAID was a dominant funder and convening voice in the space; its withdrawal has left a leadership vacuum and raised concerns about further fragmentation in global strategy and accountability (Standing Together For Nutrition, 2025). In this context, improving coordination is not only an operational necessity, it's now a foundational requirement for sustaining progress.

The CNF's Programme Window directly targets these gaps by aligning donors through joint investment frameworks and guiding funding to the highest-priority needs. It also supports country-level coordination through planning tools and investment roadmaps (UNICEF, 2025). While promising, these mechanisms require strong engagement from donors and governments to reach their full potential, especially in the absence of formerly centralized leadership.

2.4. Summary of Industry Challenges

Together, these challenges reflect a system in transition - one that has made important strides, but still faces deep-rooted inefficiencies, fragmentation, and structural vulnerabilities. The CNF was designed with many of these pain points in mind, offering new mechanisms to improve funding, coordination, and local ownership. Its success will depend on how well these tools are applied in practice. In the following sections, we will discuss this further and demonstrate how analytical modeling and visualization can help donors, governments, and implementing partners navigate this complexity, fill critical gaps, and support more effective program design and advocacy.

3. Methodology

3.1. Approach

Our methodological approach is structured to align closely with the guiding questions of this report. The State of the Practice section addressed the first guiding question by examining the key challenges facing the treatment of SAM and the distribution of RUTF today, as well as how emerging mechanisms like the CNF attempt to address them. The Results and Discussion section builds on these findings by presenting four scenario-based case studies, each designed to exemplify how modeling and visualization tools, when applied to real-world decision contexts, can help stakeholders navigate remaining gaps in these challenges by managing complexity, testing strategies, and more effectively communicating program tradeoffs. We combine insights from the State of the Practice and our case study-based results to discuss which challenges are addressed by mechanisms like the CNF, where modeling and visualization tools can provide added value, and what structural or systemic gaps remain. The remainder of this Methodology section explains the design of the modeling tool used in these case-based scenarios. Then we describe the structure, assumptions, and parameter values used to simulate supply chain behavior under different programmatic conditions.

3.2. MIT Nigeria MoH CAVE App Introduction

3.2.1. Application Background

The UNICEF & MIT Computational and Visual Education (CAVE) Lab Application (referred to as the UNICEF CAVE App) is a planning tool developed by the MIT HSCL in collaboration with UNICEF, as part of a broader initiative to support Nigeria's transition toward national ownership of nutrition supply chain operations (Nigeria Federal Ministry of Health, 2020a). Rather than producing a static report, the tool was developed to provide a more adaptable, data-driven platform for planning, testing, and communicating supply chain strategies, especially for the delivery of RUTF across Nigeria's emergency zones (MIT Humanitarian Supply Chain Lab, 2024).

3.2.2. Core Application Features

At its core, the CAVE App features an interactive map interface representing real-world supply nodes across six northern Nigerian states. These include:

- Four suppliers (NutriK, Ariel, Dabs, and Edesia [Tema, Lagos])
- Three federal warehouses (Abuja central and two zonal warehouses)
- Six state central medical stores (CMS)
- Over 100 local government area stores (LGA)

Users can toggle nodes on or off, adjust cost, capacity, and lead time parameters, and simulate a variety of network designs. The application allows for manual determination of product flow paths (e.g., supplier → warehouse → LGA) but also supports "level-skipping" when needed, allowing simulation of decentralized or emergency delivery models (MIT Humanitarian Supply Chain Lab, 2024).

3.2.3. Modeling Framework and Functionality

The UNICEF CAVE App operates as a practical distribution requirements planning (DRP) model, progressing in monthly time steps. Among other things, it takes into account randomized weekly demand patterns by Local Government Areas (LGAs) (based on Integrated Food Security Phase Classification forecasts and adjusted for seasonality); budget ceilings that define the financial boundaries of a scenario; storage and distribution capacity limits at each node; supplier-specific lead times; and fixed ordering schedules that govern how product flows through the system (MIT Humanitarian Supply Chain Lab, 2024).

Unlike traditional optimization tools, the app is not designed to produce idealized solutions. Instead, it was built to support practical planning, particularly in collaborative workshop environments where users can quickly explore tradeoffs, test different network designs, and visualize system-wide impacts in an intuitive, transparent manner. Its goal is to support decision-making by making operational constraints and tradeoffs visible, not to prescribe an optimal solution under ideal conditions (MIT Humanitarian Supply Chain Lab, 2024).

Product flow in the application follows a hierarchical structure from the supplier to the central warehouse, to the state warehouse, and then to the LGA stores. If a node is deactivated or reaches its capacity, the model automatically reroutes the product to the next viable level up the chain. Rather than enforcing complete demand fulfillment, the tool seeks to maximize the share of demand met under the defined constraints, making it possible to reveal bottlenecks, delays, and system inefficiencies.

Users can adjust a range of scenario inputs, including cost assumptions for distribution and storage, node-level capacity constraints, supplier availability and lead times, and total available funding. These levers allow for realistic modeling of complex delivery scenarios and provide insights into the operational and financial implications of strategic supply chain decisions (MIT Humanitarian Supply Chain Lab, 2024).

3.2.4. Output and Decision Support Capabilities

Once a scenario is configured and executed, the CAVE App generates various visual and quantitative outputs designed to support interpretation and strategic planning. These outputs include week-by-week product flows, inventory levels at each node, and dynamic visualizations of storage and distribution bottlenecks across the supply chain. Users can view how and when individual facilities reach capacity, where unmet demand accumulates, and how delivery timelines vary across geographies (MIT Humanitarian Supply Chain Lab, 2024).

The model also calculates a standardized set of performance indicators supporting operational and financial evaluation (MIT Humanitarian Supply Chain Lab, 2024). For the purposes of our case studies, these are grouped into two primary categories. Standard KPIs include percentage of demand met, storage cost, distribution cost, total cost, and budget utilization. Capacity-related KPIs highlight the number of facilities operating at full storage or distribution capacity and the duration of those constraints, helping users understand when and where systems are likely to break down under pressure.

All outputs are displayed in an interactive dashboard and can be compared across multiple scenarios. This functionality is particularly useful in workshop settings or planning discussions, where decision-makers may want to test competing designs, pressure-test tradeoffs, or align investment priorities. By pairing visual storytelling with quantitative results, the app is intended to support more informed, transparent, and collaborative decision-making.

3.2.5. Application Within This Report

In this project, the UNICEF CAVE App was adapted to explore planning challenges relevant to the implementation of the CNF. The tool's structure, flexibility, and visual outputs make it well-suited to support scenario-based analysis aligned with the CNF's focus, particularly around budgeting, supply chain configuration, supplier engagement, and contingency planning.

The scenarios developed for this report are designed to reflect real-world decision points that governments, donors, and implementing partners may encounter when engaging with the CNF. Each scenario demonstrates how the UNICEF CAVE App can be used to test strategies, clarify tradeoffs, and strengthen planning and advocacy efforts. The Results section that follows describes these scenarios in greater detail.

3.3. Data Gathering and Assumptions

3.3.1. Data

The scenarios presented in this report rely on representative inputs intended to support learning and exploration rather than prediction. All data used in the CAVE App simulations were informed by a combination of prior modeling work conducted with UNICEF, stakeholder feedback from the Nigeria MoH, and UNICEF documentation and planning assumptions. In many cases, these values are either directionally accurate or illustrative, designed to reflect realistic ranges without requiring complete accuracy or operational validation (MIT Humanitarian Supply Chain Lab, 2024).

The application assumes a monthly planning horizon and models demand at the LGA level based on Integrated Food Security Phase Classification (IPC) acute malnutrition projections and UNICEF stakeholder insights (Integrated Food Security Phase Classification, 2023; MIT Humanitarian Supply Chain Lab, 2024). Demand is randomized within defined thresholds to reflect seasonal and regional variation and applied as a static target within each scenario. All scenarios are configured to maximize demand met within the available budget, rather than to enforce full coverage (MIT Humanitarian Supply Chain Lab, 2024).

3.3.2. Product Cost Assumptions

To isolate logistics performance from procurement cost, all scenarios are modeled as in-kind contributions, meaning product costs are excluded. Given that the product cost does not drive the decisions being considered, this allows for more focused analysis of storage, distribution, and lead-time dynamics under various design and budget constraints. Please note that while this simplifying assumption was made, the model is capable of handling product cost parameters by supplier, and both new and existing scenarios could be run with these parameters moving forward.

3.3.3. Storage Cost Assumptions

Holding costs are applied on a weekly, per-carton basis, with tiered values that increase at lower levels of the supply chain to reflect differences in facility scale and operating conditions. The following base rates were used:

- Federal Central Warehouse: $0.10 per carton per week
- State Central Warehouse (CMS): $0.15 per carton per week
- LGA-Level Stores: $0.21 per carton per week

These values were drawn from earlier modeling efforts by MIT's HSCL in collaboration with UNICEF and the Nigerian Ministry of Health (MIT Humanitarian Supply Chain Lab, 2024) and were designed to reflect a simplified yet representative storage cost structure across different network tiers.

Given the impact of storage cost assumptions on system performance and budgeting, we further explore these parameters in our scenario analysis in the following results section. In Scenario B (Budgeting Tool), we conduct sensitivity tests by increasing and decreasing holding costs, helping illustrate how these factors influence tradeoffs in supply chain design, performance, and feasibility.

3.3.4. Distribution Cost Assumptions

Distribution costs in the model are applied as a per-carton, per-kilometer rate. A flat, blended rate of $0.003 per carton per kilometer was used as the base case rate across all transportation legs and scenarios. This value reflects an aggregated estimate derived from prior modeling with UNICEF Nigeria and MIT's HSCL (2024), and is intended to offer a simplified, scalable baseline for exploring a range of distribution network configurations.

While this uniform rate supports usability and comparability across scenarios, it is important to recognize that real-world transport costs vary significantly depending on factors such as vehicle type, road condition, route distance, load size, and border crossings. For example, long-haul deliveries to central warehouses often benefit from economies of scale and well-maintained roads, while last-mile deliveries to remote LGAs may involve shorter, slower, and more expensive trips due to terrain, insecurity, or lack of infrastructure.

To account for this variability and assess the sensitivity of results to this assumption, we conducted a targeted sensitivity analysis in Scenario B (Budgeting Tool), adjusting the distribution cost parameter to reflect a broader range of plausible values. This analysis helped demonstrate how sensitive supply chain performance and cost-efficiency can be to differences in distribution cost structures, an important consideration when translating model outputs to real-world contexts.

3.3.5. Lead Time Assumptions

Lead time assumptions in the CAVE App are structured to reflect the combined effect of procurement processing time and transportation duration. These values are intended as rough estimates rather than precise figures and were selected based on previous engagements (MIT Humanitarian Supply Chain Lab, 2024), but also to highlight how delivery timelines vary across different sourcing options and geographies. The lead times assigned to each supplier range from 2 to 24 weeks, depending on the supplier's location and intended delivery function. Specific lead time values for each scenario are outlined in the Results section.

To maintain simplicity, in our use of the model, we often blended lead time values to incorporate both upstream supplier timelines and average in-country transit times. While this approach allows for intuitive scenario comparisons, it also introduces limitations, particularly in emergency or localized planning, where actual lead times can vary significantly based on route conditions, customs delays, or supplier readiness. Despite this, the simplified structure is well-suited for the purposes of this model, enabling users to observe how timing impacts demand fulfillment, storage utilization, and overall system responsiveness across different configurations.

4. Results and Discussion

4.1. Scenario-Based Results

In the preceding sections, we established the persistent challenges that continue to affect the treatment of SAM and the distribution of RUTF, alongside an evaluation of how new mechanisms, particularly the CNF, seek to address them. While the CNF represents a promising step forward, several critical gaps remain. Some lie outside the scope of the CNF itself and will require broader sectoral action and coordination. Others, however, reflect limitations within the CNF's current structure and implementation approach.

Many of these challenges can be more effectively addressed, or at the very least, more clearly identified, communicated, and advocated around, through the use of analytical tools that support modeling, visualization, and scenario-based storytelling. These tools are particularly valuable in helping decision-makers clarify tradeoffs, stress-test plans, and build consensus around complex operational decisions.

To demonstrate this potential, the following section introduces four case-based scenarios developed using the UNICEF CAVE App, each aligned with a practical planning question relevant to the

CNF's rollout. The scenarios are illustrative rather than predictive, designed to explore how decision-support tools can surface operational blind spots, inform better program design, and support more coordinated action among donors, governments, and implementing partners.

All scenarios are grounded in a base Nigerian MoH planning configuration, developed through prior engagement with UNICEF and the Nigerian government. Please note that this base case was, and continues to be, intended purely for illustrative purposes. The application and use cases presented here are also broadly applicable and could be easily adapted to reflect other countries' contexts.

Each scenario, focused on budgeting, technical support, supplier localization, and emergency preparedness, reflects a real-world use case and maps directly to one or more of the CNF's three operational windows. These cases serve as the foundation for the analyses and discussions that follow.

4.1.1. Scenario A: Technical Support Tool

In addition to providing procurement co-financing, the CNF's matching window also offers technical support to help countries improve their planning, forecasting, and budgeting for essential commodities (Child Nutrition Fund, 2025a). While current guidance primarily focuses on procurement-side budgeting, this technical assistance could be expanded to help countries strengthen their in-country distribution and storage planning. These key activities fall under national responsibility and are critical to program success, but are under-resourced and under-analyzed (USAID Advancing Nutrition, 2022).

This scenario serves as an illustrative example of how a tool like the UNICEF CAVE App could support such a technical engagement. By simulating multiple distribution network configurations, CNF advisors could work with national stakeholders, such as the Nigerian MoH, to explore logistical trade-offs, understand structural inefficiencies, and assess value implications of different distribution networks.

4.1.1.1. Scenario Setup and Parameters

All scenarios use the same baseline parameters:

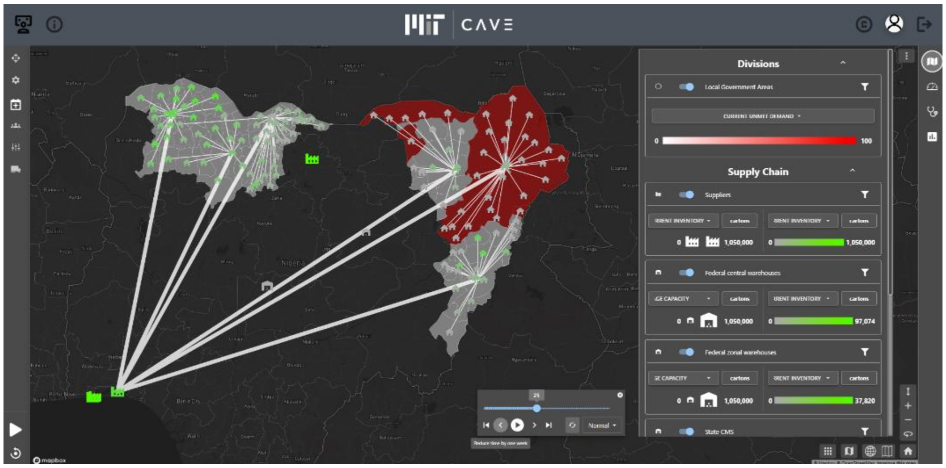
- Supplier: Ariel (4-week lead time)
- Product Cost: Modeled as an in-kind contribution ($0) to isolate logistics costs from procurement costs
- Budget: $2 million (total)
- Cost Parameters:
    - Holding Costs: Central = $0.10, State = $0.15, LGA = $0.21 (per unit/week)

- Distribution Cost: $0.003 (per unit/km blended rate)

Four simplified supply chain structures were modeled to explore how different design choices might impact performance. These configurations are adapted from past engagements with UNICEF and Nigerian stakeholders, but are presented here in a standardized form for ease of comparison and illustrated in Figures 2 to 5:

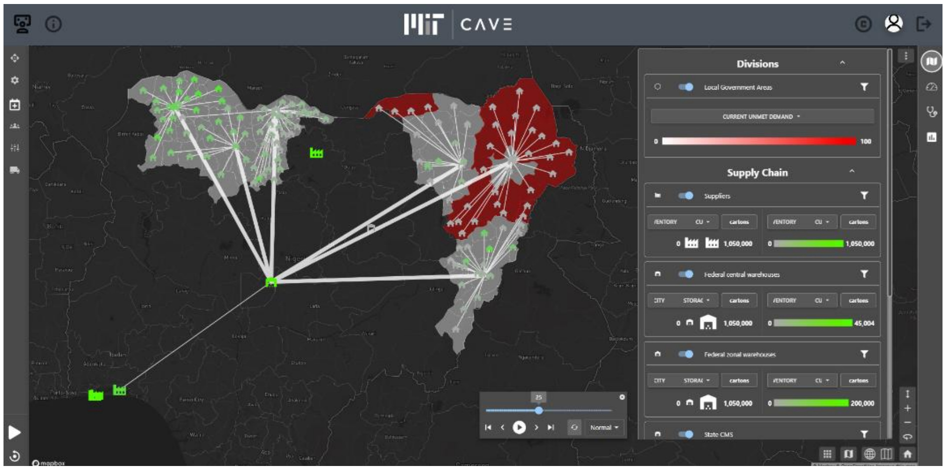
- A1: State-Centric Model (SCM): Supplier → State → LGA
  - This network reflects the current default configuration in Nigeria's decentralized structure. An example of this network map can be seen in Figure 2 below.

Figure 2. Scenario A, Network 1 (A1) Network Map: State-Centric Model (SCM)



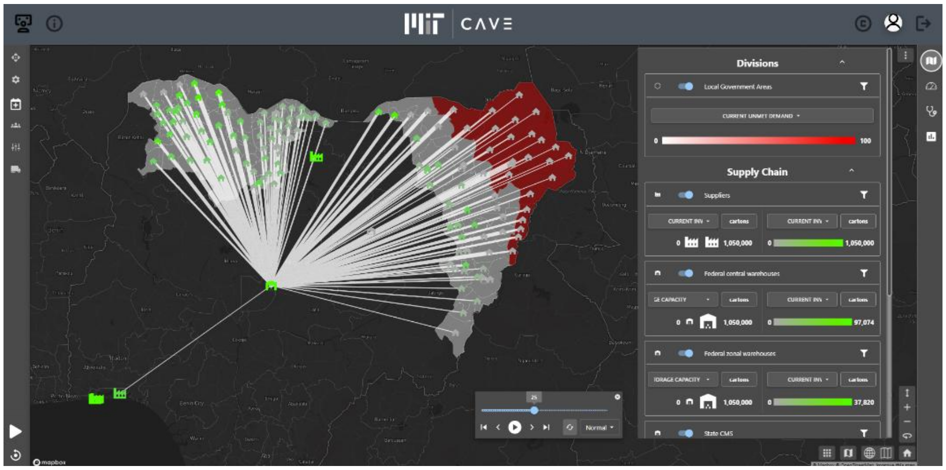
- A2: Federal Centralized Model (FCM): Supplier → Federal Central Warehouse → State → LGA
  - This network introduces an Abuja-based federal warehouse layer to centralize inventory before state distribution. An example of this network map can be seen in Figure 3 below.

Figure 3. Scenario A, Network 2 (A2) Network Map: Federal Centralized Model (FCM)



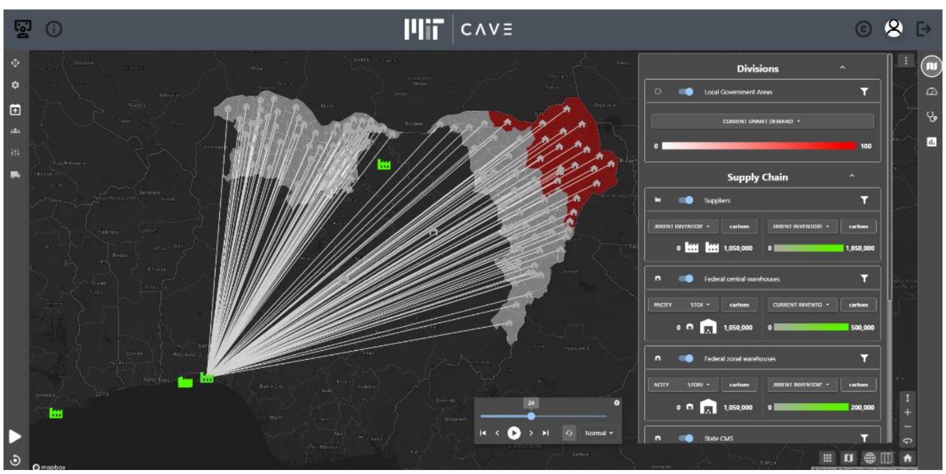
- A3: Federal Direct Model (FDM): Supplier → Federal Central Warehouse → LGA
    - This network bypasses the state level entirely, with centralized dispatch directly to LGAs. An example of this network map can be seen in Figure 4 below.

      Figure 4. Scenario A, Network 3 (A3) Network Map: *Federal Direct Model (FDM)*



- A4: Direct Delivery Model (DDM): Supplier → LGA
    - The most decentralized network, this model routing deliveries directly from supplier to LGAs without any intermediary warehousing. An example of this network map can be seen in Figure 5 below.

      Figure 5. Scenario A, Network 4 (A4) Network Map: *Federal Direct Model (FDM)*



4.1.1.2. Scenario Insights

The results revealed meaningful trade-offs in demand fulfillment, cost allocation, and stockout vulnerability, as seen in the accompanying charts and graphs (Figure 6, Tables 1 and 2).

Figure 6: Technical Support Scenario (A): Cost Structure and Target Demand Graph

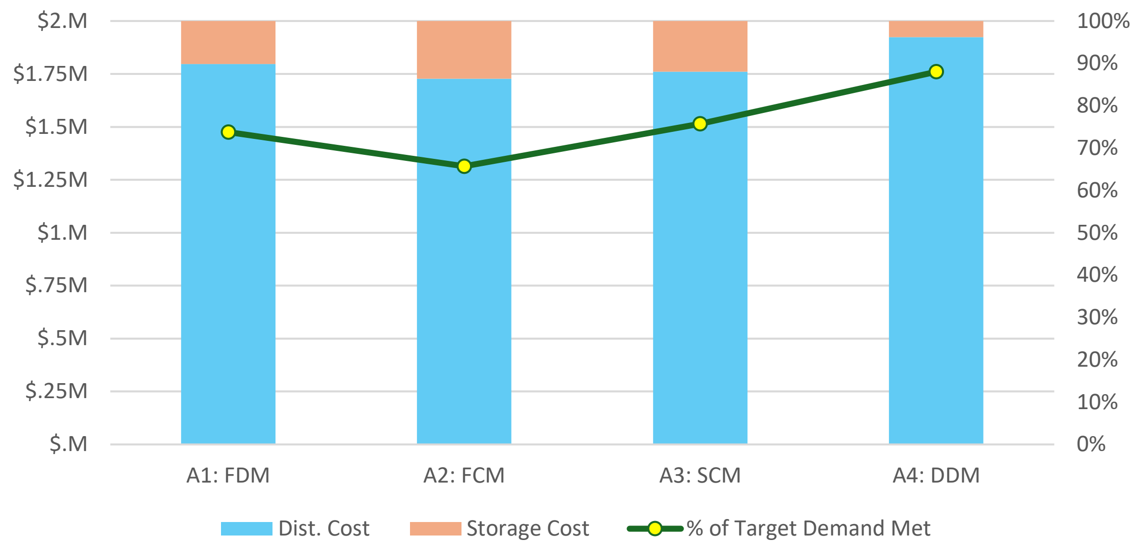


Table 1: Technical Support Scenario (A): Cost Structure and Target Demand Summary

Network Configuration	Distribution Cost (M)	Storage Cost (M)	% of Target Demand Met
A1: FDM	$1.80	$0.20	73.80%
A2: FCM	$1.73	$0.27	65.70%
A3: SCM	$1.76	$0.24	75.70%
A4: DDM	$1.92	$0.08	88.00%

Table 2: Technical Support Scenario (A): Stockout Summary

Network Configuration	Number of LGA stores with at least one stockout (Stores)	Avg. Stockout Magnitude per Stockout Event (Cartons)
A1: FDM	74	160
A2: FCM	97	139
A3: SCM	46	145
A4: DDM	21	128

The Direct Delivery Model (DDM) achieved the highest level of demand fulfillment, covering 88.0% of target children, a notable gain over the other configurations. This model also recorded the lowest number of LGAs experiencing at least one stockout (21) and the lowest average stockout magnitude per event (128 cartons). Interestingly, this was achieved with the lowest total storage cost ($75,624, just 3.78% of budget) and a correspondingly high distribution cost ($1.92M, 96.22%). The performance suggests that direct-to-LGA delivery may be highly effective in reaching children when the distribution system is strong and geographic reach is manageable, even with minimal storage layering.

The State-Centric Model (SCM), Nigeria's current default structure, ranked second, meeting 75.7% of demand and demonstrating moderate cost balance (storage: 11.99%, distribution: 88.01%). SCM also had a relatively low number of LGAs with stockouts (46) and a mid-range stockout severity (145 cartons per event). These results suggest that SCM provides a strong baseline of efficiency and coverage without over-concentrating cost on any one function, supporting stable operations across a broad network.

In contrast, the Federal Direct Model (FDM) covered only 73.8% of demand, and although its distribution cost share (89.84%) was similar to SCM, its storage cost was slightly lower (10.16%). The FDM model experienced significantly more pressure at the LGA level, with 74 stores reporting at least one stockout and the highest average stockout size (160 cartons) across all scenarios. This suggests that the absence of intermediate buffers or decentralized storage can lead to fragility at the last mile, even if overall system efficiency appears comparable on the surface.

Finally, the Federal Centralized Model (FCM) was the least effective configuration, covering only 65.7% of demand and showing the highest number of stockout-affected LGAs (97). It allocated the most significant portion of its budget to storage (13.59%) but did not deliver improvements in reach or resilience. This reinforces the risk that introducing centralized warehousing may introduce inefficiencies and bottlenecks unless tightly coordinated with downstream distribution strategies.

It is important to note, however, that the Direct Delivery Model (DDM) may benefit from certain simplifying assumptions within the CAVE App that would not fully hold in real-world operations. Specifically, the model uses straight-line ("as the bird flies") distances and applies a uniform, blended distribution cost per kilometer, regardless of the leg or complexity of the route. In practice, direct delivery to hundreds of LGAs would likely involve higher per-unit costs, greater coordination burdens, and risks related to vehicle routing and last-mile accessibility. These limitations will be discussed in more detail in Section 4.3. In a real-world planning or workshop setting, such assumptions would be contextualized and adjusted through local government input, allowing the tool to evolve alongside a more nuanced understanding of infrastructure, accessibility, and resource availability.

Collectively, these insights underscore that how logistics budgets are spent matters as much as how much is spent. Models that reduce storage infrastructure too aggressively (e.g., FDM) or centralize it without improving responsiveness (e.g., FCM) may fail to maximize reach. Conversely, models like DDM and SCM show that careful balancing of distribution intensity and localized access points can yield high performance under funding constraints.

4.1.1.3. Interpretation and Strategic Value

This scenario offers a clear example of how a tool like the UNICEF CAVE App can be used to support CNF-aligned technical assistance by helping ministries assess logistics system performance under realistic budget constraints. While procurement matching may be the financial centerpiece of CNF support, its success depends entirely on a country's ability to store and distribute commodities effectively.

By comparing how different network designs influence demand coverage and logistics costs, stakeholders can explore where a proposed structure may fall short, either by failing to reach enough people or by misallocating limited funds to unnecessary storage layers or inefficient delivery paths. Engaging national teams in this type of analysis helps build their ability to test assumptions, quantify tradeoffs, and make informed adjustments over time. Tools like the UNICEF CAVE App can play a valuable role in strengthening government-led planning, not by prescribing a single solution, but by equipping decision-makers with the means to evaluate and adapt their systems themselves. As the CNF continues to scale, this kind of support will be critical to achieving not just greater funding alignment but lasting localization and operational sustainability.

4.1.2. Scenario B: Budgeting Tool

One of the most practical applications of the CAVE App model for countries engaging with the CNF is as a budgeting tool to support applications to the CNF Match Window. Under this mechanism, national governments are required to cover in-country logistics costs, including taxes, storage, and distribution (Child Nutrition Fund, 2025a). Many countries may be newly exposed to these logistics costs, and accurate budgeting will be critical to maximizing matched procurement value while ensuring sufficient operational funding to move products effectively.

In this scenario, we simulate how the Nigerian MoH, a leading CNF country with strong in-country distribution capabilities, could use the model to prepare an optimized funding request and budget. The analysis also supports sensitivity testing for storage and distribution costs, which may vary significantly depending on location, infrastructure, or delivery approach.

4.1.2.1. Scenario Setup and Parameters

Key baseline parameters include:

- Network Design: State-Centric Model (Supplier → State → LGA)
- Supplier: Ariel (4-week lead time)

- Procurement Mode: Modeled as an in-kind contribution to isolate logistics costs from procurement costs
- Budget: $2 million (total)
- Cost Parameters:
  - Holding Costs: Central = $0.10, State = $0.15, LGA = $0.21 (per unit/week)
  - Distribution Cost: $0.003 (per unit/km blended rate)

4.1.2.2. Base Case Insights (Walkthrough)

Using the UNICEF CAVE App, the Nigerian Ministry of Health runs the baseline scenario with a $2 million logistics budget. The model simulates delivery using a state-centric distribution model with a single supplier (Ariel) and fixed lead times. In this scenario, procurement is modeled as an in-kind contribution, so the entire budget is allocated to storage and distribution. Upon reviewing the results, the Ministry observes the following key outputs:

- Target Demand Fulfilled: 632,256 units (approximately 75.7% of total need)
- Total Logistics Budget Used: $2 million
- Distribution Costs: $1,760,195
- Storage (Holding) Costs: $239,805

With this information, the Ministry can now estimate the total procurement value needed to supply 632,256 units of RUTF. Using a conservative unit procurement cost of $46.50, the calculation would be:

- 632,256 units × $46.50 = $29,399,904

This is the estimated total procurement value that would be required to fulfill the demand reached in the base scenario. Next, the Ministry can determine an appropriate CNF match window application amount. Since the CNF typically matches procurement funding (not logistics), the Ministry should only apply for a portion of this amount based on how much co-financing they can provide and their confidence in covering the resulting logistics costs.

Assuming a 50% co-financing structure, the Ministry might apply for ~$14,699,952 in procurement costs to be matched by the CNF. At the same time, they must allocate approximately $2 million in unmatched budget to cover in-country logistics ($239,805 for storage and $1,760,195 for distribution). Please note that there are additional CNF administrative fees that apply as part of the matching mechanism, which would be considered in a more detailed real-world implementation (Child Nutrition Fund, 2025a).

This exercise demonstrates the practical utility of the tool. This baseline analysis enables government actors to simulate realistic delivery plans, estimate associated costs, and prepare informed CNF applications with justified funding requests and a logistics plan to support them.

4.1.2.3. Sensitivity Analysis Insights (Walkthrough)

Beyond the base case, the tool can also be easily adapted to run sensitivity analyses, helping planners explore how cost fluctuations or delivery constraints might impact outcomes. This flexibility is critical for preparing realistic budgets and contingency strategies in environments characterized by uncertainty and variability. The data discussed in the following insights are illustrated in the accompanying charts and graphs (Figure 7, Table 3 and 4).

Figure 7: Budgeting Tool Scenario (B): Cost Structure and Target Demand Graph

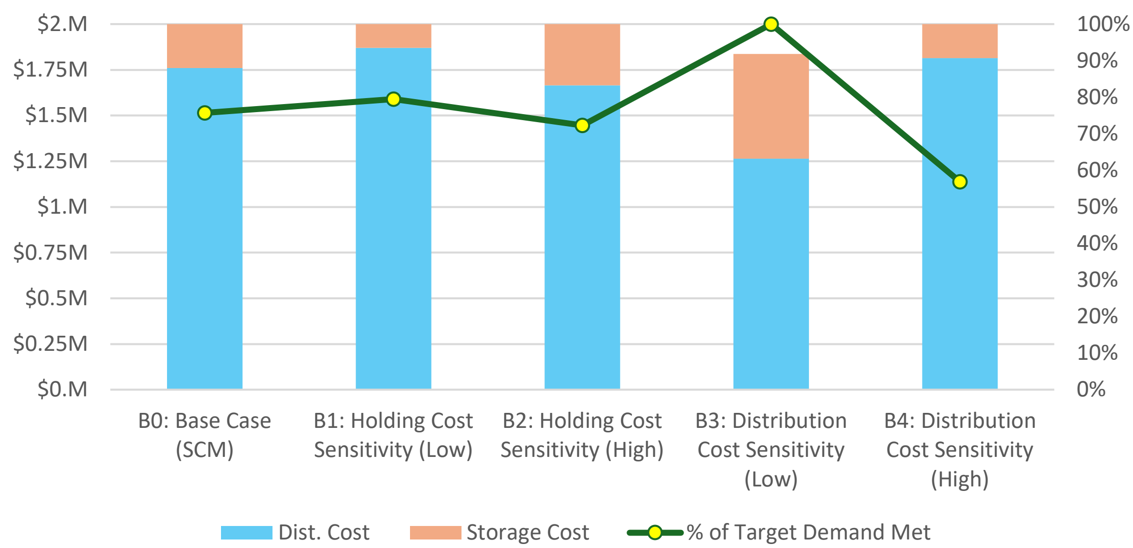


Table 3: Budgeting Tool Scenario (B): Cost Structure and Target Demand Summary

Budget Case	Distribution Cost (M)	Storage Cost(M)	% of Target Demand Met
B0: Base Case (SCM)	$1.76	$0.24	75.7%
B1: Holding Cost Sensitivity (Low)	$1.87	$0.13	79.5%
B2: Holding Cost Sensitivity (High)	$1.67	$0.33	72.3%
B3: Distribution Cost Sensitivity (Low)	$1.26	$0.57	100.0%
B4: Distribution Cost Sensitivity (High)	$1.81	$0.19	56.9%

Table 4: Budgeting Tool Scenario (B): Stockout Summary

Budget Case	Number of LGA stores with at least one stockout (Stores)	Avg. Stockout Magnitude per Stockout Event (Cartons)
B0: Base Case (SCM)	46	145
B1: Holding Cost Sensitivity (Low)	33	135
B2: Holding Cost Sensitivity (High)	59	144
B3: Distribution Cost Sensitivity (Low)	0	0
B4: Distribution Cost Sensitivity (High)	63	148

To illustrate this functionality, we extended the baseline scenario through a simplified sensitivity analysis. In this analysis, the Nigerian MoH tests how changes in key logistics parameters, specifically holding costs and distribution costs, affect performance indicators such as the percentage of demand met, total budget required, and the allocation of budget across cost categories.

The first analysis involved adjusting holding costs across all node levels (Central, State, and LGA) by ±50%. When holding costs were reduced (Scenario B1), the model showed an improvement in the percentage of demand met, rising to approximately 79.5%. Conversely, increasing holding costs (Scenario B2) resulted in a decline in demand fulfillment to about 72.3%. These shifts demonstrate how even modest changes in storage cost assumptions can meaningfully influence logistics performance, especially in a fixed-budget context where higher storage costs eat into available funding for distribution.

Next, the Ministry ran a similar test on distribution costs, decreasing (Scenario B3) and increasing (Scenario B4) the base value by 50% while keeping storage costs constant. While the base model allocated roughly 88% of the total logistics budget to distribution, higher distribution costs significantly compressed the volume of product that could be delivered, reducing the target met (56.9%) and altering the proportion of funds absorbed by transport. On the other hand, lowering distribution costs expanded delivery capacity within the same $2M budget, freeing up funds that could be reallocated to increase overall reach or build in buffers.

Through this analysis, the MoH can better understand the relative sensitivity of the logistics system to cost drivers, enabling more informed risk planning and scenario testing. These kinds of insights not only strengthen CNF applications but also help ministries proactively prepare for pricing changes, infrastructure disruptions, or budget reallocations that may occur during implementation.

4.1.2.4. Interpretation and Strategic Value

This scenario demonstrates the value of the UNICEF CAVE App as a strategic planning tool for ministries of health preparing CNF Match Window applications (Child Nutrition Fund, 2025a). By simulating real-world delivery systems and isolating logistics costs, the model enables decision-makers to determine how much RUTF they can realistically distribute within a given logistics budget, and by extension, how much procurement funding they can responsibly request for CNF matching.

This is a vital insight. While the CNF match mechanism effectively mobilizes procurement funding, its success is entirely dependent on the government's ability to store and distribute those goods. Without proper logistics planning and budgeting, matched RUTF shipments risk being underutilized or delayed at critical points in the supply chain. In this way, effective logistics execution is not secondary; it is foundational to the CNF's intended impact.

Using the CAVE App, the Nigerian MoH can both estimate real delivery costs and test sensitivity to fluctuations in key parameters like storage and transport pricing. These capabilities allow governments to build defensible, adaptable budgets that account for local variability and operational risk. As CNF scales globally, tools like this will be essential to ensuring that matching mechanisms result in not just procurement, but actual product delivery and impact.

4.1.3. Scenario C: Supplier Localization

The CNF's Supplier Window is designed to strengthen supply resilience and sustainability by providing financing solutions for local manufacturers of essential nutrition supplies (UNICEF, 2025). Through tools like concessional loans, guarantees, and pre-financing facilities, the CNF helps producers in low- and middle-income countries overcome cash flow constraints and expand their production capacity (UNICEF, 2025).

A key rationale behind the Supplier Window is that building local production capacity is not just a procurement strategy; it is a long-term systems investment that supports localization, reduces dependence on international procurement cycles, and enables faster, more flexible delivery in emergencies (UNICEF, 2025). This is especially relevant for countries like Nigeria, which face persistently high rates of child wasting, coupled with logistical and funding constraints in last-mile delivery (USAID Advancing Nutrition, 2023).

One of the first implementations of the CNF Supplier Window came in late 2023, when UNICEF, in partnership with the UN Capital Development Fund (UNCDF), extended a $2.5 million loan to Ariel Foods FZE, a Nigerian-based manufacturer of RUTF (Child Nutrition Fund, 2025b). This concessional loan was the inaugural investment under the CNF Supplier Finance Facility and aimed to expand Ariel's production capacity to serve more than 100,000 children annually. In addition to boosting local manufacturing, the investment helps stabilize the domestic market by reducing reliance on international suppliers and promoting national ownership of nutrition programming (Child Nutrition Fund, 2025b).

To illustrate how the CNF and government partners might use a tool like the UNICEF CAVE App in this context, this scenario models a localized supply configuration that includes both Ariel Foods in southern Nigeria and NutriK, a smaller, secondary supplier based in the north. By simulating different combinations of local supplier use, the model helps decision-makers explore the trade-offs in cost, responsiveness, and system efficiency that come with geographically distributed sourcing. The analysis is intended to support more strategic planning around supplier diversification and localization. These are key priorities not just for efficiency, but also for resilience.

4.1.3.1. Scenario Setup and Parameters

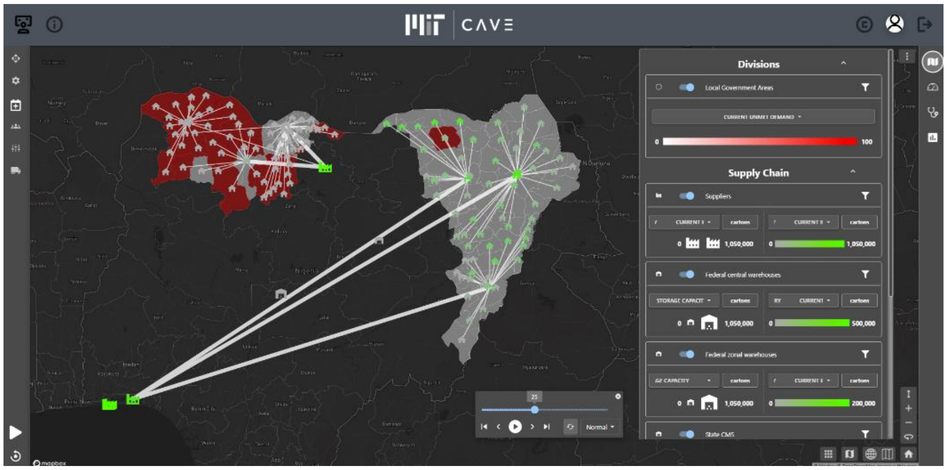
This scenario builds upon the base case of a single supplier (Ariel Foods) operating under a state-centric distribution model with a fixed $2 million logistics budget. The objective is to simulate how the addition of a localized northern supplier, NutriK, could improve distribution efficiency and demand fulfillment.

Three configurations are compared:

- Base Case C0: Single supplier (Ariel Foods) serving all LGAs with a 4-week lead time.
- Scenario C1: Split supplier base with Ariel and NutriK, both assigned a 4-week lead time. LGAs in Nigeria's north-west are routed to NutriK, while those in the north-east remain served by Ariel.
- Scenario C2: Same supplier split as Scenario C1, but lead times are adjusted to better reflect real-world conditions: 3 weeks for Ariel and 2 weeks for NutriK.

All other parameters, including holding and distribution costs, are held constant across scenarios. Procurement is again modeled as in-kind ($0) to isolate and focus the analysis entirely on logistics and supply planning. Figure 8 below shows an example of a base split supplier scenario (C1) network map.

Figure 8: Scenario C, Network 1 (C1) Network Map: Split Supplier, 4 Week Lead Time



4.1.3.2. Scenario Insights

The results highlight how a tool like the UNICEF CAVE App can be used to explore the potential impacts of supplier localization under realistic budget constraints. The data presented in these insights are illustrated in the accompanying charts and graphs (Figure 9, Table 5 and 6).

Figure 9: Supplier Localization Scenario (C): Cost Structure and Target Demand Graph

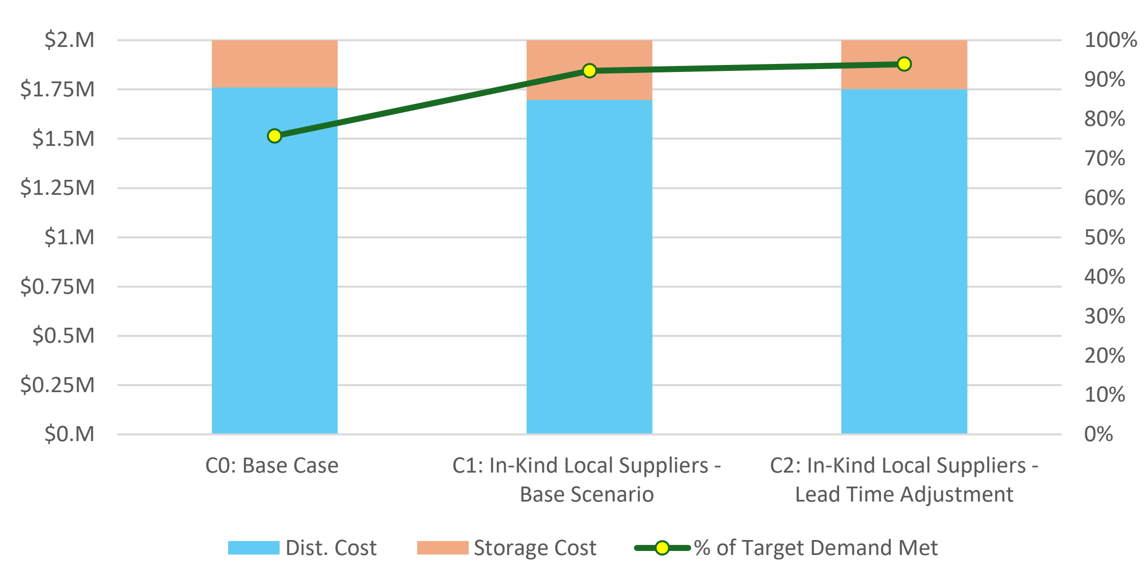


Table 5: Supplier Localization Scenario (C): Cost Structure and Target Demand Summary

Supplier Case	Distribution Cost (M)	Storage Cost (M)	% of Target Demand Met
C0: Base Case	$1.76	$0.24	75.7%
C1: In-Kind Local Suppliers - Base Scenario	$1.7	$0.3	92.2%
C2: In-Kind Local Suppliers - Lead Time Adjustment	$1.75	$0.25	93.9%

Table 6: Supplier Localization Scenario (C): Stockout Summary

Supplier Case	Number of LGA stores with at least one stockout (Stores)	Avg. Stockout Magnitude per Stockout Event (Cartons)
C0: Base Case	46	145
C1: In-Kind Local Suppliers - Base Scenario	27	125
C2: In-Kind Local Suppliers - Lead Time Adjustment	24	112

In the first localized scenario (Scenario C1), where NutriK is introduced alongside Ariel without changing lead times, the percentage of demand met increases from 75.7% to 92.2%, a significant 16.5 percentage point improvement compared to the base case. Storage costs rise modestly to 15.12% of the logistics budget, while distribution costs decline to 84.88%, suggesting that regional sourcing can shift the cost balance by reducing average transport distances. Stockout performance also improves notably: the number of LGA stores experiencing stockouts falls from 46 to 27, and the average stockout magnitude decreases from 145 to 125 cartons per event.

Despite these improvements, delivery timing remains effectively unchanged compared to the base case (average 11 weeks). In the second localized scenario (Scenario C2), supplier-specific lead times are adjusted to better match real-world expectations (3 weeks for Ariel and 2 weeks for NutriK). This further improves demand fulfillment to 93.9%, with storage and distribution costs rebalancing slightly (storage at 12.37%, distribution at 87.63%). Stockout performance improves again: only 24 LGAs experience stockouts, with the average stockout size falling to 112 cartons. A slight improvement in average delivery time is observed (10.9 weeks), though the latest delivery stretches marginally to 12 weeks (from 11 weeks in the base case), reflecting subtle trade-offs in delivery dynamics across the system.

Together, these scenarios demonstrate how localizing supplier sourcing, or other strategic adjustments, can be quantitatively explored before long-term investments or supplier partnerships are formalized, helping partners visualize operational impacts beyond high-level assumptions.

4.1.3.3. Interpretation and Strategic Value

This scenario exemplifies how the UNICEF CAVE App can serve as a decision-support tool for exploring supplier localization strategies within the CNF framework. Rather than assuming localization will automatically lead to better outcomes, the tool allows partners to simulate different sourcing configurations, assess their potential benefits and trade-offs, and make more informed, evidence-based decisions.

The modeled results show that under the given assumptions, localized supplier sourcing can lead to meaningful improvements in demand coverage and stockout reduction. However, these gains must be weighed against factors like increased storage costs, potential logistical complexity, and real-world delivery risks that the model simplifies. In a workshop or technical support setting, these scenarios could be further adapted using local knowledge to refine assumptions about costs, road infrastructure, seasonality, and supplier reliability.

By enabling governments and donors to visualize the operational consequences of supplier investments before making major strategic commitments, tools like the CAVE App help to de-risk localization strategies and ensure that Supplier Window funding decisions are grounded in a holistic view of the supply chain, not just production capacity alone.

In this way, simulation tools complement financial investments by supporting strategic, system-wide thinking, moving the CNF closer to its goal of building resilient, locally owned nutrition supply chains.

4.1.4. Scenario D: Emergency Planning (Back-Up Supply)

The frequency and intensity of humanitarian emergencies, whether driven by conflict, natural disasters, or political instability, have risen steadily over the past decade (World Food Programme, 2023). These crises place immense pressure on nutrition supply chains, especially for life-saving commodities like RUTF, which must be delivered rapidly to vulnerable populations to prevent spikes in child mortality.

While the humanitarian sector is moving toward greater localization of procurement and distribution, established international suppliers such as Edesia continue to play a critical complementary role. Particularly in emergency contexts where localized systems may be overwhelmed or disrupted. In a new environment of reduced USAID centralized planning and an evolving role for mechanisms like the CNF, discussions with stakeholders suggest that suppliers like Edesia could provide immense value by acting as backup supply hubs, ready to respond quickly when local supply is insufficient or interrupted (Edesia Nutrition, 2025).

To support this evolving role, Edesia has invested in pre-positioned stock and regional warehousing in Tema, Ghana, enabling faster deployment than traditional overseas shipments. This pre-position aims to reduce delivery lead times during acute emergencies and enhance national and regional response capabilities. This scenario explores how a tool like the UNICEF CAVE App can be used to model the effectiveness and trade-offs associated with integrating a backup, pre-positioned supplier into national nutrition supply planning.

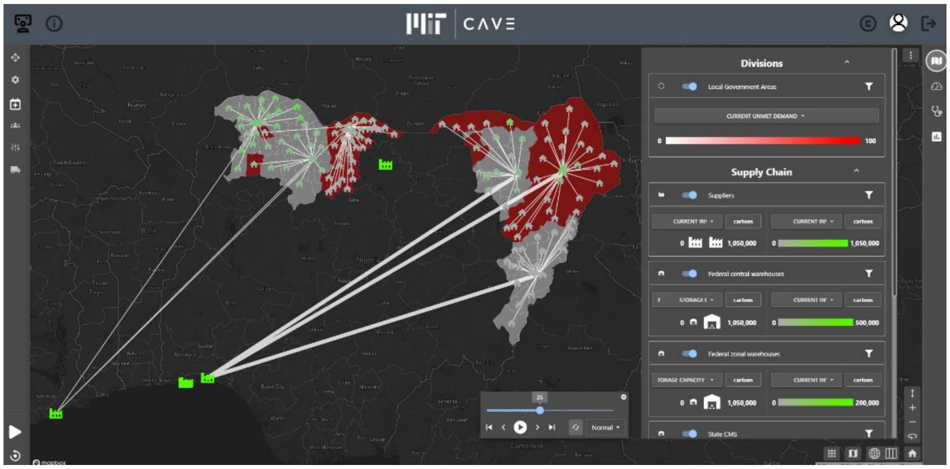
4.1.4.1. Scenario Setup and Parameters

This scenario builds upon the base model of a state-centric distribution structure, using a $2 million logistics budget and an in-kind procurement setup to isolate logistics costs. All distribution and holding cost assumptions remain constant to ensure comparability across models.

Four configurations are compared:

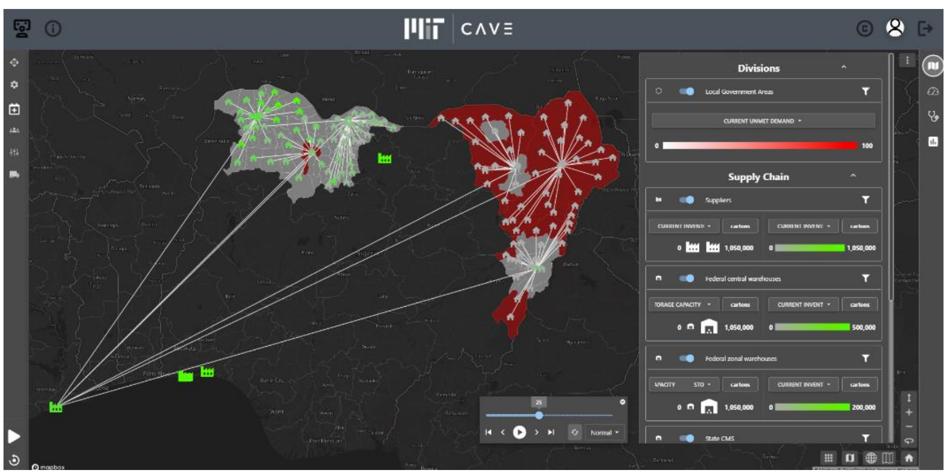
- Base Case D0: Single supplier (Ariel Foods) serving all LGAs with a 4-week lead time. State-centric model. All parameters are consistent with the base case in previous scenarios.
- Scenario D1: Introduces Edesia's Tema warehouse in Ghana as a secondary supplier with a 6-week lead time to account for cross-border movement and customs clearance. LGAs in the north-west region are routed to Tema, while north-east LGAs continue to be supplied by Ariel. This scenario models a partial back-up situation where emergency support is needed for a specific region or supplier. An example of this network design can be seen in Figure 10 below.

Figure 10: Scenario D, Network 1 (D1) Network Map: Emergency Back-Up, Split Supplier



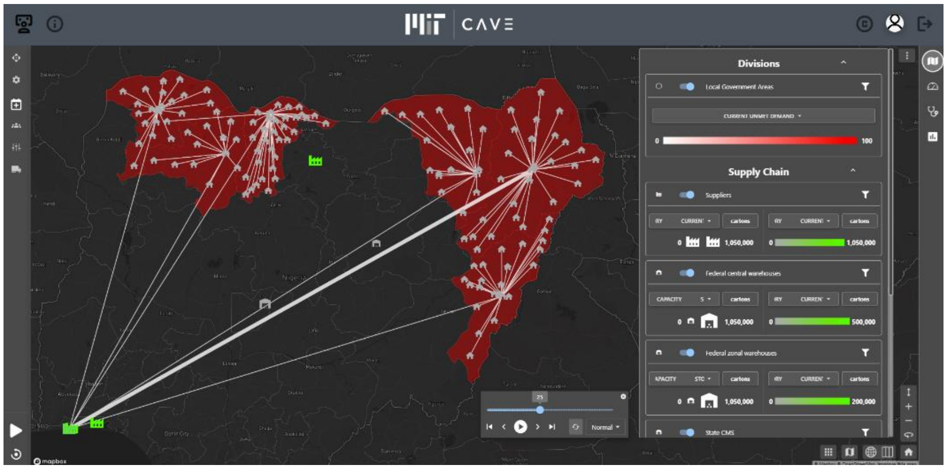
- Scenario D2: Routes all LGAs exclusively to Edesia Tema with a 6-week lead time, representing a full national backup scenario where local supply systems are disrupted, and external support is required across the entire country or region. An example of this network design can be seen in Figure 11 below.

Figure 11: Scenario D, Network 2 (D2) Network Map: Emergency Back-Up, Single Supplier



- Scenario D3: Routes all LGAs to a simulated Edesia Lagos Port node, representing imported supply from Edesia's U.S. headquarters with an assigned 24-week lead time. This scenario models a worst-case overseas contingency, accounting for international shipping, customs, and inland delivery delays. An example of this network design can be seen in Figure 12 below.

Figure 12: Scenario D, Network 3 (D3) Network Map: Emergency Back-Up, Overseas Supplier



Each scenario provides insight into how different back-up strategies affect supply chain resilience, responsiveness, and risk under emergency conditions.

4.1.4.2. Scenario Insights

By simulating different degrees of supply chain disruption and backup sourcing, partners can better plan for and anticipate challenges that may arise when local systems are overwhelmed. The data presented in these insights are illustrated in the accompanying charts and graphs (Figure 13, Table 7 and 8).

Figure 13: Emergency Planning Scenario (D): Cost Structure and Target Demand Graph

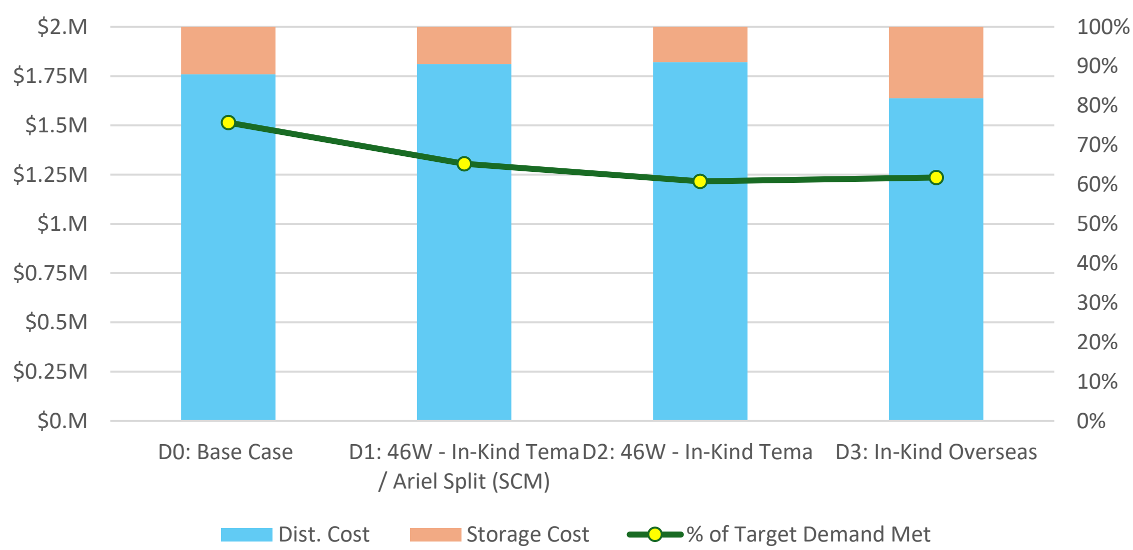


Table 7: Emergency Planning Scenario (D): Cost Structure and Target Demand Summary

Emergency Case	Distribution Cost (M)	Storage Cost (M)	% of Target Demand Met
D0: Base Case	$1.76	$0.24	75.70%
D1: 46W - Tema (6w) / Ariel Split (4w)	$1.81	$0.19	65.30%
D2: 46W - Tema (6w)	$1.82	$0.18	60.80%
D:3 Overseas (24w)	$1.64	$0.36	61.80%

Table 8: Emergency Planning Scenario (D): Stockout Summary

Emergency Case	Number of LGA stores with at least one stockout (Stores)	Avg. Stockout Magnitude per Stockout Event (Cartons)
D0: Base Case	46	145
D1: 46W – Tema (6w) / Ariel Split (4w)	87	111
D2: 46W - Tema (6w)	64	146
D3: Overseas (24w)	136	147

In Scenario D1, where north-west LGAs are routed to Edesia Tema while the north-east continue to receive product from Ariel, the percentage of demand met falls from 75.7% in the base case to 65.3%. Despite the decline, the backup system is able to deliver support to a significant portion of the target population during disruption. Storage costs decrease but distribution costs increase to $1,812,146, reflecting longer transport routes. These distribution costs would likely rise even further due to factors not captured in the current model assumptions and capabilities. Specifically, road network conditions, non-linear routing constraints, and additional cross-border customs and transport costs from the Port of Tema. The number of LGAs experiencing at least one stockout jumps to 87, nearly doubling from the base case of 46. Importantly, delivery delays increase, with the latest delivery stretching out to week 45, which is a critical risk given the necessity of timely RUTF delivery.

In Scenario D2, where all LGAs are served by Edesia Tema, the strain intensifies. The percentage of demand met drops further to 60.8%, with storage costs decreasing slightly to $178,875 and distribution costs increasing again to $1,821,125. Despite the slight increase in logistics costs, the ability to meet demand worsens, reflecting the capacity limitations of relying on a single external supply hub. Interestingly, the number of LGAs experiencing stockouts falls to 64, lower than in D1, though the average stockout magnitude rises back to 146 cartons, showing that stockouts, when they occur, are more severe. Delivery times remain consistent with D1, with late deliveries extending out to week 45, reinforcing the risk that broader reliance on a single pre-positioned warehouse may not significantly mitigate delays during large-scale emergencies.

Scenario D3 explores an even more extreme condition: complete reliance on overseas supply imported into Lagos Port, with a 24-week lead time. Here, the percentage of demand met recovers slightly to 61.8%, which may be driven by the centralization of supply at an accessible in-country port (geographically close to Ariel), slightly offsetting lead time challenges. However, this improvement in service level comes at a high cost: storage costs spike dramatically to $361,387. Distribution costs fall to $1,638,613, driven by the efficiency of distributing from a central point like Lagos. However, it is critical to remember that international shipping and customs clearance costs are not captured here and would substantially increase the total cost to the government or implementing partners. Critically, 136 LGAs experience stockouts, more than double the number in D1, and the earliest initial deliveries are delayed until week 27. This extreme delay would severely limit the effectiveness of an emergency response, particularly when treating acute wasting, where every week can be lifesaving.

4.1.4.3. Interpretation and Strategic Value

This scenario demonstrates how a tool like the UNICEF CAVE App can be used to strengthen emergency preparedness by modeling different backup supply strategies. This helps governments, donors, and suppliers proactively plan for surge needs. Rather than relying on assumptions, partners can simulate different emergency sourcing structures and quantify each option's effectiveness under real-world constraints.

The results show that integrating regional pre-positioned supply hubs, such as Edesia's Tema warehouse, can be a highly valuable and effective component of national contingency planning. Even under significant disruption scenarios, backup sourcing from pre-positioned stock enables a large portion of target demand to be met, while offering faster activation potential than traditional overseas imports. Particularly in partial backup scenarios (D1), Edesia's pre-positioned supply helps maintain meaningful system coverage (65.3% of demand) with only moderate increases in distribution costs, demonstrating the operational importance of having regional surge capacity available.

For suppliers like Edesia, the UNICEF CAVE App can serve as a powerful tool to demonstrate the strategic value of investments in regional pre-positioning. By visualizing how backup capacity directly impacts key performance indicators like demand coverage, stockout reduction, and delivery lead time, suppliers can better communicate their critical role to governments and funding partners, making the case for further integration into emergency supply frameworks.

At the same time, the model highlights important considerations that emergency planners must account for. For example, even well-positioned backups have limitations, particularly under full national disruption scenarios. Delivery delays and stockouts can still occur, and reliance on overseas imports, while sometimes necessary, carries high risks for response timing. These insights reinforce the importance of layered contingency planning, where localized sourcing, regional backups, and international supply options are combined thoughtfully to ensure flexibility and minimize response gaps.

Notably, the CAVE App allows these risks to be explored and mitigated early, enabling governments and partners to design more resilient, proactive supply strategies. Through iterative scenario analysis and localized adjustments, stakeholders can refine contingency plans, pre-position strategic buffer stocks, and align supplier agreements around realistic response expectations. This scenario highlights that with the right planning tools and partnerships, backup suppliers like Edesia can be a critical asset in ensuring that lifesaving nutrition products reach children quickly and reliably, even under the most challenging emergency conditions.

4.2. Discussion

The treatment of severe acute malnutrition and the distribution of ready-to-use therapeutic food have long been constrained by deeply entrenched operational and structural challenges. Chronic underfunding, volatile procurement cycles, fragmented coordination, and weak integration with national health systems have prevented many high-burden countries from delivering consistent, efficient, and sustainable wasting treatment. Even as supplier networks have expanded and costs have fallen, local manufacturers continue to face barriers to scale. Donor priorities shift, government capacity varies, and national ownership of wasting programs remains limited in many settings (UNICEF Supply Division, 2023). Despite years of investment and progress, the system still struggles to reach every child in need, and the sector remains reactive, donor-driven, and vulnerable to disruption.

Recent shifts in the global nutrition landscape have brought these vulnerabilities into sharper focus. The dismantling of USAID in 2025 removed not only a dominant source of funding but also a key coordinating force (Standing Together For Nutrition, 2025). At the same time, new frameworks such as the Child Nutrition Fund are attempting to replace outdated models with more decentralized, country-driven approaches (UNICEF, 2024b). This moment represents both a disruption and a rare opportunity to fundamentally rethink how the system operates.

The CNF responds to many of the sector's most pressing issues. Its Programme Window seeks to align donor funding with country needs. Its Match Window encourages domestic co-investment in nutrition, creating stronger financial ownership. Its Supplier Window offers new financing tools to strengthen regional production (UNICEF, 2025). Together, these mechanisms reimagine how SAM treatment is resourced and delivered.

Even as the CNF addresses long-standing structural challenges, its implementation introduces new gaps, highlighted in our State of the Practice and reinforced through the scenario analysis. These gaps must be acknowledged and proactively managed.

The burden of planning, forecasting, and budgeting is now shifting to national governments, many of which lack the technical capacity, data systems, or operational experience to fulfill these roles at scale (USAID Advancing Nutrition, 2022). The Match Window's exclusion of in-country logistics creates a significant blind spot (The Child Nutrition Fund, 2025a), as countries are expected to fund transportation and storage costs without direct support.

The Budgeting Tool Scenario (Scenario B, Section 4.1.2.), showed how difficult it can be to realistically estimate matched funding needs without tools that account for network design, storage constraints, or distribution costs. Our Technical Support (Scenario A, Section 4.1.1.) and Emergency Planning (Scenario D, Section 4.1.4.) Scenarios demonstrated how dramatically these costs and bottlenecks can vary depending on network structure, geographic reach, and supplier configuration. Supplier engagement is incentivized but not strategically coordinated. The Supplier Localization scenario (Scenario C, Section 4.1.3) showed that while local sourcing improves demand fulfillment and system resilience, performance is highly sensitive to supplier location and lead time. Without planning tools, governments and donors risk making investment decisions that do not align with actual delivery challenges and long-term sustainable market health.

More broadly, the CNF's structure assumes that countries and partners can navigate an increasingly complex system - matching investments, optimizing supply configurations, and responding to emergencies - without new planning capacity or data tools. This risks recreating the same inefficiencies and misalignments the CNF was designed to solve. Technical capacity for modeling and visualization can play a critical role in filling these gaps. Tools like the UNICEF CAVE App can help operationalize CNF engagement by making supply chain tradeoffs explicit, aligning stakeholders around feasible options, and strengthening both internal planning and external advocacy. They do not replace local expertise or policy guidance, but they help bridge the gap between strategy and execution.

Our scenario analysis demonstrated this. In each case, the model revealed critical tensions: between centralized control and local ownership, between supply diversity and delivery performance, between funding availability and actual program cost. It helped visualize how specific choices, such as warehouse configuration or supplier location, can dramatically influence delivery timelines, stockouts, and demand coverage. These are not abstract problems. They are decisions that countries and donors must make under tight constraints, often with limited visibility. Analytical tools provide a way to surface, test, and communicate those decisions before they become bottlenecks.

At the same time, modeling is not a silver bullet. It cannot solve structural underfunding or substitute for long-term political commitment. What it can do is help countries and partners make smarter use of the resources they do have, and advocate more effectively for the ones they still need. As the CNF continues to scale, integrating tools like these into country support, supplier engagement, and donor coordination will be essential.

This is a rare moment in global nutrition. A long-standing support system has been dismantled. New mechanisms and system reforms have an opportunity to emerge. Analytical tools exist to make implementation more responsive, inclusive, and accountable. Whether this opportunity is realized will depend not just on funding levels or program design, but on whether the sector is willing to embrace new ways of working, and to invest in the visibility, planning, and alignment needed to make them succeed.

4.3. Limitations and Future Work

4.3.1. Modeling Tool Development Opportunities

While the modeling and scenario analysis presented in this report demonstrate the potential of tools like the UNICEF CAVE App to support strategic decision-making, they also highlight several areas where further development could enhance the tool's relevance, usability, and impact, particularly as we hope it can move from an exploratory, storytelling-focused application toward a more operational resource.

The UNICEF CAVE App was intentionally designed to be interactive, flexible, and accessible in workshop environments, enabling humanitarian actors to explore complex delivery questions and surface key tradeoffs (MIT Humanitarian Supply Chain Lab, 2024). Its use in these settings not only demonstrates its value in clarifying decisions but also reveals the specific features needed to support deeper exploration. This creates a powerful feedback loop. As the tool is tested and applied, it generates clear insights into what refinements could improve its effectiveness and realism over time. In our scenario analysis, this process was already underway, some immediate examples include:

- *Multi-node sourcing and inventory blending:* At present, each node in the model receives RUTF from a single supplier. Enabling multi-sourcing across nodes would improve realism and allow users to reflect more typical supply configurations, especially in countries where multiple suppliers contribute to different regions or tiers of the supply chain.

- *Route-specific distribution costing:* The model applies a uniform per-kilometer distribution cost across all network legs. While useful for simplified scenario comparison, this approach overlooks the significant cost variation between transport legs, e.g., full-truckload shipments to central federal warehouses vs. last-mile motor bicycle deliveries to remote LGAs. Allowing differentiated cost structures based on leg type, geography, or shipment size would better capture the operational realities and enable more precise budgeting.
- *Geographic accuracy and route modeling:* Currently, the model estimates distances "as the crow flies." Future versions could incorporate road network and congestion data to more accurately reflect transit times, cross-border complications, or regional accessibility challenges. While implementation may depend on the availability of road datasets and empirical evidence, this enhancement would structure the model to more accurately represent the logistics context.
- *Improved time-based visualizations:* The tool models delivery over time, but its current visual interface limits how easily users can analyze stockouts, delays, or performance week-by-week. More robust time-based charts and diagnostic outputs could help planners understand when, not just where, interventions are breaking down and how these breakdowns develop.
- *Built-in sensitivity analysis:* In our Emergency Planning scenario, we manually adjusted lead times to explore system responsiveness. A built-in sensitivity analysis feature would streamline this process, helping users stress-test strategies across a range of conditions with less effort.
- *User interface and scalability improvements:* As the model is considered for wider use, several UI and UX upgrades could support speed and accessibility:
    - Tools to update parameters across multiple nodes (e.g., apply holding cost to all LGAs),
    - Enhanced import/export features for data and results,
    - Preconfigured templates for easier application in new countries or response contexts.

4.3.2. Project Scope Limitations and Future Engagement

Our analysis was based on a focused engagement and was limited by time constraints and access to field-level stakeholders in Nigeria. While the scenarios presented reflect extensive prior work with UNICEF and the Nigerian MoH, there remains significant room for deeper collaboration and co-design with operational users.

Still, we view this work as a meaningful foundation. The modeling tool and its approach have demonstrated value in surfacing delivery tradeoffs, improving shared understanding, and supporting more transparent planning. As the CNF evolves and country ownership becomes a more central pillar of wasting treatment, these kinds of tools can help national actors manage new responsibilities and more confidently advocate for program investment and design.

We look forward to continuing to advocate for, and support, future iterations and expanded testing of the UNICEF CAVE App or similar tools. Whether it be further refinement of the model, its application for continued advocacy, or its use in CNF implementation support, this continued work will continue to highlight the role that analytical storytelling and visualization can play in strengthening program delivery, making the case for smarter, more coordinated investment.

5. Conclusion

The global nutrition sector is at a crossroads. For decades, the treatment of severe acute malnutrition has been constrained by underfunding, operational fragmentation, and a persistent disconnect between strategy and execution. While progress has been made, particularly in expanding supplier networks and lowering product costs, the system remains reactive, donor-driven, and vulnerable to disruption.

The dismantling of USAID in 2025 exposed these weaknesses (Standing Together For Nutrition, 2025). At the same time, the emergence of the Child Nutrition Fund offers a new approach, one that promises more sustainable, country-driven engagement. With its three interconnected windows, the CNF reimagines how resources are mobilized, how suppliers are supported, and how countries co-invest in their own systems (UNICEF, 2025). However, this shift also introduces new expectations. Countries are now asked to forecast, budget, coordinate, and plan at levels that many are not yet equipped to handle. In doing so, the CNF risks replicating past inefficiencies unless implementation is accompanied by new forms of planning, decision support, and capacity-building.

This report has shown how modeling and visualization tools can help fill that gap. Through scenario-based case studies grounded in Nigeria's nutrition landscape, we demonstrated how these tools can support budgeting, network design, supplier planning, and emergency preparedness, areas where many of the CNF's operational gaps are most visible. These tools make complexity tangible. They help surface constraints, test tradeoffs, and build shared understanding between governments, donors, and implementing partners.

Yet, tools alone are not enough. They must be integrated into how we design, fund, and manage nutrition programs. They must be paired with political will, systems strengthening, and long-term investment in local ownership. The CNF is not a solution in itself, but it creates the enabling architecture for new approaches to take root. Modeling and analytical storytelling, if embedded effectively, can help realize that potential.

This is a rare window for reinvention. What happens now, how we plan, collaborate, and operationalize, will determine whether this moment delivers lasting progress or simply shifts the burden in new ways. The opportunity exists. The tools are available. The question is whether the sector is ready to use them.

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