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*A supply chain analysis of*  
*Ready-to-Use Therapeutic Foods for the Horn of Africa:*  
**The Nutrition Articulation Project**

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## Executive Summary

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In May 2007, leading international agencies including the WHO, World Food Program, UNICEF and SCN signaled a shift from hospital-based to community-based treatment for severe acute malnutrition (SAM) with ready-to-use therapeutic food (RUTF). Demand for RUTF, which had been growing steadily throughout the decade, more than doubled in the year following the joint statement. Production capacity of RUTF also increased, but at times has not been able to keep pace with rising demand. Given the trend towards RUTF as the preferred treatment for SAM, demand and production will continue to increase. An effective and efficient supply chain for RUTF will be critical in the fight against malnutrition and the achievement of the Millennium Development Goals with respect to child mortality.

As the leading global procurer of RUTF, UNICEF commissioned this study of the RUTF supply chain. The objectives of the study included documenting the current RUTF supply chain, identifying opportunities for supply chain improvement, recommending Key Performance Indicators to monitor supply chain performance, and creating an articulation guideline to aid future studies of nutrition supply chains. On the supply side, the study focused on Plumpy’Nut®, a specific RUTF produced by the French company Nutriset, which is the primary RUTF purchased by UNICEF. On the demand side, this study focused on countries in the Horn of Africa (Kenya, Somalia and Ethiopia), where malnutrition has been a persistent concern.

Analysis of the current RUTF supply chain focused on the flows of product, funding, and information throughout the Plan-Procure-Produce-Deliver cycle for RUTF. As each UNICEF Country Office identifies need and obtains funding for RUTF, a purchase order is processed through the UNICEF Supply Division and released to Nutriset, initiating the production and transportation of Plumpy’Nut® to Africa. This entire cycle, using surface transportation, averages approximately 80 days, with a range of 40-120 days. Using air transportation, as has been done extensively over the past year for the hunger crisis in Ethiopia, can reduce this time. Air transportation, however, raises the transportation cost per kilogram from \$0.17 to \$2.40, increasing the percent of landed cost incurred for transportation from 4% to 39%. The ability to quickly respond to hunger crises is further hampered by the availability of funding, as each country office must obtain commitments from funding agencies for financial resources to cover the purchase, transportation, and program delivery of RUTF before purchase orders can be released. The lack of clarity in two vital flows of information also impedes performance of the RUTF supply chain: accurate assessment of the need and demand for RUTF, and shared information throughout the RUTF supply chain regarding order, in-transit and warehouse levels of RUTF.

Investigating the structure of the supply chain that UNICEF currently uses to plan, procure, produce and deliver RUTF into the Horn of Africa revealed a complex network of organizations



that must work together to ensure timely, cost-effective delivery of RUTF into countries plagued with severe acute malnutrition. Analyzing the performance of the RUTF supply chain and discussing this analysis with key participants helped document the challenges that plague the RUTF supply chain and identify several opportunities for reconfiguring the supply chain. With many potential supply chain configurations to consider, appraising the outcome of changes to the supply chain is a complicated task. A dynamic modeling tool was developed to test the impact on a wide variety of performance measures of changes to both the underlying data of the RUTF supply chain and the configuration decisions that dictate how RUTF is supplied to treat severe acute malnutrition in the Horn of Africa.

Several opportunities for improvement of the RUTF supply chain were identified and recommended:

- Pre-position buffer stock to decrease lead times and improve delivery of RUTF
- Diversify the supplier base to better serve global needs
- Increase collaboration with funding partners and across agencies operating in the Horn of Africa
- Improve data quality for assessments of forecasted need for RUTF
- Improve information flow through increased transparency and new information communication mechanisms

Additionally, Key Performance Indicators (KPIs) within the following four categories were identified:

- Lead Time
- Landed Cost
- Quality
- Access

A small number of KPIs are already being tracked, but the majority of the recommended KPIs are not currently monitored. Improved data collection procedures must be implemented to gather the information necessary to assess performance across these measures on an ongoing basis.

To facilitate implementation of these recommendations, a time-phased recommendation plan has been developed that separates recommendations for short-term (0-6 months), medium-term (6-18 months) and long-term (18-36 months) implementation. A web-based Articulation Guideline was created as a complementary resource to this report in order to aid future supply chain analyses in the nutrition sector. The Articulation Guideline describes each step in a supply chain analysis, identifies the strategic issues associated with that step, and provides examples from the RUTF supply chain analysis for each step.

# 1

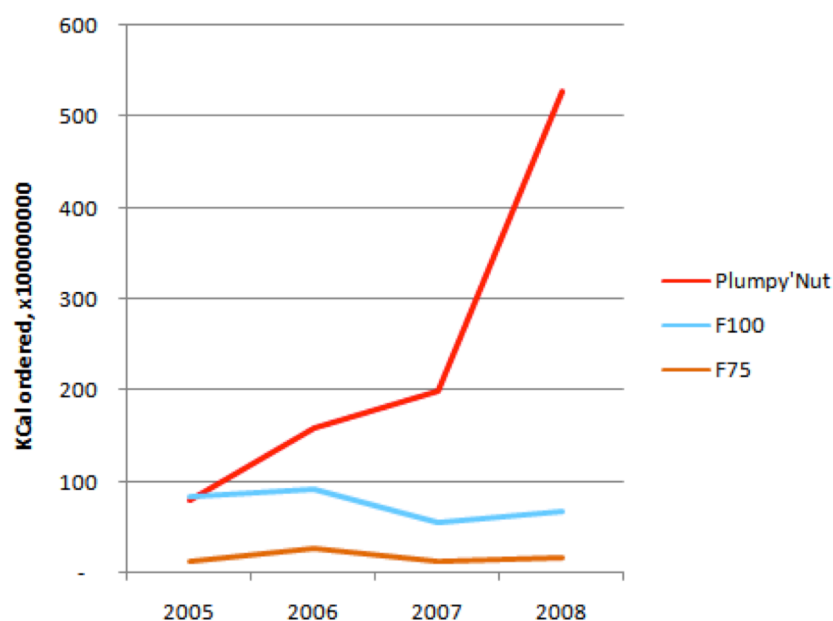
## Introduction

The shift from treating severely malnourished children in hospitals to treating them in community-based programs signals a strategic change in nutrition policy (Lancet, 2007). It also presents challenges in the supply of ready-to-use therapeutic foods (RUTF). A multi-agency endorsement of the new community-based treatment practices in 2007 signaled a new era in the treatment of children with severe acute malnutrition (SAM) (WHO, WFP, UNSSCN, UNICEF, 2007). Primary screening for nutritional status can now be conducted by community members using a simple armband that associates arm circumference with level of malnutrition. Children classified with SAM are referred to a health facility, where they are assessed and placed into a care regimen: those with complicated cases of SAM are treated in a hospital in-patient setting, while those with uncomplicated SAM receive home-based care with periodic check-ups at the health facility. This community therapeutic care (CTC) approach has introduced the possibility of reaching many more children with a less expensive and potentially more sustainable model than the traditional model, which relied on case identification by health professionals followed by in-patient care only (Grobler-Tanner and Collins, 2004; Collins, 2001; Collins, 2006).

A key component of the shift to CTC is the provision of RUTF. The previous course of treatment through therapeutic feeding centers involved the use of therapeutic milks F75 and F100. RUTF are portable, shelf-stable, single-serving foods that are used in a prescribed manner to treat children with SAM.

They are nutritionally equivalent to F100, the former clinical standard for the treatment of SAM, and they come prepared and correctly dosed. Because they are not water-based, they do not as easily host contaminants. Children 6 to 59 months of age who meet clinical guidelines for SAM without complications are given RUTF to eat at home directly from the packet. Depending on a child's weight, a protocol details how many packets of RUTF will be needed per day

*Figure 1: Nutrition commodities ordered by UNICEF Country Offices (in kcal)*

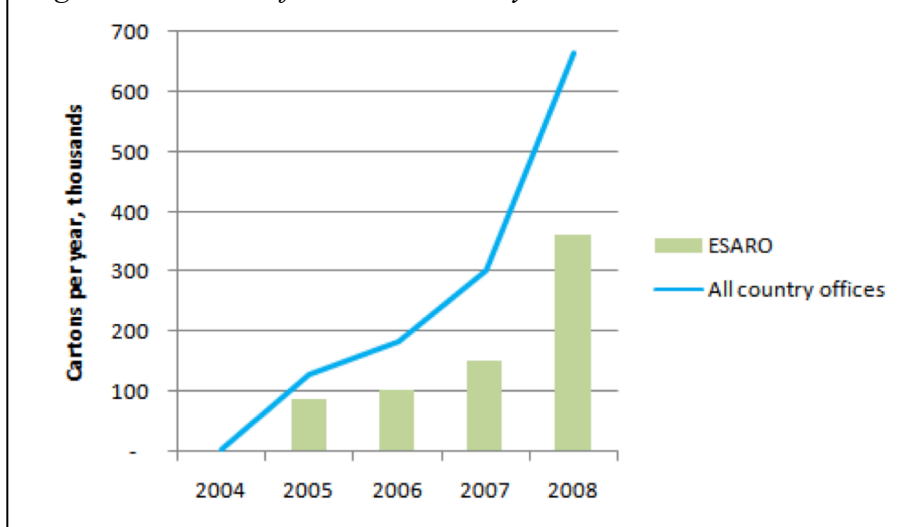


to treat the malnourished child (Valid International, 2006). A caretaker is typically given one or two weeks' worth of RUTF to bring home, along with medicines such as the antibiotic Amoxicillin, and is asked to bring all empty packets back to the next follow-up appointment. Although some programs also use F100 milk alongside RUTF, generally, as consumption of RUTF has increased for UNICEF programs, the amount of F100 and F75 ordered has correspondingly decreased (Figure 1).

There are several RUTF products, all soft or easily crumbled, energy-dense foods fortified with vitamins and minerals. UNICEF most often purchases a type called Plumpy'Nut®, an oil-based paste of peanuts, sugar, and milk powder, fortified by nutrients. Most Plumpy'Nut® is made in Malaunay, France, by a company called Nutriset. Plumpy'Nut® is packaged in foil sachets weighing 92 g, each containing 500 kcal, which are then packed into cartons weighing 13.8 kg each. Nutriset has franchises around the world that also produce RUTF products, all based on the Plumpy'Nut® formulation: Project Peanut Butter in Malawi produces Chiponde in 275 g resealable bottles, Société de Transformation Alimentaire (STA) in Niger packages its RUTF in sachets as well as small pots, and Hilina Enriched Foods in Ethiopia uses sachets, as does the newest franchise, Vitaset, in the Dominican Republic. Additionally, there is a Nutriset partner franchise in the Democratic Republic of Congo (Amwili).

Nutriset has reported an ongoing international scale-up in demand: the amount of Plumpy'Nut® sold has nearly doubled every year since 2005. This pattern has been seen in orders for RUTF placed by UNICEF Country Offices: UNICEF first purchased RUTF in 2001 but orders rose dramatically by late 2007, with quantities increasing nearly tenfold by 2008 (Figure 2). Just over

*Figure 2: Cartons of RUTF ordered by UNICEF, 2004-2008*

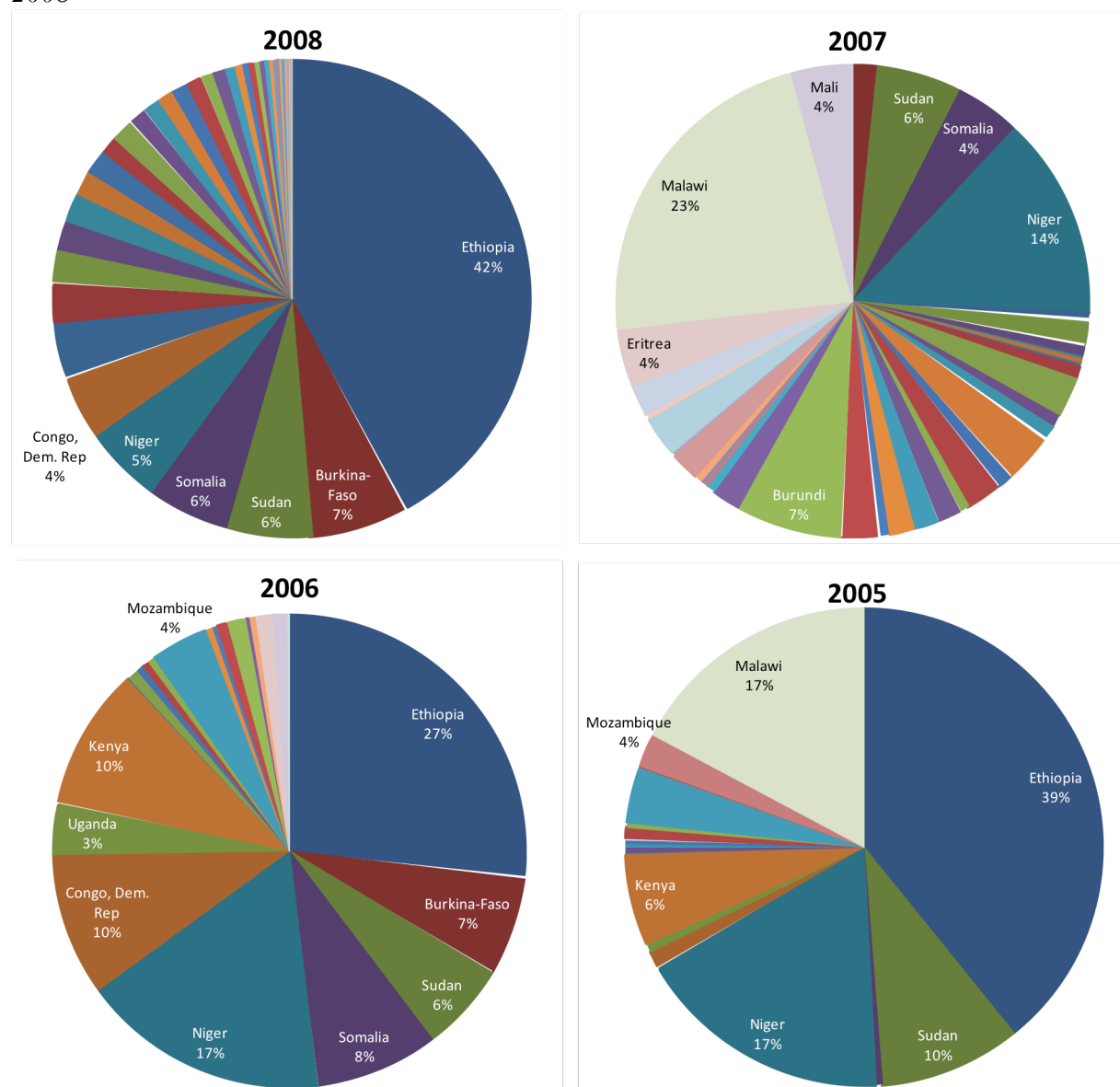


half of orders placed each year come from offices in the eastern and southern Africa region (ESARO).

The reasons for the recent increase in ordering of RUTF are manifold. In addition to the 2007 multiagency statement and the associated increase in international attention and endorsement of

the new approach, contextual factors increased rates of RUTF consumption. Most notably, CTC is a particularly useful model in emergencies, where the establishment and maintenance of traditional therapeutic feeding centers would be extremely expensive and not very effective (Collins, 2001). Countries experiencing large-scale, ongoing nutrition emergencies (including Malawi, Niger, Ethiopia, DR Congo, and Ethiopia) are consistently among those with the largest RUTF orders (Figure 3).

*Figure 3: International order volumes of Plumpy'Nut® by UNICEF Country Offices, 2004-2008*



*Countries experiencing nutrition emergencies, including Ethiopia, Sudan, Niger, and Malawi, are consistently among those with the largest orders. There have also been a greater number of countries placing orders for RUTF, since 2005.*

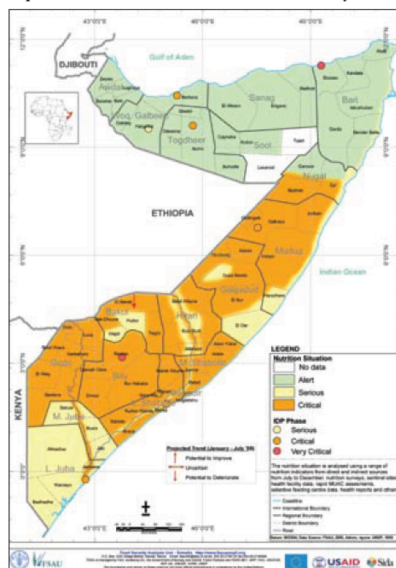
As demand for Plumpy'Nut® has increased, however, there has been limited production capacity to meet it. Production capacity for RUTF will expand at the Nutriset facility in France, and Nutriset has announced plans to expand its international capacity with the addition of franchises in Ghana, Mozambique, Yemen, Cambodia, Senegal and Sudan (Zeilani, 2008). Nutriset also has granted a license agreement to Valid Nutrition authorizing production and distribution of peanut-

based RUTF in several African countries. However, Nutriset did not authorize production in Kenya or Ethiopia under this licensing agreement.

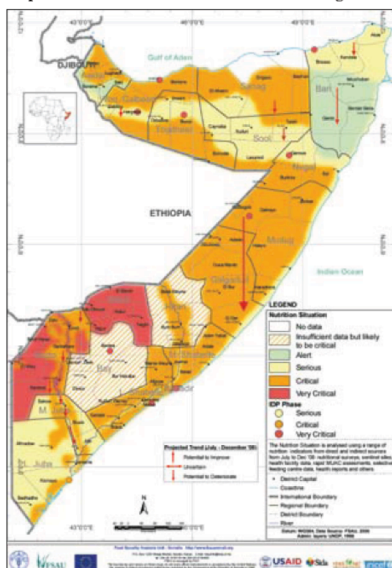
Food security and nutrition concerns have been important in the Horn of Africa for decades, but the international food crisis has combined with regional drought, flooding and civil unrest to severely affect the nutrition situation in eastern Africa. There have been reduced crop yields, combined with higher overall food and fuel costs in the region. In Kenya, the cost of food and fuel has been on the rise for several years, and in the past year prices of basic food commodities have increased up to 40% (FEWS, 2009; Ministry of Public Health and Sanitation, Kenya National Bureau of Statistics, Ministry of Medical Services, 2008). Somalia has seen similar

*Figure 4: The nutrition situation within Somalia worsened considerably in 2008*

Map 8: Somalia Estimated Nutrition Situation January 2008



Map 9: Somalia Estimated Nutrition Situation August 2008



*Between January and August 2008, more regions within Somalia lapsed into “critical” nutrition status (orange shading) and areas of Bakool and Gedo, along the borders with Ethiopia and Kenya, reached “very critical” (red) status.*

increases in cereal prices, where the Food Security Analysis Unit indicated that the nutrition situation worsened throughout 2008, with more regions transitioned into “critical” and “very critical” nutrition status (Figure 4) (Food Security Analysis Unit - Somalia, 2008). UNICEF’s Somalia Country Office reported widespread malnutrition rates above the 15% emergency threshold—with some regions over 20%—and estimated that 180,000 children were acutely malnourished in 2008 (UNICEF Somalia, 2008).

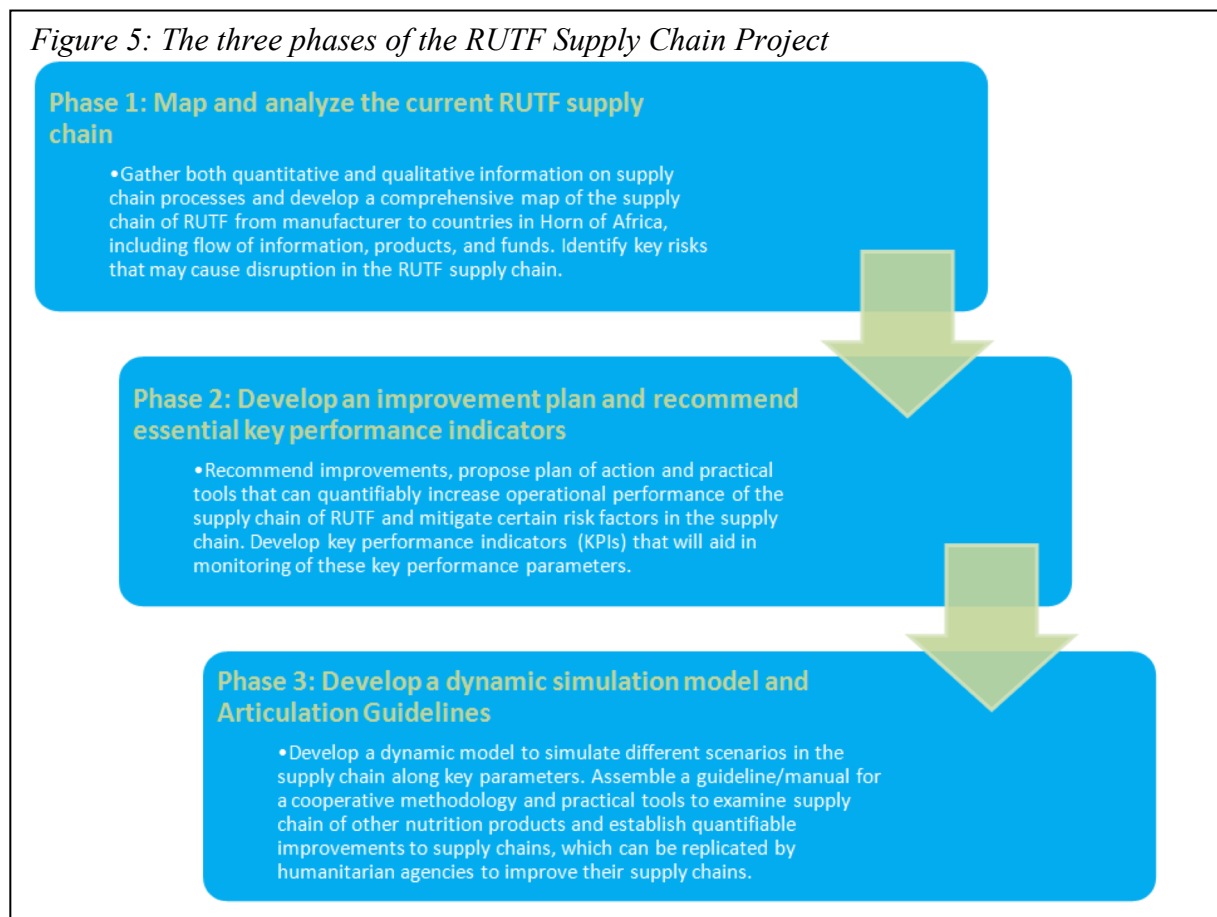
Natural and manmade disasters will continue to

threaten the nutrition status of children around the world, and demand for RUTF is projected to continue its rapid upward trend. UNICEF is the largest buyer of Plumpy’Nut® globally (accounting for roughly 60% of purchases) and therefore has a unique stake in understanding the performance of the RUTF supply chain. Through its wide-reaching network of partners and programs, UNICEF is particularly well-positioned to analyze how effectively and efficiently RUTF reaches malnourished children, as well as to recommend improvements to this supply chain.

This project involved a multi-institutional collaboration to conduct a supply chain analysis for RUTF in the Horn of Africa. The analysis puts forward recommendations for improving the efficiency and effectiveness of the supply chain. The project also serves as a model of how such an analysis might be replicated in other regions or applied to examine the supply chain of other nutritional products.

The project brought together an interdisciplinary team led by the Program on Global Health and Technology Access at Duke University's Sanford Institute of Public Policy and the University of North Carolina's Kenan-Flagler Business School. The project also engaged experts on nutrition and infant feeding (from UNC Gillings School of Global Public Health) as well as value chain analysis (from the Center on Globalization, Governance & Competitiveness at Duke University) to provide advisory input on special topics. Most importantly, the project drew upon the expertise and experience of UNICEF, NGO, and local government officials and staff in the Horn of Africa, as well as Nutriset and Kuehne+Nagel. The project team's multidisciplinary strengths allowed it to consider also the policy, public health, and nutritional implications of dynamic changes to the value chain of RUTF.

*Figure 5: The three phases of the RUTF Supply Chain Project*



The team worked with project partners to gain a better understanding of the supply chain, both through qualitative interviews and secondary data analysis. This informed an analysis of the current supply chain, including the development of a dynamic modeling tool that can help stakeholders see the impact of planned changes in the supply chain through a series of simulations. The team used its analyses and the dynamic modeling tool to develop



recommendations on how to increase the effectiveness of the supply chain, as well as accompanying guidelines to facilitate future supply chain analyses for other commodities or in other geographical contexts. The project was executed in three phases (Figure 5). The project methodology is outlined in Appendices 1 and 2.

The objectives of this project were fourfold:

1. *To develop shared understanding of the RUTF supply chain* among UNICEF divisions and partner organizations, including suppliers, freight forwarders, and NGOs. This shared understanding will provide more transparency to the system and allow each party to make decisions and carry out its responsibilities more effectively.
2. *Make recommendations to allow the supply chain to be more responsive.* By identifying and correcting inefficiencies in the system, the supply chain can be more responsive to the needs of those involved. Although many of the challenges facing the RUTF supply chain are not within the control of UNICEF or its partners, there are a number of actions that can be taken to minimize the impacts of supply chain disturbances.
3. *Identify risks that could disrupt the RUTF supply chain.* By identifying potential disruptions, UNICEF can use scenario planning tools to develop risk mitigation strategies.
4. *Develop a methodology and guidelines for the analysis and improvement of a nutrition product supply chain, which can be effectively used by other humanitarian organizations*

Time and resource constraints limited the scope of the research project to Kenya and Somalia, although data from other countries in the region (most notably Ethiopia, which has been a major driver of RUTF demand in recent years and also has its own supply source for RUTF) were used where relevant for context or comparison. This project focused on the Horn of Africa because that region is facing escalating levels of malnutrition, exacerbated by recent stressors such as post-election violence in Kenya, and drought in Somalia and Ethiopia. The focus was also exclusively on the supply chain within UNICEF for Plumpy’Nut®-like RUTF formulations. However, many of the supply chain characteristics and recommendations in this report may be relevant for other commodities procured by UNICEF.

This report presents the findings of the RUTF Supply Chain Project. Section 1 explains the purpose of supply chain analysis and how to apply these concepts to RUTF in the Horn of Africa. Section 2 presents an analysis of the Product, Funding and Information flows for the RUTF supply chain. Section 3 describes the dynamic modeling tool developed for this project. In the Section 4, the Action Plan lays out a roadmap to implement supply chain improvements as well as Key Performance Indicators. The final section outlines areas for future opportunity.

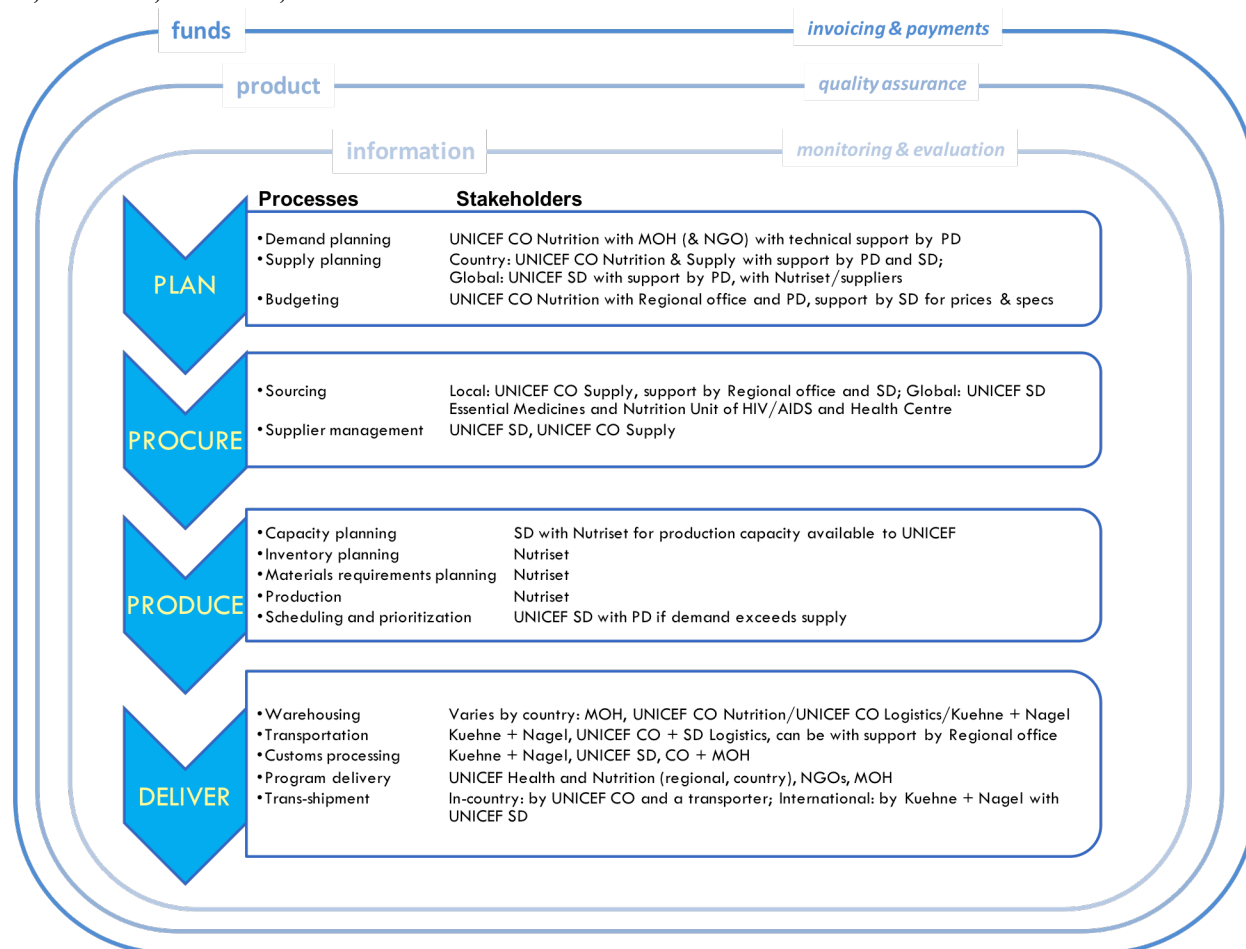
## 2

## Supply Chain Concepts and Applications

### Principles of Supply Chain Management

Supply chain analysis is the study of how a product reaches a consumer, from the time demand is predicted to the time the good is delivered. It examines the performance of all players and activities involved in the supply chain. Efforts to improve processes and flows—termed “supply chain management”—focus on how to efficiently procure, manufacture, transport, warehouse, and distribute a good or service at the “right quantities, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirements.” (Kaminsky, D. Simchi-Levi, E. Simchi-Levi, 2003)

*Figure 6: The range of stakeholders and key activities under each process of the RUTF supply chain: Plan, Procure, Produce, Deliver*



*Cross-chain flows of information, products, and funds encircle all of these processes.*

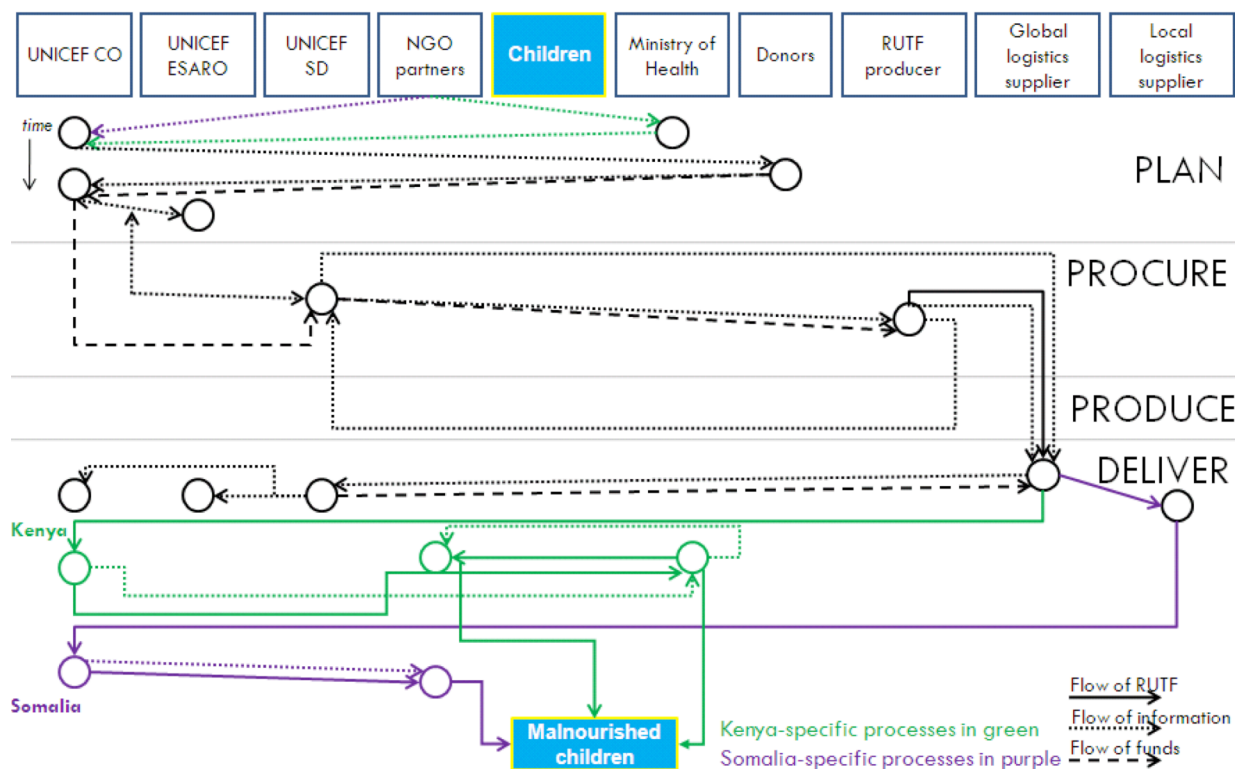


Every supply chain utilizes a set of fundamental processes to *Plan*, *Procure*, *Produce* and *Deliver*. Supply chain decisions are made with an objective to streamline three types of flows—product, information, and funds—within the supply chain. This is not an easy task because supply chains often involve many stakeholders who have varied and sometimes conflicting objectives. An alignment of these objectives is also an important aspect of effective supply chain management. Figure 6 gives an overview of each of these key processes and flows for the RUTF supply chain.

### The current supply chain of RUTF in Kenya and Somalia

The supply chain for RUTF begins and ends with severely malnourished children. Many stakeholders, across a variety of functions, play a role in getting RUTF into the hands of the children who need it (Figure 7).

Figure 7: The RUTF supply chain in Kenya and Somalia



The arrows denote different flows (information, product, and funding). When they differ, flows for Kenya are depicted in green, while flows for Somalia are depicted in purple. Note that most RUTF supply chain activities by the Ministry of Health in Kenya are conducted at the district level, with coordination and oversight from the national-level Ministry. This includes information collected from districts to delivery directly to the districts.

### *Plan*

UNICEF and its partners maintain estimates of RUTF need in their communities, based on demographic information combined with partners' knowledge of their projects and catchment areas. The order planning process starts when a Ministry of Health or an NGO partner identifies a specific need for RUTF among severely malnourished children in its area. The partner then assesses how much RUTF is required for treating these children, and relays this information either directly to the UNICEF Country Office (in Somalia) or to the Ministry of Health and then UNICEF (in Kenya). Program officers in the UNICEF Country Offices (CO) then use their planning documents to determine if the amount of RUTF is accessible for this partner, i.e., they determine whether the quantity seems reasonable and funding exists to pay for it. In Somalia, this may involve reviewing Project Cooperation Agreements (PCAs) with partners; in Kenya, this may be based on annual work plans with the Ministry of Health. If there is insufficient funding, program staff at the UNICEF COs and Regional Offices (ROs) will work with donors to develop concept notes and seek monies for the purchase and delivery of the RUTF.

### *Procure & Produce*

Once the money is raised, the COs and ROs submit a purchase requisition to UNICEF Supply Division. This purchase requisition may need to be adjusted, based on available RUTF supply or viability of a target delivery date, and the UNICEF offices work to coordinate such details and finalize the purchase requisition. After funds for RUTF purchase and transport to port of entry are transferred from the CO to Supply Division (SD), Supply Division releases the purchase order to the RUTF producer. If no further adjustments to the purchase order are necessary, the producer will schedule the production of RUTF in accordance with the purchase order target delivery date. UNICEF procurement regulations mandate that all purchases must be carried out through competitive tenders. In an effort to avoid ongoing delays, SD biannually conducts competitive tenders for the forecasted quantity of regularly supplied goods. As a result of this tender process, long-term arrangements (LTAs) are established for the next 24 months with the bidder(s) that offered the lowest acceptable offer (with an option to renew for an additional 12 months). Based on these LTAs, Supply Division releases purchase orders to producers according to the requisitions arriving from COs.

### *Deliver*

Once the RUTF has been manufactured and packaged, the RUTF producer communicates with a global logistics supplier to arrange a date for materials pick-up from the production facility, containerization, and transport to the port of export at Le Havre for sea freight and to Paris for air freight. The global logistics supplier moves the RUTF product from France to the region or destination country; for the Horn of Africa, RUTF arrives via Mombasa or Addis Ababa. Funds for global transportation—from Le Havre via Mombasa (if by sea) or via Jomo Kenyatta International Airport in Nairobi (if by air)—are included in the COs requisition monies. SD pays for transport upon invoice from the logistics supplier. Kenyan and Somali orders of RUTF have largely been shipped via sea so they travel via a transshipment port to Mombasa from France.

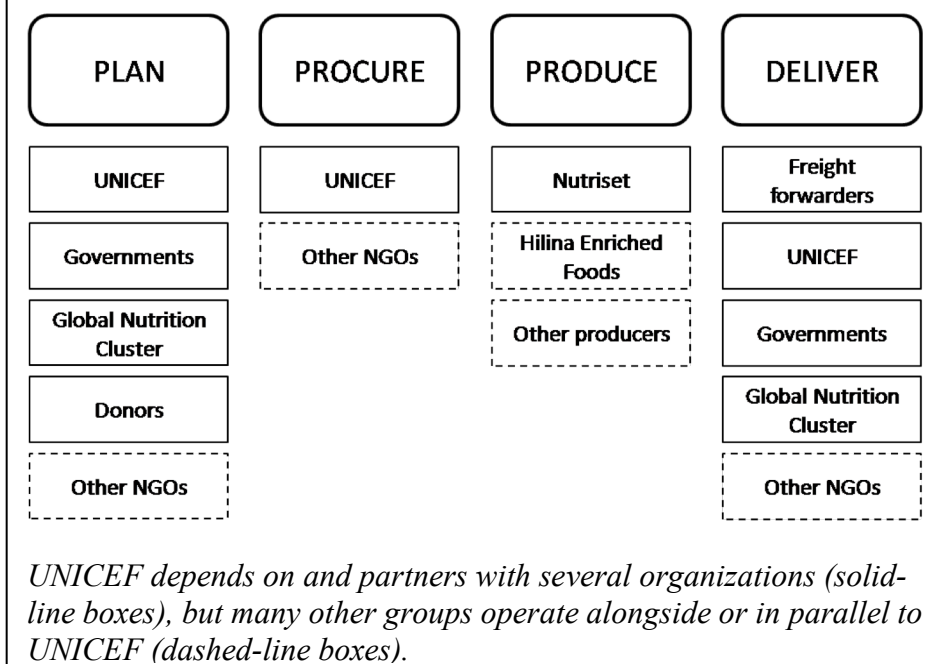
Upon arrival at Mombasa, the containers bound for Kenya are cleared for customs and are then transported by truck to the UNICEF warehouse in Nairobi. From there, the Ministry of Health works with NGO partners and the UNICEF CO to release RUTF for distribution to the districts, where the District Nutrition Officer and/or NGO partners store RUTF until it can be used.

The RUTF provided to partners in Somalia is held at a bonded, in-transit warehouse in Mombasa until a local freight forwarder can move it to Somalia. This usually happens by sea, from Mombasa to Mogadishu, at which point it is either stored at a UNICEF warehouse in Mogadishu or is moved by truck to warehouses in districts throughout Somalia. In some circumstances, the RUTF is moved by land from the Mombasa warehouse to parts of Somalia. The RUTF is then held at UNICEF warehouses until partner NGOs request deliveries of RUTF for children in their catchment area.

In addition to plan, procure, produce, and deliver processes, there are other ongoing activities, including monitoring and evaluation, invoicing and payments, and quality assurance. Monitoring activities extend throughout stages of the supply chain: freight and production partners report to UNICEF on their performance, and NGO partners are asked to report on progress toward their objectives in treating severe acute malnutrition. Quality assurance mechanisms begin with RUTF producers, who are required to inspect ingredients for contaminants and products for both contaminants and nutritional value. Producers also are subject to periodic inspections by UNICEF to ensure hygienic conditions and consistency of product quality. Additionally freight forwarders, as well as COs and NGOs, report visual damage to UNICEF such as sachet leakage or carton breakage.

It is important to note that UNICEF's supply chain for RUTF does not operate in isolation (Figure 8). A range of partners and stakeholders operate across the RUTF supply chain, both those integral to UNICEF's programming, as well as organizations that work alongside or in parallel to UNICEF. Some organizations have their own supply chains for RUTF—for example, Médecins Sans Frontières (MSF) procures RUTF from Nutriset and then imports it directly for its programs. NGOs in Kenya and Somalia sometimes must independently procure RUTF due to UNICEF supply shortages; in these instances, they purchase directly from Nutriset and work with an import agency in-country to arrange for transport and customs clearance. This is significant because supplies of RUTF are sufficiently limited that decisions by one stakeholder can have a ripple effect on other organizations. If one stakeholder miscalculates his projected demand and faces a mid-year shortage, for example, this can stress the RUTF production system and cause delays or cuts in production volume available to other partners.

Figure 8: Stakeholders in the RUTF supply chain



Throughout this report, there will be references to *need* for RUTF and *demand* for RUTF. Need assesses the theoretical market for a product during a period of time, while demand looks at the true number of people requesting a product when that time arrives. As a purely hypothetical example, it is projected that 1000 children will need RUTF during 2009 (*forecasted need*). When April arrives, however, there is a clear nutrition emergency caused by a drought so estimates of need are adjusted and the new *actual need* is now 5000 children. A partner NGO in this region had planned at the outset of the year to give RUTF to 300 children (*forecasted demand*). When they revised their plans in the face of the famine in April, they increased the number of children to be served with RUTF to 800 (*actual demand*). There may only be enough RUTF produced to treat 600 children, however, which would make *unmet need* 4400 children (the 5000 in actual need minus the available quantity) and the *unmet demand* as 200 children (forecasted demand minus available product). This is graphically depicted in Figure 9. The terms that will be used most frequently in this report are forecasted need (often called just “need”) and actual demand (referred to as “demand”).

Figure 9: Differences between need and demand for a product

	Need	Demand
Forecasted	1000	300
Actual	5000	800
Available RUTF = to treat 600 children		
Unmet	4400 (5000-600)	200 (800-600)

Supply chain management is often complicated by uncertainty in demand and supply and a lack of coordination in production and delivery networks, combined with multiple entities' different (and sometimes misaligned) incentives. In addition, the RUTF supply chain in eastern Africa has been significantly influenced by contextual factors, such as:

- *Multiple agents involved in a web of relationships:* The RUTF supply chain for eastern Africa spans the globe and includes RUTF manufacturers, global transport entities, local governments, international non-governmental organizations and donors, as well as UNICEF offices from New York to Nairobi and beyond. The management of the many stakeholders is understandably difficult. Coordination and communication among those in such a complex network is challenging, requiring that decisions be made with inadequate information. Compounding these difficulties is the fact that stakeholders may have different or conflicting objectives and expectations, which can lead to delays, stock-outs, and large variability of order volumes—impacting the supply chain's overall efficiency (Kaminsky *et al.*, 2003).
- *Uncertainties in demand:* The ultimate goal of supply chain management is to efficiently match supply and demand, a goal complicated by uncertainty throughout the supply chain (Swaminathan, 2001). Demand for RUTF has increased annually but at a variable rate, which makes it difficult to predict future patterns of demand for the product, especially with so much of the annual supply of RUTF consumed in areas hit by emergencies (Figure 3). Additionally, orders are only placed once funding is received—perhaps suggesting that annual order volume is less indicative of need than of funding availability. Furthermore, the nutrition community is continuing to debate the sustainability of large-scale treatment programs. As an example, the BASICS program funded by USAID—which advises governments on the most effective interventions to meet the major needs in newborn and child health—has been advocating a move away from widespread CTC projects. They support an “Essential Nutrition Actions” (ENA) package that focuses on an integrated set of behavior change to prevent malnutrition in young children (including breastfeeding, complementary feeding, iodine supplementation, etc.). Citing the already limited resources available for child health, both in terms of financing and health workers, as well as the importance of addressing malnutrition beyond SAM, BASICS is advising an ENA approach that uses CTC only in crisis situations (with the expectation that Ministries of Health should never have to pay for RUTF) (USAID and BASICS, 2001). With such discussions actively under way in the global nutrition community, future demand for RUTF may be especially unpredictable.
- *Variability in supply:* Demand and supply are very closely linked: poor estimates of demand can lead to surpluses in supply at the local level, and accurate demand estimates can be thwarted by inadequate supply to meet that demand, causing stock-outs and shortages. This interdependence may encourage gaming throughout the supply chain, as stakeholders adjust their behaviors to account for potential disruptions elsewhere. Situations like these can create a bullwhip effect, where a small surge in demand is amplified as various entities in the supply chain revise their individual forecasts. There may also be concerns about affordability and sustainability of pricing. Recent increases in demand have not significantly reduced the price of Plumpy'Nut® (see Figure 25 later in this report), though UNICEF does enjoy a 4% price discount from Nutriset. This lack of economies of scale may be due in part to increased raw ingredient costs or limited capacity for RUTF coupled with high demand. Nutriset has invested in expanded

production capacity for 2009 and anticipates that prices for RUTF will decrease by approximately 5%.<sup>1</sup>

- *National-level context:* The supply chain of RUTF in eastern Africa has been influenced significantly by national-level contextual factors. Continued instability in Somalia, for example, has affected the supply chain there on many levels. Many logistics operations for the Somalia CO now operate out of Nairobi, which impedes visibility and oversight for the supply chain. Warehouses and ports are periodically rendered inaccessible, raising freight costs (for overland transport from Mombasa) and necessitating re-orders for blocked supplies. Somalia is also experiencing population shifts and large numbers of internally displaced persons, which can cause problems ranging from challenges in estimates of need to difficulties in delivering a multi-week course of treatment. Although Kenya is not in the same heightened state of emergency as Somalia, it too has special concerns that affect its RUTF supply chain. Early 2008 saw post-election violence in Kenya that blocked imports and hindered transport, while simultaneously increasing need.

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<sup>1</sup> It is unclear whether expanded production capacity worldwide will significantly impact prices; the same root causes for famine, such as civil unrest or drought, may also disrupt local or regional sourcing of key RUTF components for manufacture. Countries least resilient to economic shocks suffer from local political instability, which can also interfere with local supply chains and production. Higher RUTF ingredient costs and panic buying can reduce the supply available locally to source the manufacture of RUTF. Restrictions on the imports/exports of some products can also reduce the availability or affordability of RUTF components in the supply chain.

### 3

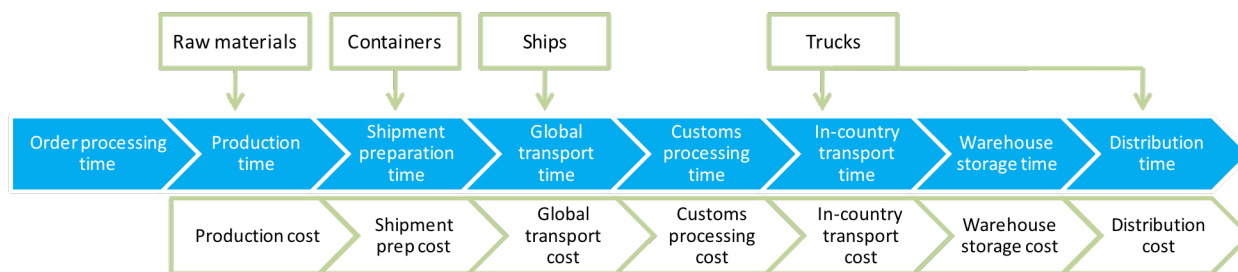
## Analysis

### Product Flow

Effective supply chains must have a reliable and efficient system for moving goods between steps in the supply chain. This facet of supply chain management is known as Product Flow. Product Flow is generally a linear and forward-moving process, and it is the keystone that holds the supply chain together: the stronger the product flow, the stronger and more reliable the entire supply chain.

The efficiency of the RUTF product flow process relies on the coordinated efforts of a number of different entities all working closely together. RUTF is manufactured by Nutriset in Malaunay, France, shipped globally by Kuehne + Nagel (K+N), Scan Logistics, or DHL, transported from the port of arrival by local logistics suppliers, and distributed by implementing partners in-country (Figure 10). Each step is comprised of two components: “lead time,” the length of time required for each step of the product flow process, and “component cost,”<sup>2</sup> the cost associated with each of these steps.

*Figure 10: Detailed product flow for RUTF*



*Blue arrows represent lead time components, and green arrows represent component costs. Material inputs to the product flow sequence are highlighted in green boxes above.*

Efficient lead time and minimized component cost are essential to ensure timely delivery of the commodity for programs serving severely malnourished children in the Horn of Africa. Efficiency in the earlier steps of product flow allows for more time for local distribution, which is logistically the most difficult of the product flow steps. Minimizing the component costs for

<sup>2</sup> Data on component costs can be used to determine the “landed cost,” the cost of goods that have been delivered to the port of destination, unloaded, passed through customs, warehoused locally, and transported to the final destination.



product flow can result in cost savings, and when less money is allocated for transportation, more can be used to purchase RUTF.<sup>3</sup>

UNICEF places two types of orders for RUTF: non-emergency and emergency.

- Non-emergency orders are planned in advance. These comprise nearly half of all orders placed by Kenya, Somalia, and Ethiopia COs. Often these orders are entered into UNICEF's order tracking system months in anticipation of actual need. Non-emergency orders are typically shipped via sea freight. Non-emergency orders are sometimes expedited to meet a level of demand that was neither anticipated by forecasting nor funded sufficiently in time.
- Emergency orders are non-planned orders placed due to an unexpected increase in the need for RUTF due to a disaster situation. Emergency orders are often shipped via air freight. This shipping approach is expensive and imposes trade-offs between decreasing lead time and minimizing costs. Using air freight, RUTF can be transported from Nutriset's facility in France to any location in the world within a few days. However, air freight can cost up to 14 times more than sea freight.

Several challenges pertaining to product flow were identified in the supply chain analysis. There is significant variability in lead time for the product flow process, and some transport decisions added significantly to the overall cost of RUTF. These challenges are explored in greater depth below.

#### Variable lead time is inefficient and can erode trust

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Efficient lead time is a crucial component of the overall effectiveness of product flow. This project uncovered lead time variability at each step of the supply chain for both emergency and non-emergency orders, as shown in Figures 11-16).<sup>4</sup>

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<sup>3</sup> The project team faced limitations in the analysis of these steps due to missing or insufficient data. Often, too few data points existed for a meaningful analysis.

<sup>4</sup> Due to a lack of data points for downstream steps in the product flow process, customs clearance, local transportation, and distribution lead time were not evaluated for Ethiopia. Customs clearance time and warehouse to end location time were based on anecdotal evidence collected through stakeholder interviews.



Figures 11-16: Stacked time charts depicting the minimum, average and maximum lead time at each step of the supply chain for RUTF orders from Kenya, Somalia, and Ethiopia (aggregated across all orders, emergency and non-emergency)

Figure 11: Lead time for non-emergency orders to Kenya (\*: anecdotal evidence)

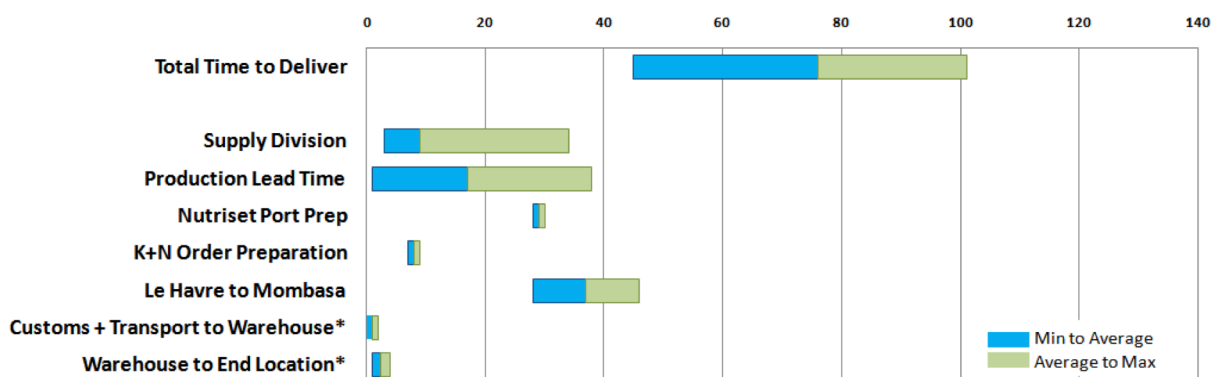


Figure 12: Lead time for non-emergency orders to Somalia (\*: anecdotal evidence)

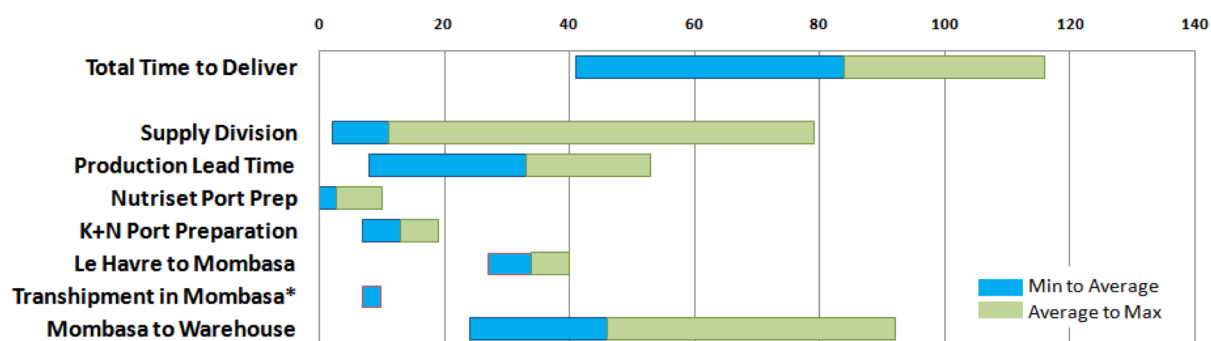
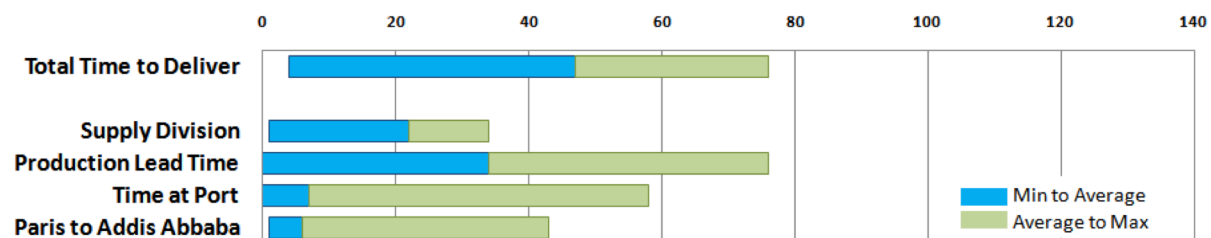
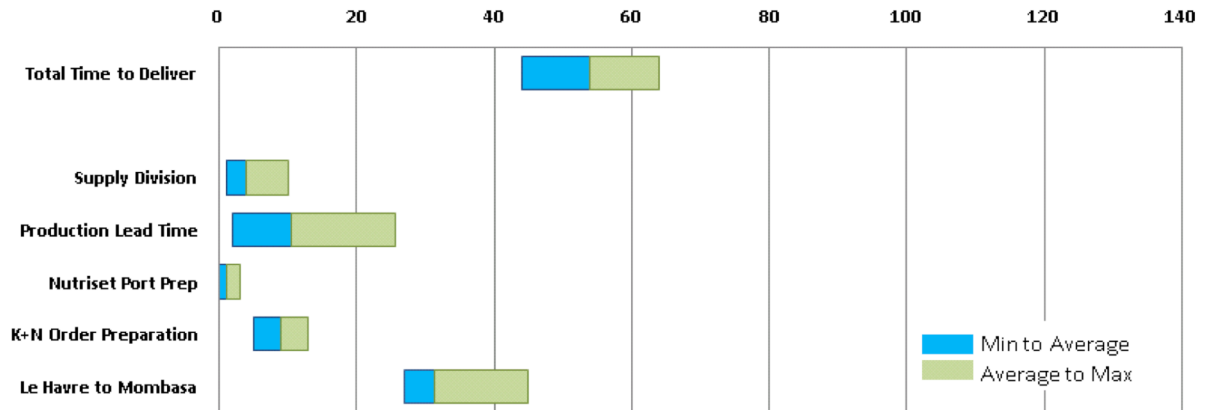
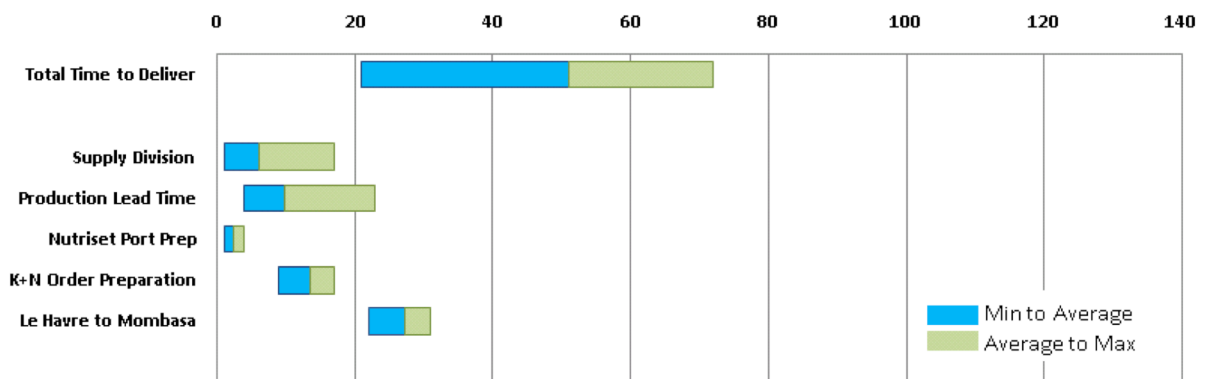
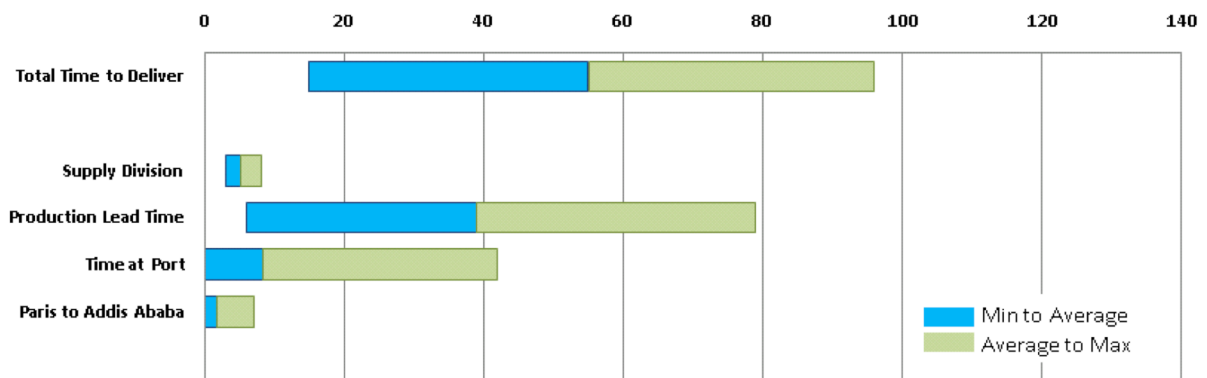


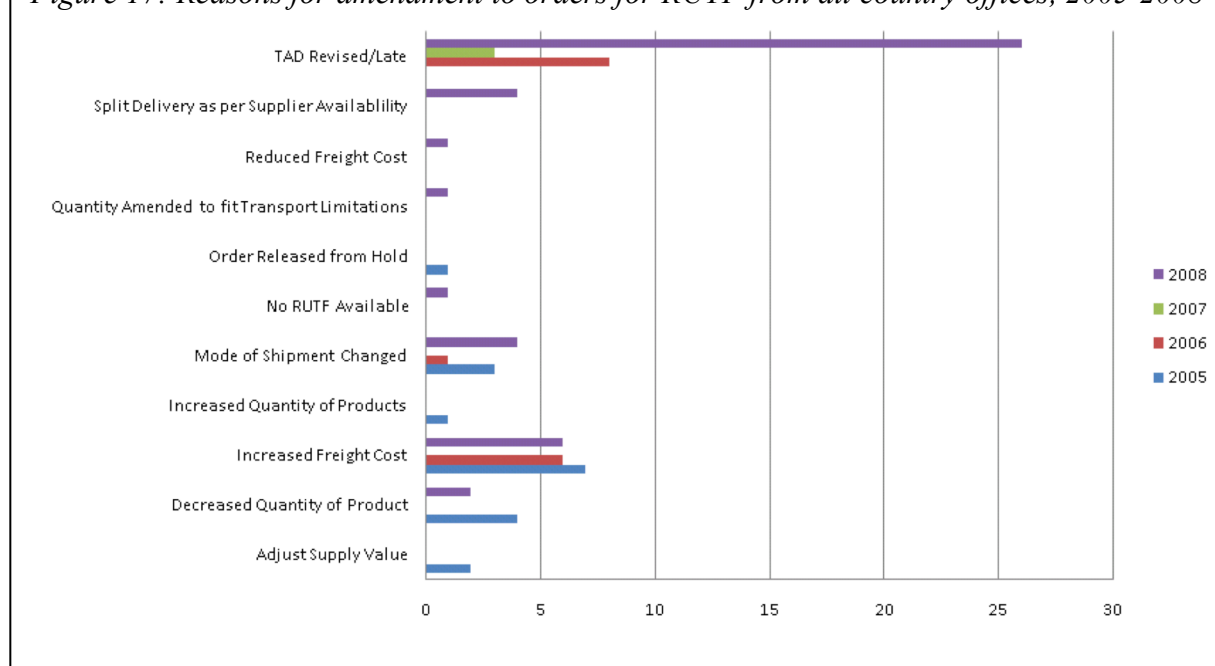
Figure 13: Lead time for non-emergency orders to Ethiopia



*Figure 14: Lead time for emergency orders to Kenya**Figure 15: Lead time for emergency orders to Somalia**Figure 16: Lead time for emergency orders to Ethiopia*

This variability has a direct effect on the ability to establish effective plans around the RUTF supply chain, especially because it can be extremely hard to predict arrival dates for orders of RUTF. Many orders receive an amendment for an adjusted Target Arrival Date (TAD), which means the TAD was extended due to a foreseeable interruption in the supply chain. Figure 17 breaks down reasons for amendments for all orders to Kenya, Somalia, and Ethiopia from 2005 to the present. The overwhelming majority of amendments related to TAD. One might expect, then, that plotting actual arrival dates with revised TADs would show a dramatic increase in the number of on-time arrivals. This is not the case, however. Even after TADs were adjusted, orders still arrived late 75% of the time. The use of TADs has evolved in recent years as a freight calculator to inform CO estimates of TADs was introduced and UNICEF began officially revising TADs to assess performance.

*Figure 17: Reasons for amendment to orders for RUTF from all country offices, 2005-2008*



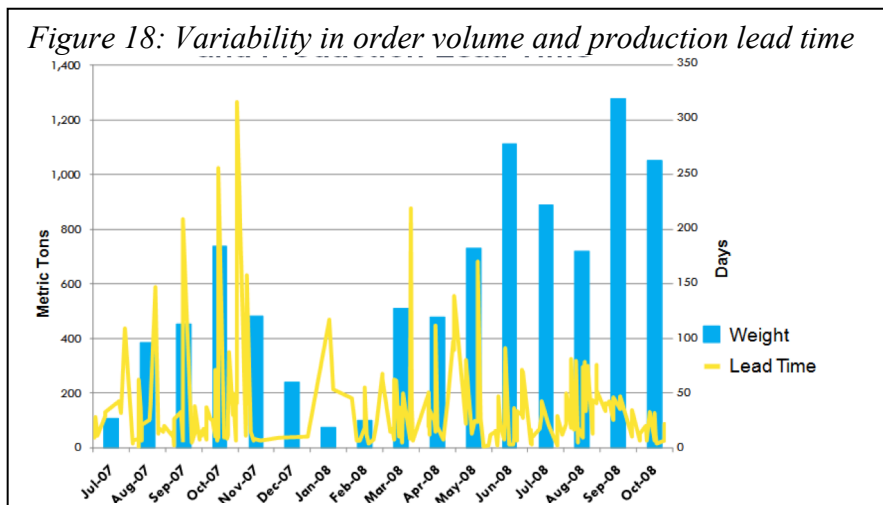
This observed variability might result from a number of different factors. For example, at the local level, this may include local transportation delays due to seasonal weather problems, waiting periods to prepare for shipments of multiple supplies for a district (not just RUTF), and the necessity of driving partially empty trucks due to road weight restrictions.

There remain unforeseen challenges in the supply chain that postpone orders and cause variability, even after UNICEF and RUTF producers and transporters account for known postponements by revising TADs. The stacked time charts above (figures 11-16) indicate that two supply chain steps in particular drive the wide range of variability in lead times: production process and global transport (from Le Havre/Paris to Mombasa/Addis Ababa<sup>5</sup>).

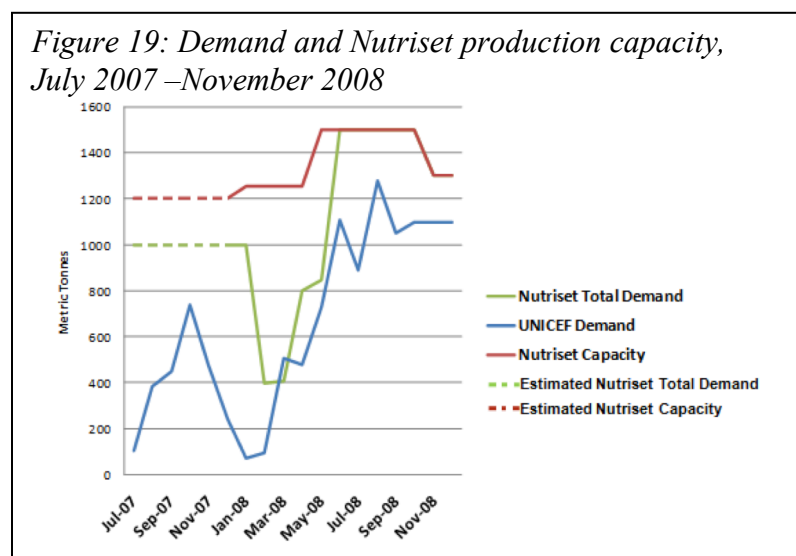
<sup>5</sup> RUTF sent by sea to Kenya and Somalia originates from Le Havre and is shipped to Mombasa, while air-lifted orders are sent from Paris to Nairobi, or to Addis Ababa in the case of Ethiopia.

*Production process variability may be caused by uneven ordering behaviors*

Variability in lead time early in the supply chain may be partially explained by the fact that non-emergency orders can be drafted far in advance of their being routed for production. COs are encouraged to plan these orders, which are then only initiated once funds are available and production can be scheduled; in the stacked time charts above, non-emergency orders from the Horn of Africa can remain at SD for up to nearly 80 days. UNICEF also routes orders to Nutriset and communicates a production timetable based on the relative priority of each order.



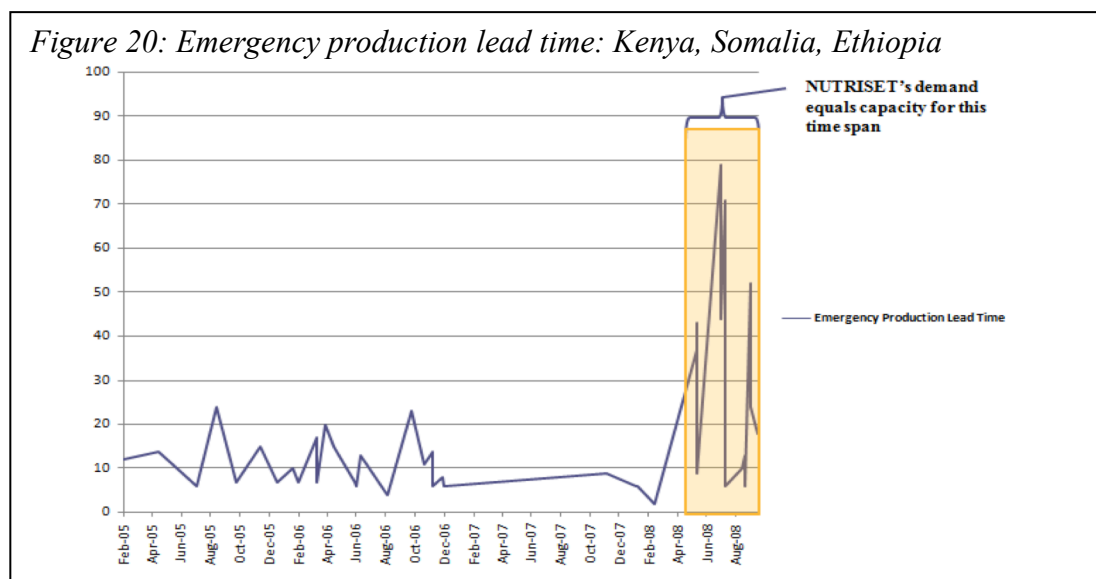
However, this does not explain the consistently variable production lead time for both emergency and non-emergency orders. Worldwide inconsistency of order volumes may be a contributor to increased production lead time as indicated in Figure 18, which shows that production lead time increases following a spike in order amounts. During periods of high demand, the production facility may be forced to operate at or near maximum capacity and must place some orders on hold. The trend is further elaborated in Figure 19, which shows production capacity for Nutriset in 2008; from May through November the manufacturer operated at maximum capacity.



production lead time for emergency orders from Kenya, Somalia and Ethiopia are plotted against these months when production was at maximum capacity, there is an increase in lead time (Figure 20). This variability in lead time therefore uncovers an underlying issue with order placement for RUTF: better forecasting and more proactive funding could help smooth orders of RUTF throughout the year, which should in turn decrease variability in production lead

time and improve the product flow in the supply chain.<sup>6</sup>

<sup>6</sup> The project team also investigated the effects that order weight may have on production lead time. Appendix 2 uses a scatter plot to demonstrate the relationship between lead time and order weight (for orders from Kenya,



*Variability in global transport is caused by a number of factors*

Transportation of RUTF from Le Havre/Paris to Mombasa/Addis Ababa is one of the longest and most variable steps in the supply chain, regardless of whether the shipment is classified as an emergency or non-emergency order.<sup>7</sup> This length and variability is the result of a multitude of factors, including:

- Port of departure delays: Before RUTF can be loaded onto a ship bound for Africa (via a transshipment point), Nutriset and Kuehne+Nagel must secure a container, load RUTF into the container, and prepare required documentation. Any of these steps can, and sometimes does, delay the departure of RUTF from Le Havre.
- Lengthy times at the point of transshipment: When sent by sea, RUTF is not shipped directly from France to Africa—it stops at a port of transshipment. Transshipment ports can be congested, creating more holdups as ships wait to enter and depart. Stakeholders indicated that the global transportation time can be significantly lengthened due to interruptions at the point of transshipment.<sup>8</sup>
- Port of arrival delays: Difficulties at the port of arrival in Mombasa can also cause delays and introduce additional variability. Congestion at the port and issues with regulatory paperwork are cited as frequent problems. For example, customs release times at Mombasa for RUTF are around 16 days due to additional steps in the release process, most notably a Letter of No Objection from the Kenya Veterinary Department and a permit from the Kenya Dairy Board. In addition, there is a 30% backlog of orders at the customs office in Nairobi (Stakeholder interviews, 2008). Stakeholders also report that

Somalia, and Ethiopia). The data show no discernable relationship between the weight of an individual order and the length of time it takes to produce it.

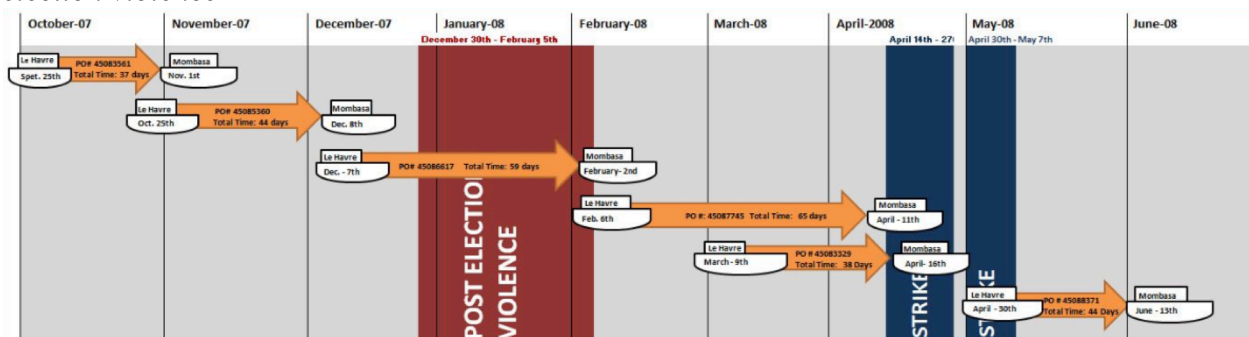
<sup>7</sup> It is important to note that for countries with few RUTF orders, like Kenya, it is hard to assess variance. A larger study population of orders would be necessary to assess true variance for these countries.

<sup>8</sup> Data separating sea freight times into pre-transshipment and post-transshipment segments are not yet collected. These will be added into the newest round of data synchronization between UNICEF and K+N in 2009.

shipments into Ethiopia via sea regularly experience customs clearance delays of 6 months to one year (Stakeholder interviews, 2008).

Sometimes exceptional circumstances have the potential to disrupt global transportation. Some stakeholders suggested that recent port strikes at Le Havre and election violence in Kenya might have caused delays in the shipment of RUTF. However, the data do not clearly support this theory (Figure 21). The port strike and election violence may have caused some delays for orders shipped during that time period, but some orders actually had a *shorter* lead time when shipped through Antwerp during the port strike at Le Havre.<sup>9</sup> Additionally they do not explain the long lead times for orders shipped before or after these events. Regardless of the ports of export or entry, there is variability in lead time.

Figure 21: Lead times for RUTF shipped before, during and after Le Havre strike and Kenya post-election violence



This variability erodes trust in the supply chain and inhibits efficient proactive planning. Inefficient planning can lead to spikes in order volumes which, as noted above, can increase production lead time. It is an interrelated cycle, so improvement in one step can lead to overall improvement for the entire system.

#### Extended transportation lead time places further stress downstream in the supply chain

Figures 11-16 show not only a wide *range* of lead times for global transportation, but also *lengthy* lead times. K+N indicated that pure sailing time from Le Havre to Mombasa, without interruptions, is 25 to 27 days (Stakeholder interviews, 2009). In reality, however, the 27 non-emergency orders sent by sea to Mombasa since 2005 experienced transport times of 34 days on average (with a range of 27 to 46 days).<sup>10</sup>

Shortened transportation time would not only increase the rate of on-time arrivals, it would also allow more time for distributing RUTF later in the supply chain, the most logistically

<sup>9</sup> Stakeholders report that Antwerp often experiences shorter global transportation lead times than Le Havre but there are regulatory (including customs on foodstuffs) and logistical (such as more lengthy and expensive over-land transportation costs) barriers that prevent the supply chain from using it as the regular port of export.

<sup>10</sup> In 2009 K+N is increasing its estimate of sailing time from Le Havre to Mombasa to 35 days to account for known factors that lengthen transport time.

challenging step. For example, orders to Somalia face a number of potential disruptions during transport from Mombasa to Mogadishu, then to UNICEF warehouses, and beyond. The UNICEF logistics presence has been withdrawn from Mogadishu due to security concerns,<sup>11</sup> and warehouse accessibility is limited in two locations in the Central South Zone, so management of the final stage of product flow can be quite difficult. If time were saved earlier in the supply chain, there could be more flexibility in distribution times, thereby helping to avoid stock-outs for programs in the field.

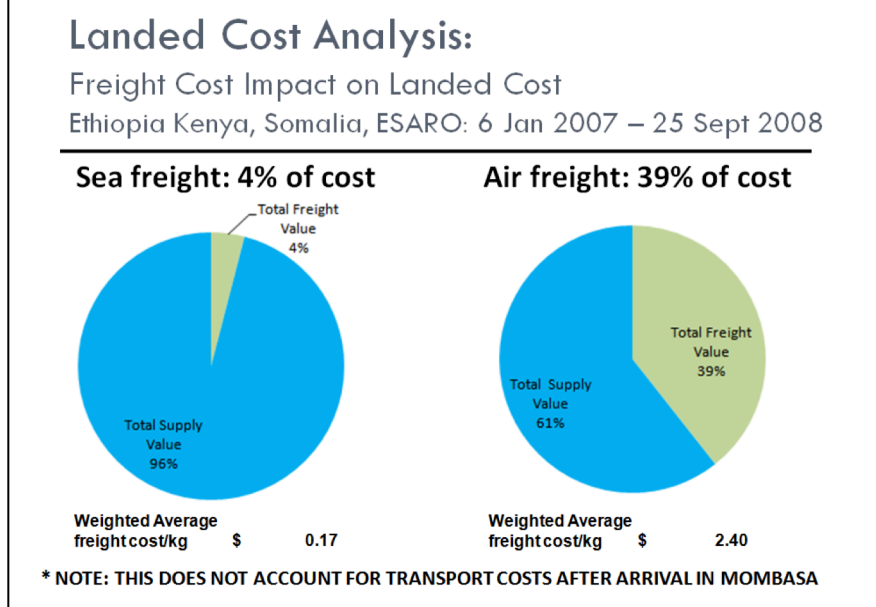
### Uneven ordering can cause large increases in global transportation costs

The cost of transporting RUTF from France to eastern Africa is a significant factor in the supply chain. Between January 2007 and October 2008 air freight to Kenya, Somalia, or Ethiopia averaged \$2.40/kg; by contrast, sea freight averaged only \$0.17/kg. From May to October 2008 air freight was used for nearly all orders to Ethiopia and for one-third of emergency orders (and 21% of non-emergency orders) to Kenya and Somalia.<sup>12</sup> Widespread drought and famine in Ethiopia combined with a national-level initiative around RUTF rapidly increased demand and risked local stock-outs—and the funds to meet this need arrived late in the year, so very rapid order fulfillment and transportation were required. Additionally, because overland RUTF movement into Ethiopia encounters lengthy transport and customs delays, air freight was the only way to meet the escalated need.

In Figure 22, the cost of air freight and sea freight was assessed as a portion of the total cost of an order of RUTF.<sup>13</sup> The graphs show

that, on average, orders shipped by air use 39% of their total budget on transport, while those sent by sea spend 4%. While the majority of shipments are transported by sea, the fourteen-fold

*Figure 22: Contribution of Sea Freight and Air Freight to Cost of RUTF*



<sup>11</sup> Note that global freight forwarder transport direct to Mogadishu is not possible due to liability.

<sup>12</sup> Non-emergency orders are sometimes shipped via air. This can be because they are very small order quantities; because air freight can (by exception) be less expensive than sea freight; or because the order was placed late and therefore needs expedited delivery, but UNICEF does not classify an “emergency” when it is due to lack of planning.

<sup>13</sup> Note that total cost here includes only cost of procurement plus cost of global transportation. There were no per-order figures provided for customs costs, in-country transportation costs, warehousing costs, or local distribution costs, so these could not be factored into this total cost formula. Ideally, these data should be added into the total cost.



increase in transportation costs for air freight means that even a relatively small number of airlifted orders can have a significant effect on cost. For example, one of the four RUTF orders shipped to Kenya in 2008 was shipped via air freight. If this order had been shipped by sea instead of air, Kenya would have seen a 42% drop in the total cost spent to ship RUTF in 2008, from \$12,063 to \$6,955. Given the current supply chain configuration, air shipment was necessary for this order due to the unexpected level of malnutrition resulting from the displacement caused by post-election violence. An alternative supply chain configuration, however, may have allowed for appropriately rapid response to this need without resorting to expensive air shipment. As another example, only 1 of the 13 RUTF orders shipped to Somalia between May and November 2008 traveled by air. However, if this single order had been shipped by sea Somalia would have seen a 9% drop in transportation costs for this time period, from \$117,620 to \$107,021. It is far more cost-effective to ship orders by sea, thereby freeing more funds for the purchase RUTF.

#### Future demand for RUTF is uncertain

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The demand for RUTF is projected to increase in the coming years but this is based on a number of assumptions and the degree of the increase is uncertain. In order to consider a range of potential challenges to the product flow process, three possible future demand scenarios were identified for RUTF. These scenarios create different sets of potential challenges to product flow.

Demand could **decrease** for RUTF as other alternatives are developed, or if malnutrition prevention efforts succeed. This may reduce some stresses on the supply chain, although others will remain.

- *Approval of RUTF products from new suppliers and shift toward RUSF products:* Growing demand for RUSF (ready-to-use supplementary food) products might decrease global demand for RUTF. However, it also may stress the supply of RUTF by stretching the availability of ingredients (such as peanuts or milk) for RUTF or competing for the same manufacturing lines, consequently limiting production and risking an increase in prices due to limited supply.
- *Long and variable transportation lead time:* Although decreased demand might reduce production lead time, the long and variable transportation lead times noted earlier would not be affected by decreased demand for RUTF: even a single order of RUTF could still be delayed at the ports of departure, transshipment, or arrival.

Demand could **remain the same** for RUTF. In this case, the supply chain could either continue to face the same challenges it currently faces in product flow or it could refine its activities to increase efficiency and effectiveness.

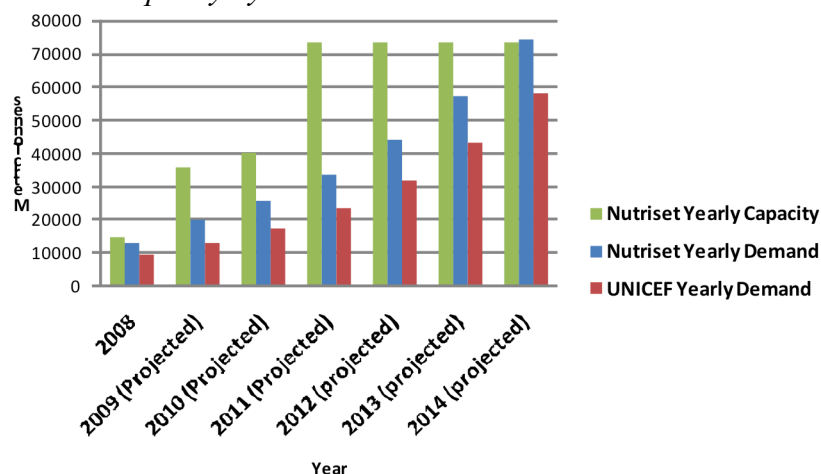
If demand **increases** for RUTF—arguably the most likely scenario—this risks increasing stress on the supply chain as it struggles to keep pace.

- *Increased production lead time:* An increase in demand could create delays in production lead time as manufacturers struggle to keep up. When demand approaches the limits of current production capacity, availability of RUTF will become increasingly limited. Production facilities operating at 100% capacity risk delays in fulfilling orders, which will contribute to further variability downstream in the supply chain.



- *Increased variability in transportation lead time:* Congested shipping ports and an increase in emergency orders will also lead to greater variability of transportation lead time (and cost, if airlifts continue).
- *Demand will exceed supply:* By the end of 2008 RUTF demand matched Nutriset's capacity to produce. Between May and November, production facilities were operating at 100% of total monthly capacity and this placed a strain on the supply of RUTF. Over the coming two years, worldwide demand for RUTF is expected to grow at a rate of 30% per annum<sup>14</sup>. In order to meet this surge in demand, Nutriset will increase its production capacity for RUTF sachets to 35,000 MT in 2009 and again to 40,000 MT in 2010 and 73,500 MT in 2011. This is only a temporary solution; if growth remains steady at 30% each year, demand will again reach the limits of production capacity by 2014 and further scale-up will be necessary (Figure 23). In addition, if greater demand for RUTF results from its broader use, such as among HIV/AIDS patients, the trajectory of increased demand may be steeper, and demand may exceed capacity sooner than 2014.<sup>15</sup>

Figure 23: Yearly demand will again reach Nutriset's maximum production capacity by 2014



Additionally, if worldwide demand reaches worldwide capacity, competition for RUTF will increase as more players contend for finite quantities of RUTF, creating a situation where some RUTF customers would be willing to pay a premium for the limited RUTF, thereby increasing prices.

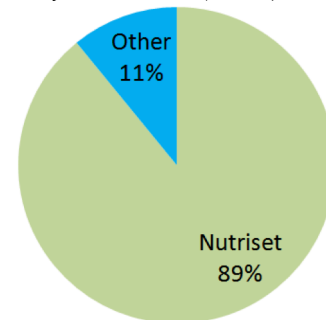
<sup>14</sup> These projected demand data were provided by Nutriset.

<sup>15</sup> This analysis is based on data provided by Nutriset in December 2008. Updated data indicate that capacity constraints will be lessened through further expansions planned by Nutriset.

### One dominant world supplier for RUTF may be an unreliable system

Currently Nutriset produces 89% of all RUTF ordered by UNICEF per year (Figure 24). This proportion will increase in 2009 when Nutriset's new production lines will double its current production capacity. Nutriset has taken a number of precautions to protect the production process including security staff, and the ability to shift staff and equipment to quickly scale production outside of France, including in the United States. However, even with these precautions, there are considerable risks in having a vital product like RUTF produced only by one dominant world supplier. If Nutriset's manufacturing facility were to go off-line for any reason—be it mechanical failure, worker strike, natural disaster, or a host of other reasons—the ramifications could effectively halt the entire RUTF supply chain for all of Nutriset's customers. A single global producer also limits the extent to which the supply chain includes surge capacity: in the face of a complex emergency, Nutriset would be forced to prioritize those orders—thereby stressing their production while also reducing the company's ability to meet needs elsewhere in the world.

*Figure 24: Producers of RUTF ordered by UNICEF (2008)*



### Efforts to expand production capacity may face logistic, legal, and financial challenges

Efforts are ongoing to increase the worldwide production capacity for RUTF. Nutriset has provided license agreements to franchises in several countries, and UNICEF itself is seeking new sources of RUTF. These new manufacturers may face some challenges as they come on line, including a reliance on international sourcing of inputs (which may themselves be increasing in price), the potential role of patent protection on the Plumpy'Nut® product and production process, and logistical difficulties in scaling up production including raising capital funds, procuring equipment, and securing contracts. Some of these difficulties could significantly impact the viability of these new production sites.

- Currently, the Nutriset “Plumpy'Nut® in the field” franchises purchase their vitamin and mineral premix from the Nutriset facility in France, and most import (at minimum) their milk powder. Increasing worldwide demand for dairy has pushed prices upwards in recent years so local manufacturers may face shortages and high prices on these commodities. There may be ways to work around these high prices. For example, there have been reports of local producers in Malawi using donated milk powder—but input ingredient donations may limit the sustainability of a local production facility and it may raise new quality concerns over the finished product. UNICEF may wish to work closely with its network of suppliers to advise them on such matters.
- Nutriset filed for patent protection for the Plumpy'Nut® product and process in several countries. While the true coverage of this intellectual property can be hard to obtain

(especially for developing countries),<sup>16</sup> Nutriset has offered some license agreements to other producers in Africa, except where it has already extended an exclusive license to its local franchisee. Valid Nutrition reports that it has been licensed by Nutriset for production in much of Africa, but not in countries such as Kenya or Ethiopia. Of note, Valid Nutrition has already developed a non-peanut based RUTF product based on chick pea and sesame seed, now used in some programs for AIDS patients, but opted not to patent the product, so that others could produce or sell the product as they might wish.

- Lastly, new producers need significant capital start-up costs for equipment and ingredient sourcing. They also need to feel relatively secure in the future demand scenarios for RUTF to justify their investments, and they need to bid on and qualify for contracts.

### Quality of product needs rigorous oversight

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Compromises in the quality of RUTF might also lead to disruptions in product flow, resulting in supply chain uncertainty. From aflatoxin in peanuts to substandard nutrient levels, RUTF quality is an important concern, particularly as other local manufacturers come on line to produce RUTF. A breach of quality at the manufacturing level could immobilize the entire RUTF supply chain especially at a global supplier like Nutriset. While quality problems at a smaller regional supplier would disrupt product flow, the supply chain would not halt altogether because high-priority regional orders could be re-sourced from other suppliers. The risk of quality problems is not limited to the manufacturing level. Spoilage or damage can happen en route or during storage at regional and local warehouses. These quality compromises disrupt product flow as well as create sunk costs in procurement, global shipping and warehousing, affecting the component cost at each of these steps.

Quality assessments for RUTF are performed at the manufacturing facility, where ingredients and raw materials are tested for contaminants, and finished products are batch tested before shipment. During global transportation, the freight forwarder visually inspects cartons of RUTF for damage. It is critical that transparency in the quality assessment process be created so that all stakeholders in the RUTF supply chain openly and consistently participate in the quality assessment process (for example, by providing feedback on quality-related issues). This will help mitigate any future breaches in RUTF quality.

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<sup>16</sup> Data on intellectual property protection have been shared with UNICEF but not made available to this project, so no analysis was made as to whether patents may be a blockage to future innovation.

## Funding Flow

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The flow of funds is critically important to the functioning of the RUTF supply chain. The timing and reliability of available funding influences strongly the production and distribution schedule of the product, and the magnitude of funding received over the annual cycle sets the budgetary constraint on purchases of RUTF. If funds are not available when needed, the supply chain often works in a reactive mode and introduces inefficiencies and increased costs. A delay in funding means children may experience a delay in treatment, and the same amount of funding will buy fewer sachets of RUTF. An ideal system would ensure that funding is available at the time of need without delay and that funding schedules would be coordinated among donors along with Country Offices.

In 2003, the Good Humanitarian Donorship Initiative laid out 23 principles and good practices of humanitarian donorship (Principles and Good Practice of Humanitarian Donorship, 2003). Several of these are germane to the handling of donor funding:

- 12. Recognising the necessity of dynamic and flexible response to changing needs in humanitarian crises, strive to ensure predictability and flexibility in funding to United Nations agencies, funds, and programmes and to other key humanitarian organizations
- 13. While stressing the importance of transparent and strategic priority-setting and financial planning by implementing organizations, explore the possibility of reducing, or enhancing the flexibility of, earmarking, and of introducing longer-term funding arrangements.

Additionally, in March 2005, ministers, agency heads, and other senior officials from countries around the world came together to create the Paris Declaration on Aid Effectiveness. Most of UNICEF's donor countries have signed on to this accord. The declaration established principles to promote alignment and harmonization of partner countries' initiatives and donor priorities, and to encourage a high level of collaboration among donors. Each of the principles is accompanied by an indicator in order to measure progress in meeting these collaborative goals. The following excerpts from the guidelines are particularly pertinent to this analysis.

**Alignment:** "Provide reliable indicative commitments of aid over a multi-year framework and disburse aid in a timely and predictable fashion according to agreed schedules (Indicator 7)."

**Indicator 7:** "*Aid is more predictable*—Percent of aid disbursements released according to agreed schedules in annual or multi-year frameworks."

**Harmonization:** Donors commit to: "Implement, where feasible, common arrangements at country level for planning, funding (e.g. joint financial arrangements), disbursement, monitoring, evaluating, and reporting to government on donor activities and aid flows. Increased use of programme-based aid modalities can contribute to this effort (Indicator 9)." [...] "Work together to reduce the number of separate, duplicative, missions to the field and diagnostic reviews (Indicator 10); and promote joint training to share lessons learnt and build a community of practice."

**Indicator 9:** “*Use of common arrangements or procedures*—Percent of aid provided as programme-based approaches.”

**Indicator 10:** “*Encourage shared analysis*—Percent of (a) field missions and/or (b) country analytic work, including diagnostic reviews that are joint (Organization for Economic Co-operation and Development [OECD], 2005).”

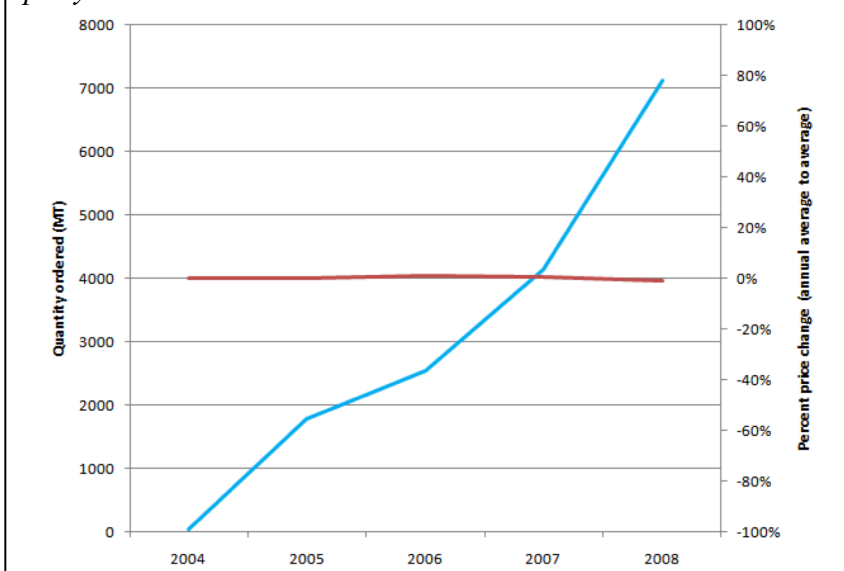
Despite endorsement of these best practices by a wide range of countries, organizations, and bilateral aid donors, the failure to follow through on these principles and good practices is at the heart of the funding flow problems affecting the RUTF supply chain.

The system of funding for RUTF has come under increasing strain as the purchase of this commodity has grown. UNICEF COs ordered \$6 million in RUTF in 2005, rising to \$9 million in 2006, \$16.3 million in 2007, and more than \$36 million in 2008. As the transition to community-based therapeutic care (CTC) using RUTF has lowered implementation costs, it has simultaneously increased the proportion of treatment costs dedicated to the commodity. RUTF accounts for fully 60 to 70 percent of the cost of treatment for SAM under the CTC model (Collins, 2005).

The primary drivers of costs for treatment under CTC may be the cost of inputs for the production of RUTF and the cost of fuel for its transportation. The price of sea freight rose by nearly one-third between 2007 and 2008, following a global trend of increased fuel prices during this period.

Over the last few years, the price that UNICEF has paid for RUTF has remained relatively stable, although one might have expected economies of scale as a result of the dramatic increase in demand for RUTF (Figure 25). This is due partially to UNICEF’s long-term arrangement with Nutriset that sets a price for a two-year period (with a provision that permits the producer to update prices annually). Additionally, increases in raw material costs have placed upward pressure on RUTF prices that counterbalances the downward price pressure one might expect to see as scale increases. Nutriset historically offered pricing discounts based on order quantity, with prices for large orders (over 6000 cartons) running about 4% lower than for small orders (under 500 cartons). Recently, Nutriset modified its pricing structure and offered further

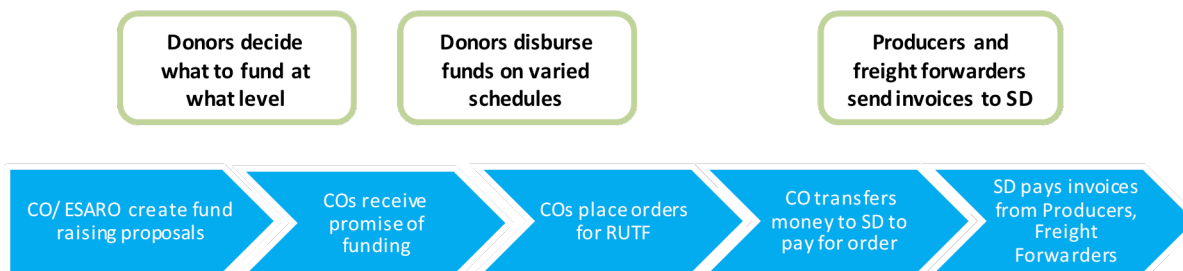
*Figure 25: Price fluctuations (average per-carton price compared to average per-carton price) versus order quantity, per year since 2005*



discounts on orders less than 7500 cartons, with the end result that UNICEF should see a decrease in price of 4-5% for the order volumes it typically places.

Funding flows for the RUTF supply chain can be characterized in one of two categories: procuring capital to pay for RUTF-related expenses (e.g., program implementation), and making payments to vendors (e.g., RUTF producers and freight forwarders) for goods and services. The following figure (Figure 26) describes the general flow of funds for the RUTF supply chain.<sup>17</sup>

*Figure 26: Detailed funding flows in the RUTF supply chain*



*UNICEF activities in blue; partners' inputs in green.*

For UNICEF, the funding process begins with the Country Offices and Regional Offices. These offices work in tandem to produce funding proposals for donors to raise monies for the nutrition program, including funds for the purchase and delivery of RUTF. There are several different types of proposals, including Consolidated Appeals Process (CAP) for ongoing emergencies, Flash Appeals for unexpected emergencies, and concept notes. Other types of proposals may arise depending on country and program need.

Donors examine proposals, assess the needs on the ground, and decide what they will fund and in what amount. A mix of factors influence this funding decision: a) local needs (harvest data, food prices, forecasted demand); b) the potential delivery of RUTF supplied (the capacity of NGO partners to implement the proposed program); and c) the local conditions for successful delivery of product (civil unrest, transportation, warehouse capacity). Once a determination of funding has been made, donors notify the CO of the decision. Funds are disbursed to COs at various times throughout the year, depending on the donors' annual cycle, the availability of funds, and the state of emergency in that country.

Once COs know they have funds lined up, they can submit purchase requisitions for RUTF. When a purchase requisition is submitted, monies are transferred to SD to pay for the product and global transportation costs. When a producer receives an order, it generates an invoice which is submitted to SD. Freight forwarders also submit invoices directly to SD once they have picked up an order for transport. SD pays invoices received from producers and freight forwarders using CO funds. With regard to transportation costs, SD is responsible for payment of global transportation only—from point of production to the point of entry. In most cases, in-country

<sup>17</sup> Despite attempts to gather specific funding information from UNICEF and from donor agencies, little data were made available. This section therefore speaks generally to challenges in the funding flows for nutrition programs and RUTF for UNICEF but does not include firm analyses.



transportation is paid by Ministries of Health and implementing partners, although this is sometimes supplemented by monies from UNICEF.

UNICEF has two major categories of funds: Regular Resources (RR) and Other Resources (OR). RR are UNICEF core funds and are generally a small portion of a program's overall budget, usually allocated to support key staff positions in the field. OR funds are granted to UNICEF through various donor vehicles. OR funds can be designated as emergency funds or as funding for regular program operations. RUTF is mainly purchased with emergency funds, as the majority of donor funding is earmarked for emergency humanitarian interventions.

The funding for the RUTF supply chain in eastern Africa comes from several donor sources: bilateral aid agencies, UNICEF National Committees, multi-donor pooled funds (e.g., the Consolidated Emergency Relief Fund), and Thematic Funds. Each has its own criteria for application, schedule for allocating funds, and methods of payment, which are detailed below.

*Bilateral agencies:* The largest donations to nutrition from this category of donors are received from government agencies such as U.S. Agency for International Development (USAID), the European Commission's Humanitarian Aid Office (ECHO), and the UK Department of International Development (DFID). Some agencies provide both RR and OR resources.<sup>18</sup>

The format of a proposal to a bilateral agency can take many forms. The most common for emergencies is the Consolidated Appeals Process (CAP). A CAP is an integrated appeal for the funding of multiple programs tailored for a specific country or a region. The CAP is produced through a series of planning workshops with key partners in a geographic region. UN agencies and NGOs jointly agree upon common goals and priorities, and formulate a Common Humanitarian Action Plan (CHAP) upon which a CAP proposal is issued in November or December each year. As the lead agency for the Nutrition Cluster, UNICEF generally heads the CHAP process for nutrition.

Most bilaterals promise a set amount of funds against the CAP at the start of their funding year and then adjust allocations quarterly as the situation on the ground changes. USAID and ECHO fund UN agencies on a full or partial reimbursement basis, requiring UNICEF to advance funds to COs for payment by the donor at a later date. CAPs cover ongoing program operations involving longer-term or regularly occurring emergencies. In contrast, Flash Appeals cover unexpected emergencies, and concept notes fill funding shortfalls for programs and supplies in the CAP. Bilaterals can usually respond rapidly to Flash Appeals during a deteriorating situation or sudden crisis on the ground.

Outside of the CAP process, bilateral aid can be allocated on a case-by-case basis. Increasingly donors are using the CAP as a standardized proposal format. This encourages interagency coordination and planning and reduces the workload on implementing agency staff who otherwise would need to create individual proposals for each donor.

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<sup>18</sup> For example, USAID gives an un-earmarked annual donation to UNICEF to support RR funds, as a line item in the U.S. Congressional budget. USAID's Office of Foreign Disaster Assistance (OFDA) donates OR funds to support emergency relief efforts.

The timing of funding allocations depends on various factors. The majority of USAID's funds usually are allocated in October, the start of the U.S. government's fiscal year. USAID also holds some funds in reserve for emergencies, and sometimes receives unexpected allocations from the U.S. government during the fiscal year. This means USAID has an unspecified amount of money beyond its initial promise of funds that it must spend down by the end of the fiscal year. When no urgent crisis beckons, such monies are released on a monthly basis to meet current needs in the field. As the end of the funding cycle approaches, there is likely to be an increase in the use of these reserve funds, particularly for the types of projects that may not have been funded as priorities at the outset, such as prevention efforts.

*UNICEF National Committees:* There are 36 UNICEF National Committees representing industrialized nations from around the world. National Committees play an integral role in fundraising, bringing in about one-third of UNICEF's annual income (UNICEF). The National Committees' boards of directors approve and allocate funds first through their quarterly meetings, and then as needed throughout the year.

Each National Committee is charged with raising funds from private sector individuals, organizations, or companies—both in response to major world crises and for general ongoing emergencies. In line with good donor practices, committee members encourage donors to give un-earmarked funds. When donors have constraints that necessitate earmarking some funds, they are encouraged to contribute to Thematic Funds because these have more flexible uses. National Committees, alongside bilaterals, furnish the majority of donations to these funds.

Proposals from COs are sometimes required for National Committee allocations (in particular, for contributions greater than six figures) and in some cases, donors already have a target country in mind. Headquarters then asks that CO to generate a proposal based on its program needs. In other cases, donors target a programmatic area and seek UNICEF's guidance on where that money would be best directed. Otherwise, donors work together with UNICEF to identify a target country and program. Funding through the National Committees is not exclusively driven by donors, however; COs can also push proposals up to donors when there are funding gaps.

*Pooled Funds:* Pooled funds recruit contributions from multiple agencies, and importantly, provide stability and predictability in the funding for humanitarian agencies. Supporting the procurement of RUTF, there are two major types of pooled funds: the UN Office for the Coordination of Humanitarian Affairs' (UN OCHA's) Consolidated Emergency Relief Fund (CERF) and Emergency Response Funds (ERFs). Bilateral agencies, independent donors, and National Committees can all participate in pooled funds. Each of these funds is used for unique purposes and has different requirements for allocation of funding:

- *Consolidated Emergency Relief Fund (CERF):* CERF allows for the rapid provision of funding for humanitarian crises. CERF provides both grant and loan facilities to UN agencies and their implementing partners. CERF grants support underfunded emergencies and rapid response needs when COs are unable to secure other sources of funding. Loans are given to provide a temporary cash flow to manage emergencies when funds have been promised but are not yet available for immediate disbursement. Loans generally must be repaid within a year. CERF can be applied to a CAP, Flash Appeal, or an Emergency Response Fund (ERF). Eligible organizations can receive funds within 72 hours of a



crisis (UN OCHA). CERF monies are an important funding source for nutrition programs in the Horn of Africa.

- *Emergency Response Funds (ERF)*: ERFs are available to provide program start-up or gap funding primarily for NGOs that cannot access CERF funds. These funds are generally given for short-term projects that were not included in a CAP, but that are in line with CHAP objectives. The applying agency submits a proposal to UN OCHA, and it is reviewed by a board comprised of UN agencies and NGOs (UN OCHA Ethiopia, 2007). ERF also become available for UN agencies when other funding options have been exhausted.

*UNICEF Thematic Funds*: The mechanism of UNICEF Thematic Funds can help stabilize and give greater predictability to the Other Resources contributions to program support (UNICEF, 2008). Thematic funding is organized around five focus areas, one of which is “Young Child Survival and Development.” Though thematic funding increased from 2006 to 2007, the amount earmarked for child survival fell both in absolute and relative terms from US \$15 million (9.2% of total thematic funding in 2006) to US \$13 million (6.2% in 2007). Thematic contributions are made at the country, regional and global levels. At the country level, these funds are consolidated into one pool for the CO to deliver results in a specific focus area. Some thematic funds also are earmarked for humanitarian response.

Thematic funding has several advantages (UNICEF, 2008):

- Since thematic contributions are received for already approved country programs and for the organization’s regional and global targets, UNICEF does not need to prepare proposals for presentation to donors.
- Thematic funding facilitates reporting to donors because UNICEF prepares a single consolidated annual report per focus area. The administrative and financial management rules and processes related to thematic funding represent an important step towards a more coherent planning and implementation process.
- Thematic funding supports the strategic shift UNICEF is making from a project approach to a program approach. It provides longer-term, flexible funding and supports longer-term achievement of the goals and targets of the medium-term strategic plan and related national and international goals.
- Thematic funding also allows UNICEF to strategically fill funding gaps when other funds are not available.

The mechanism of thematic funding holds significant promise as an approach to ensure greater long-term predictability of funding flows for RUTF. Clearly the rationale behind thematic funding recognizes the principles and good practices endorsed by the Good Humanitarian Donorship Initiative and the Paris Declaration. However, in 2007, only 15% of total Other Resources funding came to UNICEF as thematic funding, and in 2008 only 19% of UNICEF’s total humanitarian funds received through Q3 were designated as thematic funds (UNICEF, 2008; UNICEF, 2009).

Of course, only a fraction of these thematic funds is applied towards RUTF. Funds for RUTF can come from the Humanitarian Response Fund or from the Young Child Survival and Development Fund. In the past, thematic funding for RUTF came primarily from the

Humanitarian Response Fund; however changes in 2009 to the focus of the Young Child Survival Fund will direct more funds for RUTF programs.

Mismatches exist in the amount and timing of donor funding and the need for RUTF

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Improving the timeliness and predictability of receipt of funds is critical to delivering program services to SAM populations. By signing on to the Good Humanitarian Donorship principles and to the Paris Declaration, most of UNICEF's donors have acknowledged the importance of cooperation to provide timely and flexible funding. However, implementing the guiding principles can be very difficult for donors given the restrictions they face. Donors have difficulty predicting how much money will be available in a 12-month cycle, as governments may give additional allotments to bilateral aid agencies throughout the year and pooled funds also may receive additional contributions at any time. Additionally, because donors support countries globally, it is impossible to predict what disasters might place more urgent demands on humanitarian aid funds, thereby reducing the pool for countries that are not under the same level of immediate duress.

*Donor funding schedules may not coincide with the timing of need for RUTF*

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Stakeholders in the RUTF supply chain are affected not only by unpredictability in the magnitude of funding, but also by the timing for receipt of funding throughout a 12-month cycle. Both the Kenya and Somalia office staff cited unreliable funding as a major roadblock to efficient planning for the procurement of RUTF. The staggered distribution of funds leads to uneven ordering, causing unwanted variability throughout the supply chain. The availability of funds for RUTF programming and supplies varies each year, and can be very unpredictable as there are several funding mechanisms in place (described above).

Since RUTF orders can be made only when funds are in place at the Country Office, COs are often unable to procure the amount of RUTF that is actually needed. CO staff noted that they routinely base programs and priorities, as well as order quantities, on available funds rather than anticipated need. The impressions of staff about the deleterious effects of unreliable funding is corroborated by the analysis of ordering behaviors, which indicated a dramatic increase in orders for RUTF toward the end of each calendar year. Tight resources and funding restrictions decrease flexibility and hinder COs' ability to serve the needs of the local populations.

Planning is made more difficult by the fact that donors' funding schedules are staggered across the year. While UNICEF has a January to December fiscal year, USAID, for example, works on an October to September funding cycle. CAPs are designed for program planning for January through December, and are released in November or December. When USAID's fiscal year begins, the agency does not have the information needed (completed CAPs) to decide on the allocation of funding. This causes allocations to be delayed by several months, truncating the period of time COs have to spend down the funds before the end of USAID's funding cycle. While UNICEF plans for the calendar year, staff must spend down donor funds by the end of the

corresponding fiscal cycle.<sup>19</sup> While no-cost extensions from donors are commonly acceptable in unstable situations, COs may have concerns that the failure to completely spend down funds on time may suggest to donors either a lack of capacity to use requested funds or a failure to project accurately program needs. Both concerns might shape donor perceptions of future program proposals.

It is clear that the RUTF supply chain would benefit from a more reliable stream of funding. During field interviews, UNICEF staff and partner NGOs suggested multi-year funding would help facilitate planning and ensure smoother operations for RUTF-related programming. As it stands now, UNICEF must renegotiate funding for the purchase of RUTF each year, often at a point in the year when what is demanded and could be delivered exceeds the available funding. As more funds become available at points staggered throughout the year, more RUTF might be procured, but this funding uncertainty has ripple effects throughout the supply chain. NGO implementing partners are greatly impacted by this uncertainty as well; each year as they negotiate funding for program delivery, they have difficulties predicting how much RUTF UNICEF will be able to procure for them. However, multi-year funding by humanitarian donors is rare. Bilateral aid agencies have difficulty doing so because their funding follows 12-month budget cycles.

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*It can be difficult to demonstrate the urgency of need for nutrition programs*

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Complicating the funding picture, nutrition interventions are customarily viewed as non-emergency programming. A country is considered to meet official emergency standards when greater than 15 percent of the population suffers from Global Acute Malnutrition (GAM) (UNICEF Somalia, 2007). At less dire times or on the road to recovery from famine, CO personnel report that it is much more challenging to raise funds for ongoing “low-grade emergencies.” In the absence of an attention-grabbing disaster, it can be difficult to get donors to allocate funding to nutrition supplies, as they are perceived as a preventive approach, not an emergency response.

RUTF is usually purchased with funds allocated for emergency interventions. The 2007 Consolidated Emergency Thematic Reports (CETR) for Kenya and Somalia indicate that Somalia received 109% of its targeted emergency intervention funding for nutrition interventions, whereas Kenya received only 42% of its targeted amount. The seasonal drought, extreme levels of food insecurity and significant political turmoil have led to a nutrition emergency in Somalia that has persisted for several years. The percentage of Somalia’s population with SAM in 2007 surpassed emergency threshold levels. In Kenya a significant portion of the population suffers from malnutrition, but with the exception of the 2007-08 post-election violence, is generally not considered a priority country for most donors.

An “emergency” designation can, however, be detrimental in some funding situations. Although the Somalia CO succeeded in raising funds for emergency nutrition programs in 2007, it reported overarching difficulties in obtaining money; the very emergency that attracts funds can also

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<sup>19</sup> Global data show a spike in RUTF orders in September (Figure 18). These spikes may be related to the closing of USAID (or other donor) fiscal cycles in that same month.

erode donors' confidence in their ability to deliver programs. As a consequence of the high level of insecurity and limited infrastructure, donors express concerns that implementing organizations may not be able to execute planned programming effectively.

A lack of consistent, integrated planning among all major donors and partner organizations limits UNICEF's and its partners' ability to execute programs efficiently.

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Implementing partners have the most pertinent information on the type and schedule of funding that would allow them to execute programs more efficiently and effectively, and give donors greater value for their contributions. Under the current system, these partners exercise little leverage to align donor funding practices with program needs. Their dependence on good relationships with donors encourages acceptance of donor terms that are not always conducive to successful operations. For example, implementing partners are sometimes unable to conduct the kind of long-range planning that might be needed to set up a robust nutrition program (health systems strengthening, construction of food-safe warehouse facilities, or awareness-raising in the community) due to the general perception of RUTF as an emergency commodity and a lack of multi-year funds. In order to foster better dialogue and create innovations that would meet donor requirements as well as the needs of the implementing partners, there needs to be a formal process for open collaboration among multiple agencies and donors.

In the Horn of Africa, bilateral donors such as USAID and ECHO have regional representatives in Nairobi. These agents are usually in regular communication with COs, and USAID reports having strong information exchange with UN organizations and NGOs about the situation on the ground. Additionally, some informal coordination occurs among bilateral agencies in the field. USAID, ECHO and DFID hold quarterly meetings to discuss their budgets and priorities. They generally try to coordinate their response to funding proposals by dividing up funding for sectors or geographic regions as needed; however, there is no official system for doing so, and no consolidated database that tracks which organization has funded which proposal, and at what level.

With regard to interagency cooperation, stakeholders come together to create the CHAP and plan an integrated approach to humanitarian relief in the country or region. This is an effective way to build relationships among implementing organizations and to design a coordinated approach to tackle humanitarian crises. Donors participate in the development of the CHAP, and most have pledged to use the resulting CAP as a proposal against which to grant funding. However, this does not guarantee full funding of the CAP, and shortfalls still exist.

RUTF funding must cover both the commodity and program delivery. With knowledge of the full landed cost, funding forecasts could account for both components. To avoid a mismatch, UNICEF encourages donors to contribute to both commodity supplies and programming costs at the same time. Unfortunately, this is not always the case: UNICEF reported receiving a substantial private donation in 2008 that was earmarked exclusively for the purchase of commodity goods. This donation purchased 600 MT of RUTF, but included no funds to support programmatic delivery. Contributing monies or in-kind services towards RUTF delivery could generate important buy-in. In Kenya, the Ministry of Health supports District Nutrition Officers in their efforts to forecast the need and monitor the supply of RUTF. If performance-based

funding were available for the Ministry of Health to support the delivery of RUTF to districts, that might lend greater ownership and enhance the Ministry's commitment to the program.

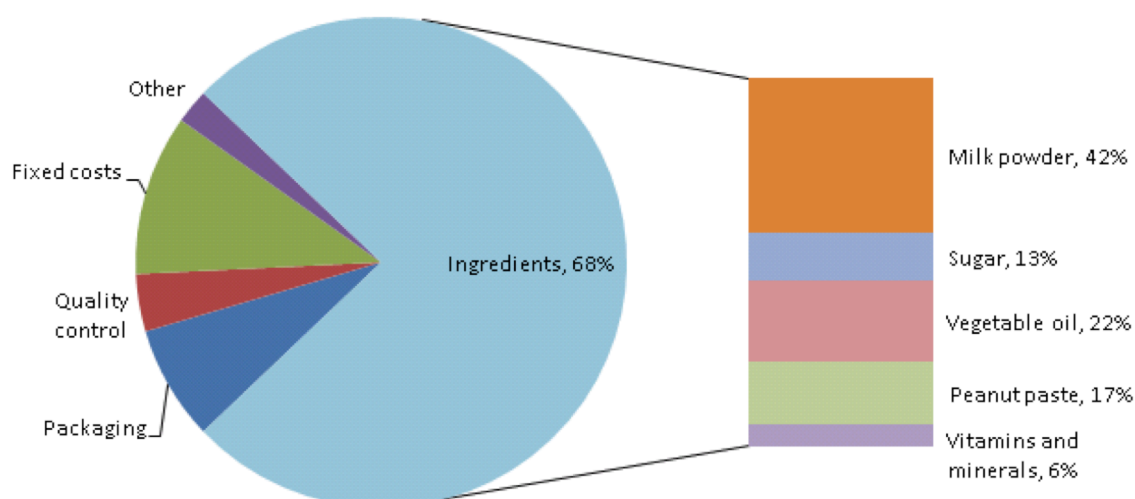
A dedicated donor to support nutrition would help assure a consistent focus on nutrition interventions. Some UNICEF initiatives have a dedicated donor behind them; these include the vitamin A project funded by Canadian SIDA and water and sanitation funds from the Dutch government. Nutrition programs could benefit greatly from this kind of long-term, dedicated support for RUTF and nutrition programming.

RUTF prices could remain stable, despite an increase in demand

### *Input costs are increasing*

Despite an increase in market competition and increase in production capacity, the price of RUTF could remain the same or rise due to an increase in raw material costs. Inputs such as milk powder, minerals and vitamins are also subject to import taxes (reportedly as high as 35%), which further exacerbates this effect (Doyon, 2008). The categorization of RUTF can be important for import taxes; RUTF used for emergencies in Ethiopia, for example, is exempt from import taxes, while "regular programs" must pay approximately 30% in taxes. Changes in component costs directly affect the landed cost of production. Figure 27 shows the breakdown of production costs for RUTF.

*Figure 27: Breakdown of production-related costs for RUTF in Malawi (Jarrett, 2001)*



*Ingredients, particularly milk powder, were strongly influential in the final price of the locally produced RUTF.*

According to data from VALID and the Clinton Foundation in Malawi, RUTF ingredients account for 68% of the cost of RUTF production. Noteworthy is the fact that milk powder currently accounts for 42% of the ingredient cost and 29% of the total cost of RUTF. As the demand for milk products has grown globally, the price of milk has risen accordingly: between 2006 and 2008, milk prices in the United States rose by nearly 50% (University of Wisconsin). This could contribute to an increase in the cost of production for RUTF.

Where RUTF is locally produced in Africa, milk powder and vitamin-mineral packets are generally sourced from overseas and imported. It is possible that individual producers in Africa may pay a higher price for these inputs if their production volume is not large enough to create economies of scale when ordering inputs. This could cause the cost of locally produced RUTF to increase disproportionately to that of other large producers. However, the benefit of the reduced cost of global transportation for RUTF is likely to exceed the increase in per unit costs incurred due to importing ingredients.

*Currency fluctuations impact how much RUTF can be purchased with donor monies*

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When COs submit proposals to donors, funding needs are calculated in U.S. dollars. RUTF procured from Nutriset is billed in euros. As currencies fluctuate, a funded dollar can realize more or less purchasing capacity. If currencies fluctuate significantly over a funding period, this currency exchange risk to UNICEF could be significant. It is possible that funds designated for the purchase of RUTF would no longer be adequate to address the need at the intended scale. This unforeseeable obstacle to program delivery can pose risks to the RUTF supply chain.

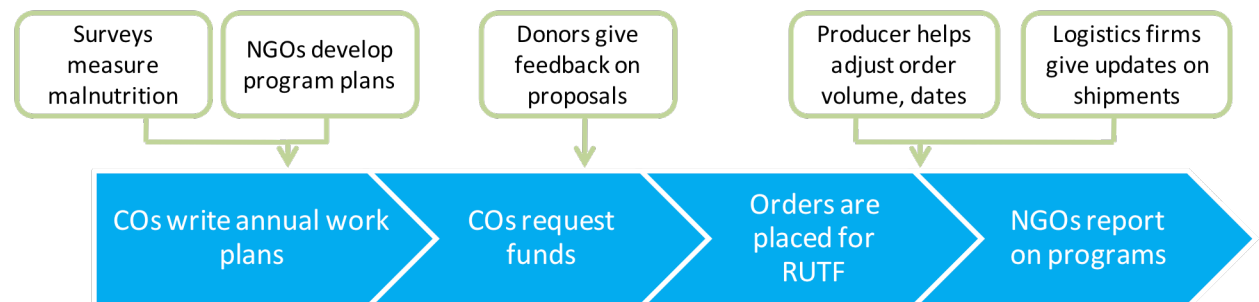


## Information Flow

Information in a supply chain is used to help activities run effectively and efficiently. It helps maintain a good balance between supply and demand, prevents hold-ups and delays in production and distribution, and provides a basis for good planning. Information should provide actionable data to stakeholders in the supply chain—in other words, it should enable them to adjust their activities to improve performance. It should be timely and it should be transparent to ensure accountability. The information should also help partners understand the associated resource costs of supply chain activities and changes.

Supply chains require information to flow between stakeholders in two directions. There are forward information flows, such as projections of need, order processes, and financial information, and backward information flows, including stock monitoring reports, quality information, and performance data. These backward information flows provide feedback to allow adaptation and anticipation in the supply chain. The information flow in the RUTF supply chain is represented in Figure 28.

*Figure 28: Detailed information flows in the RUTF supply chain*



*UNICEF activities in blue; partners' inputs in green.*

There are several systems currently in place to track information in the RUTF supply chain. UNICEF's Supply Division uses SAP, Country Offices use ProMS and warehouses use UniTrack, while K+N uses CEIL and Scan Logistics uses TWM/LWM.

Key Performance Indicators (KPIs) are an important way to assess supply chain performance. There are global-, regional- and country-level KPIs that monitor the RUTF supply chain (Figure 29). These KPIs are used by partners throughout the supply chain to gain a better understanding of what activities are performing well and which need improvement. UNICEF KPIs are complemented by monitoring activities by other partners in the supply chain. For example, the freight forwarding partners provide product damage feedback to UNICEF based on visual inspection of cartons of RUTF. Additionally, RUTF manufacturers are responsible for extensive monitoring activities for quality of ingredients, production processes, and products.



Figure 29: UNICEF's current KPIs for the RUTF supply chain

KPI	Description
Emergency response	Percent of rapid response orders shipped within 48 hours of sales order release
POE delivery performance	Percent of all orders delivered at port of entry at or within agreed upon TAD
Supplier delivery performance	Percent supplier on-time delivery
Freight delivery performance	Percent of orders picked by freight forwarders delivered on-time
Quality and delivery performance	Percent of complaints processed within 25 working days from date complaint was received
In-country transportation time	Days for over-land transportation to other countries in region
Customs release times	Days for custom release procedures
Stock value; Stock aging	Value of stock in warehouse; time spent by stock in warehouse
Stock turnover; Supply value dispatched	Rate at which stock is dispatched to consignees; value of these supplies

Blue cells indicate global KPIs (i.e., those monitored by Supply Division in Copenhagen) while those in light green are local KPIs (used by Country and/or Regional Offices). Although some COs measure and monitor KPIs this is not performed in a standardized manner.

The project identified significant challenges around information flows in the supply chain of RUTF in Kenya and Somalia. These challenges can be grouped into two main categories: those that relate to estimation of potential demand for RUTF and those that relate to the timely transfer of information in the RUTF supply chain.

Uncertainty around demand information can undermine the supply chain<sup>20</sup>

The RUTF supply chain is driven entirely by demand: production begins only when an order is placed, and orders are placed in response to partners' assessment of real requirements on the ground. If demand information is poor—both in terms of data quality and information flow—the supply chain is forced into a reactive mode.

*Differences in forecasts may cause misleading comparisons of need*

Supply chain stakeholders use forecasting information to achieve different goals. COs use nutrition surveys to understand malnutrition scenarios and to develop annual project plans and partnership agreements. Partner NGOs depend on forecasting data to place orders and monitor their progress toward meeting health and humanitarian goals. Information on rates of

<sup>20</sup> It should be noted that the gap between *need* and *demand* for RUTF may exist for a variety of reasons. This section will focus only on the role of forecasting data to decrease the likelihood that these estimates are incorrect. Other factors—including access to funding or the availability of implementing partners—also affect UNICEF's ability to meet demand for RUTF. The closer that UNICEF can come to meeting demand, the more important it becomes to develop strong estimates of demand and to better understand the relationship with need.

malnutrition can also inform capacity planning for RUTF producers, as well as donor funding priorities. Supply chain stakeholders use a variety of approaches to inform their need assessments:

- Implementing NGO: Number of admissions, amount of RUTF consumed, nutrition status
- Ministry of Health: Number of admissions, amount of RUTF consumed
- UNICEF CO and RO: Malnutrition status in country/districts
- UNICEF SD: Historic trends of RUTF consumption
- RUTF producers: Trends in ordering, qualitative projections
- Multilateral groups (e.g., FEWSNET, FSAU): Food security/nutrition status in districts
- Donors: Malnutrition statistics, historic trends of RUTF consumption, weather, other food security trends

Nutrition forecasts—which assess how many severely malnourished children a district or country may treat with RUTF in a certain period of time—can take a number of forms. There are general demographic surveys, like Demographic and Health Surveys (DHS) and the Multiple Indicator Cluster Surveys (MICS), as well as district-level surveys such as Standardized Monitoring and Assessment of Relief and Transitions (SMART) analyses.

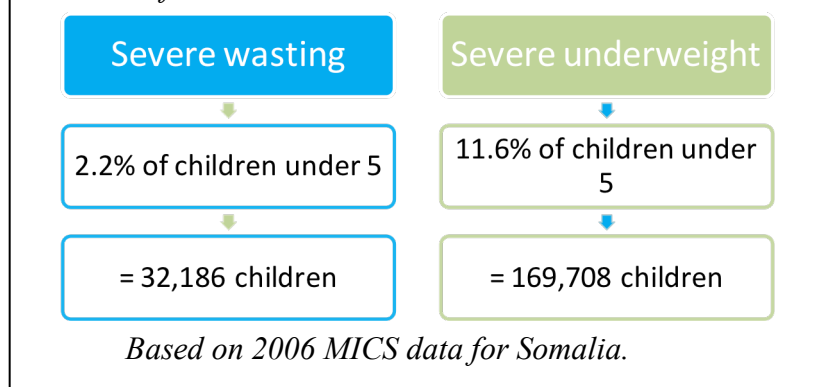
When stakeholders use different methods to assess how many children are severely malnourished, they may develop entirely different estimates of RUTF demand, ordering projections, budget needs, and program coverage. Two of the most commonly used metrics are “wasting” (a weight-for-height measure) and “underweight” (weight-for-age). Depending on which measure is used, surveys can yield very different levels of need (Figure 30). This variance affects partners’ and UNICEF’s planning efforts, in turn impacting fundraising and production processes.

Likewise, national data can miss key distinctions among districts. For example, national-level data show the prevalence of severe wasting in Somalia is 2.2% but district-level severe wasting figures have ranged from 1.0% to 5.8% (UNICEF

2009; Food Security Analysis Unit - Somalia, 2009). Depending on where UNICEF partners are implementing their programs, using national-level data would predict twice, or less than half, as many children in a district who truly require RUTF.

It is also important to consider what the surveys count. For example, the new outpatient therapeutic program protocol does not qualify children less than 6 months of age for treatment with RUTF; instead, infants and young children are treated in a hospital-based setting. Many demographic surveys, including DHS and MICS, count children less than 6 months of age in their nutrition assessments. Using these data to project the number of children with SAM who

*Figure 30: Different survey methods can yield very different numbers of malnourished children*



may need RUTF could result in over-projections. In the 2003 Kenya DHS survey, approximately 5% of those children assessed as severely wasted were under 6 months of age; among all severely wasted children in the Somalia MICS2 survey, 12% were under 6 months (MOH Kenya, 2003; UNICEF, 2009).

Additionally, most nutrition surveys measure prevalence and do not assess incidence. *Incidence* represents the number of new cases over a certain period of time, while *prevalence* represents a cross-sectional snapshot at a point in time. For a condition that recurs or that exists chronically, incidence can therefore yield a much higher value. RUTF should be used for treatment each time a child is severely malnourished so in areas where children may suffer from SAM more than once per year, annual surveys that assess prevalence may especially under-represent true disease impact and, consequentially, need for RUTF. A combination of prevalence and incidence information may be required to most accurately understand how much RUTF may be required in a district. However, this information is often unavailable to partners.

It is clear that some forecasting approaches may consistently overestimate or underestimate actual need. In addition to the implications on ordering of RUTF and expenditures of funds, poor assessment of need can also influence perceived program impact. Program coverage metrics always measure performance against a measure of need: a program served 100 children, which is 10% of the total malnourished population in a district with 100,000 children. A flawed calculation of need as the denominator can therefore affect program coverage measures.

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*The introduction of new international growth reference standards will increase apparent need*

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The limitations of the National Center for Health Statistics (NCHS)/WHO nutrition reference standard—used since the late 1970s—have been widely cited. Most notably, the use of data from mainly bottle-fed infants and children in the United States prevented generalizability to other settings. In 2006, the WHO released a new standard for nutrition assessments based on data from children from several countries (Brazil, Ghana, India, Norway, Oman and the USA), and organizations have been encouraged to use this new growth standard.

Research indicates that the numbers of children with SAM, and the resulting program costs, are estimated to increase considerably as programs begin to use the new standard.

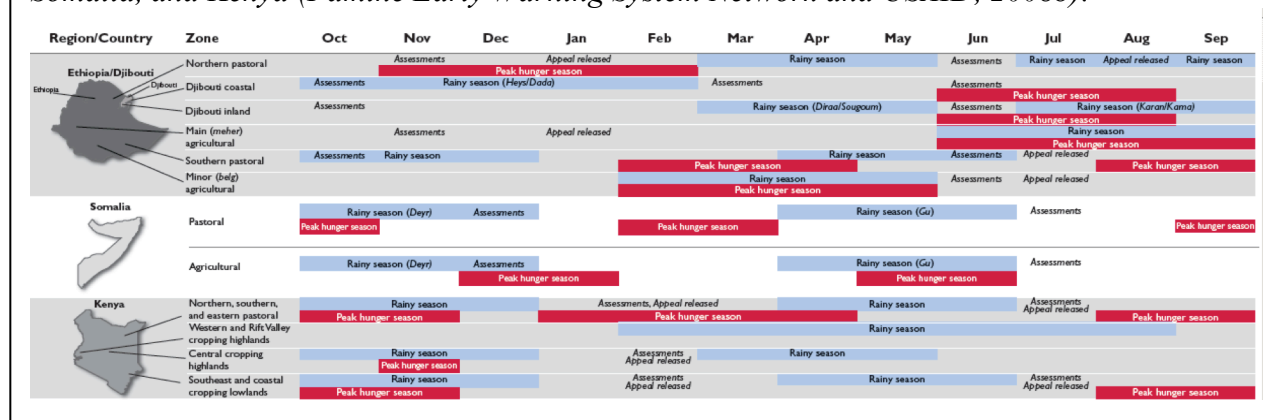
- Studies supported by the Global Nutrition Cluster found that numbers of children with SAM will rise by a factor between 1.5 and 4.2 with the new reference standard, and treatment costs will increase by 97% for SAM programs (WHO, 2008; Seal, n.d.).
- MSF in Niger recently calculated that their program will see eight times as many children classified with SAM under the new standards (Field Exchange, 2008).
- In their most recent nutrition surveys ACF has been using both the old and new reference standards. The 2008 Mandera survey found between 1.0 and 2.0% SAM using the old standard and between 2.3 and 4.7% SAM with the new standard (Andert and Muinde, 2009). The 2007 Garissa survey found 1.0-1.3% SAM with the old standard and 3.8-3.9% SAM with the new standard (Action Against Hunger, MOH Kenya, UNICEF, 2008).
- Researchers recently developed a rough algorithm for estimating new prevalence numbers from figures calculated with the NCHS standard (Yang and de Onis, 2008). Using this method, national-level prevalence of severe wasting would change to around

1.7-1.9% in Kenya with the new standard (depending on whether DHS 2003 or MICS2 data) and approximately 2.9% for Somalia (MICS3 data) with district-level data now reaching 7.2% (Hawd district).

Seasonality is often not captured in forecasts despite its importance in driving malnutrition

Well-documented seasonal changes affect nutritional status in both Kenya and Somalia, including a long peak hunger season between the rains in Kenya from July through November (plus another spike during January through April in the Northern and Eastern areas) and cycling throughout the year in Somalia (see Figure 31) (Famine Early Warning System Network and USAID, 2008b).

*Figure 31: Effects of seasonal weather patterns on projected hunger peaks in Ethiopia, Somalia, and Kenya (Famine Early Warning System Network and USAID, 2008b).*



Seasonal effects are challenging for partner NGOs' efforts to provide RUTF.

- First, order requests for RUTF must be based on actual numbers—often extrapolated from a prior month or prior quarter's admissions to an outpatient feeding program. This makes it extremely challenging for an NGO to order sufficient RUTF to meet the spike in need during the first month of a hunger period.
- Additionally, seasonality can affect trucks' ability to deliver RUTF, particularly to those partners in remote regions where roads may get washed out during severe rains. In areas where rains are seasonal and regular, NGOs can anticipate this likely delay, but they nonetheless have no way of ordering extra RUTF to account for this since their prior month or quarter's admissions do not indicate increased demand.

Both of these seasonal factors have led to stock-outs in RUTF supply for implementing partners.

There are several reasons why seasonal hunger may not be clearly evident in malnutrition data nor RUTF ordering trends. These month-by-month trends may be lost in annual, or even semi-annual, surveys. Additionally because these countries are so geographically diverse, their regions experience different rainy periods and therefore see different seasonal hunger effects—and this would be overlooked in any national-level survey. It is also possible that there are factors that dramatically impact demand for RUTF, such as civil unrest or severe drought, and that these may overwhelm the smaller seasonal changes. It is nonetheless well understood in the region that seasonal hunger is a real concern.

### Information in the supply chain is not shared effectively or efficiently between partners

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The second main challenge involves the collection and transfer of information across the supply chain. An efficient supply chain requires information to flow between stakeholders, informing their decisions and improving performance. There are two barriers to this in the RUTF supply chain. First, current systems that collect information are sometimes stand-alone systems so data is only visible to a subset of stakeholders. Second, backward information flow, including reports on handover and feedback on quality, is either unavailable or nontransparent in the RUTF supply chain.

Stakeholders in the RUTF supply chain use different systems to track information for their scope of responsibility. The systems are often not interoperable and although there is some transparency, all partners may not actively access these data. For example K+N has an online system (Track and Trace) for shipment tracking data, and the K+N office in Nairobi sends weekly reports that are made accessible on a CO's shared drive. Additionally, data from warehouses' UniTrack databases are also posted to the shared drive weekly (for the Kenya and Ethiopia COs). These data are therefore useful for CO staff actively seeking to check on a specific order but may not provide a rapidly and easily understandable view of the data nor a complete view over the supply chain. Cross-referenced data is mostly entered manually. This will evolve soon as UNICEF integrates global logistics data into SAP through the OneERP project; data from Scan Logistics is already being synchronized automatically and K+N information will soon follow. Until such data synchronization occurs, it is impossible to get the very important end-to-end measures for a supply chain because no single system exists for generating or exporting these data.

Additionally, the most meaningful data identifier varies between stakeholders, further increasing the likelihood that translating between systems may cause errors. The COs refer most often to PGMs, while SD works with POs (also maintaining links with PGMs) and K+N has its own reference numbers (though they also track PGMs and POs). The existence of these multiple software data tracking systems hinders transparency and potentially harms data integrity.

The implications of a lack of backward information flow can be considerable. The Kenya and Somalia COs do not regularly receive pertinent information on their RUTF orders, for example when they begin production or are picked up for shipment. While the information system is in place to support this (through the online Track and Trace system, or weekly reports from K+N), there are barriers to widespread data use: staff are very busy and are usually tracking many orders for multiple supplies, and the data may not be maximally user-friendly by lacking linkages with other systems or by providing good dashboard metrics. An indication of such upstream progress could help a CO assess the likelihood of later delays, as well as maintain regular communication with NGO partners on supply chain logistics. Most significantly, when there are delays or exceptions in the process the information is not always relayed efficiently to the COs. Orders for RUTF often experience delays: 45% of amended orders to Kenya, Somalia, and Ethiopia since 2005 were changed to accommodate a later Target Arrival Date. Still, more than 75% of orders are delayed an average of 27 days from the revised date of arrival. Some of the sources of this delay, which are explored in the preceding Product Flow section, may not be

within UNICEF's purview for improvements. However, improved backward information flows could at minimum help UNICEF and its partners mitigate the effects of such delays.

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*Fractured information flow hinders treatment of children with SAM*

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Since orders are triggered in response to a direct need from the field—severely malnourished children who require RUTF for treatment—these delays can have detrimental downstream effects. Interviews with NGO partners revealed that they experience substantial uncertainty around their RUTF orders from UNICEF.

Multiple partners mentioned frustration with the lack of information they receive from UNICEF. In particular, they almost always receive less RUTF than they requested and only find out when trucks arrive—or when the trucks do not arrive and a delivery is missed. One NGO reported it was forced to cancel a district's entire biweekly distribution of RUTF because their order never arrived. When clinics and hospitals face shortages of RUTF, they find that mothers stop coming to seek the sachets. Few agencies will give a family the child's entire treatment course of RUTF, so they depend upon mothers returning to the health center for refills. Partners report that once a mother has traveled and found the stocks of RUTF depleted she may be less inclined to return, and her children may be dropped from treatment.

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*Lack of data visibility and communication make it hard to place accurate orders*

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Likewise, UNICEF is frustrated with the shortage of communication back from the field to COs, ROs, or SD and logistics suppliers. There is little data visibility into inventory below the country-level warehouse, and it was reported that field officers often do not communicate stock and consumption data to CO program officers. When an order is placed by an NGO or a District Nutrition Officer, the UNICEF CO nutrition program office may not know whether there is any stock remaining at the local warehouse unless it specifically requests the information.

A notable exception to this is a new RapidSMS program, implemented by UNICEF in Ethiopia, Uganda, and Malawi to track nutrition program admissions and RUTF stock levels. Though only in pilot stage, the project has shown promising results as an inexpensive way to rapidly collect important data across a wide geographic area. The RapidSMS system allows each feeding site to instantly transmit information to UNICEF on quantities of RUTF received, in stock, and dispensed. This approach is one way to resolve the lack of data transparency between UNICEF offices and partners. It introduces new information flows into the supply chain, thereby improving projections of need, increasing quality of data on program coverage and impact, and facilitating the ordering process.

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*Absence of a complete set of KPIs prevents information transparency and ownership*

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A number of supply chain functions are not currently being tracked through KPIs, including landed cost analyses, components of lead time, details of overall product quality procedures and data (i.e., updated quality information on RUTF production process overall), access to RUTF, and information quality. Without clear KPI benchmarks and regular assessments, it is conceivable that these activities would proceed unchecked and would have the potential to



severely disrupt the supply chain. Sudden increases in landed costs could erode project funds in unexpected ways, as was seen early in 2008 when fuel prices increased dramatically and freight costs for RUTF shipments rose accordingly. Without specifically tracking and monitoring this information, it could be difficult for a stakeholder to adjust its activities in the supply chain—in this example, perhaps raising additional funds from donors to cover the new costs.

A lack of consistent monitoring on production process quality means that, if quality concerns were to halt production or remove batches from the line, there could be an undocumented disruption in production that would affect availability of RUTF. Although UNICEF has very careful quality control guidelines in its agreements with RUTF producers,<sup>21</sup> there is little mandated oversight of the production process beyond the per-order basis. In other words, although product quality is closely monitored for each order, breaches in production quality at a higher level could affect overall product availability and production timelines in such a way that the supply chain would be affected. Likewise, without clearly tracking access data, it may be challenging to ensure that the number of children reportedly treated with RUTF matches the amount of RUTF ordered. The creation of KPIs to assess performance on these additional indicators could promote transparency of information in the supply chain—both through increased data collection on these functions as well as through reporting activities.

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<sup>21</sup> Quality requirements from UNICEF include implementation of Hazard Analysis and Critical Control Point, ISO, and Codex Alimentarius standards, and clear regulations around batch testing and recall procedures.



# 4

## Dynamic Modeling

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### Description and Purpose of Decision Support Tool

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Investigating the structure of the supply chain that UNICEF currently uses to plan, procure, produce and deliver RUTF into the Horn of Africa has revealed a complex network of organizations that must work together to ensure timely, cost-effective delivery of RUTF into countries plagued with severe acute malnutrition. The uncertain and inconsistent availability of donor funding to purchase RUTF further complicates the challenge of managing this complex supply chain. Analyzing the performance of the RUTF supply chain and discussing this analysis with key participants has helped document the challenges that plague the RUTF supply chain and identify several opportunities for reconfiguring the supply chain.

With many potential supply chain configurations to consider, appraising the outcome of changes to the supply chain is a complicated task. Development of a quantitative modeling tool can be critical to both assessing the impact of supply chain configuration options and also convincing important decision makers of the benefit of implementing supply chain changes. The project team developed a dynamic modeling tool that will allow users to test the impact on a wide variety of performance measures of changes to both the underlying data of the RUTF supply chain and the configuration decisions that dictate how RUTF is supplied to treat severe acute malnutrition in the Horn of Africa.

The dynamic modeling tool also can be used as an instructional tool to help participants in the RUTF supply chain better understand how their decisions and capabilities affect the overall performance of the supply chain. Several different organizational entities within UNICEF, multiple RUTF producers, several global and local freight forwarders and transportation companies, and NGO implementing partners all play a role in the RUTF supply chain. As each group focuses on its individual piece, it is easy to lose sight of overall goals. The dynamic modeling tool integrates each aspect of the RUTF supply chain into a unified model. By measuring performance along multiple dimensions, participants can gauge the impact of their actions on the dimension that they perceive to be most critical and on the supply chain as a whole.

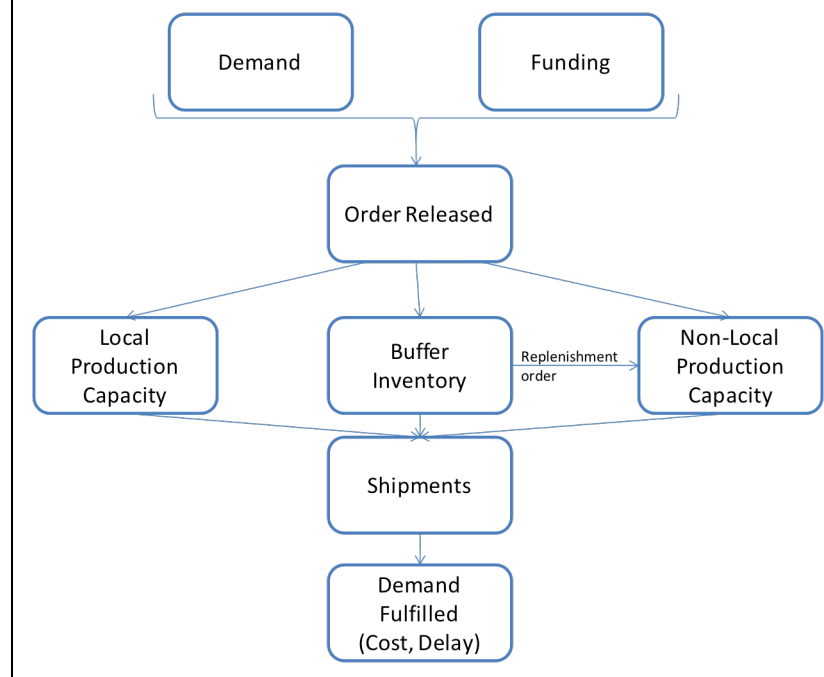
There are many classes of decision support tools. Due to the variety of performance measures that are important to UNICEF, this decision support tool is designed as a “What-If” tool. It will allow the user to gauge performance of a particular supply chain configuration across a variety of different performance measures and see how performance changes as supply chain design changes are considered. Because performance is not determined by a single objective (such as cost), an optimization tool is not appropriate for this study.

Several software programs are available to construct decision support tools. The nature of the software programs range from highly specialized to general purpose. The benefit of a highly specialized program is that it can be selected to meet the specific needs of the decision problem one is facing. Because the highly specialized software is designed for a specific type of problem, the resulting tool is often more visibly consistent with the problem. However, a specialized tool requires additional investment to purchase the software and train users. A general purpose tool, on the other hand, provides the benefit of being accessible to a much broader set of people. For this project, Microsoft Excel was selected as the software to be used for development of the decision support tool. Excel is already used by all members of the project team, and therefore facilitates the sharing of output information from the decision support tool. More importantly, because the tool is developed in software that is already available and understood by a wide audience, the tool is more likely to become a living document that can be used for training and analysis purposes beyond the completion of this project.

Figure 32 depicts a conceptual design of the key elements of the RUTF supply chain decision support tool. The model contains certain elements that do not exist in the current RUTF supply chain, but they are included to enable the analysis of potential changes to the supply chain configuration.

The RUTF supply chain begins with demand occurring in Kenya, Ethiopia, and Somalia. Each country also must secure funding necessary for procuring RUTF. Once demand and funding both exist, RUTF is procured from a local production source, a non-local production source, or a warehouse that maintains pre-positioned inventory. When production capacity or warehouse inventory is available, shipments are made from these sites to the demand location. After the RUTF has arrived in country to satisfy demand, performance measurements of the supply chain regarding various dimensions of cost and delivery time can be made.

*Figure 32: Conceptual design of supply chain decision support tool*



Although this decision support tool was developed to assess performance of the UNICEF RUTF supply chain for the Horn of Africa under different configuration choices, care was taken to design this tool so that it would have broader applicability to the Nutrition Cluster. The basic elements of the model are Demand locations, Warehouse locations, and Production locations. Since these elements are consistent with any supply chain, the decision support tool can be

modified to accommodate supply chains with very different characteristics than those of the RUTF supply chain. In some cases (such as when the numbers of demand, warehouse, and production locations are no greater than those used in this tool), adapting the tool to model a different supply chain is simply a matter of entering the data inputs (see next section) that represent the new supply chain.

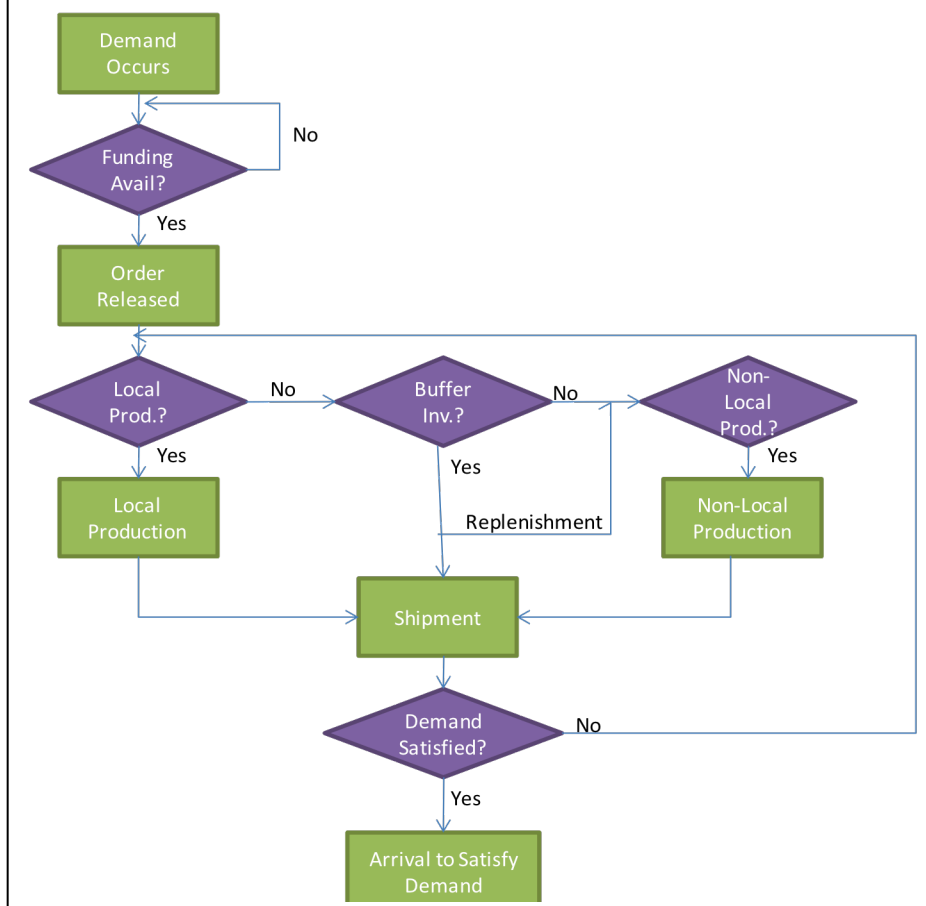
### Data Inputs / Model Outputs

Two key elements of any decision support tool are the data inputs and the model outputs. The data inputs are all the data used to drive the model. Data inputs can be further split into (1) necessary inputs to the model that are unlikely to change as the model is being used to evaluate alternative scenarios,

and (2) items that will be changed in order to assess the impact of these changes on the performance of the supply chain. The model outputs, in this case, are the indications of supply chain performance.

The decision support tool has been designed to assess performance across a variety of factors. Figure 33 provides a detailed flowchart that describes the logic that the decision support tool uses to convert the data inputs into model outputs.

*Figure 33: Flowchart of supply chain decision support tool logic*



The data inputs for this model can be broken down into several key categories, each of which will be described below.

#### *Demand*

Monthly RUTF demand for each of the three demand locations (Kenya, Somalia, Ethiopia) for two years are entered into the model. These data will be distributed into weekly demand buckets based on a specified number of weeks for each month (with the total number of weeks adding to 52). In addition to this base level of demand, it will be possible to enter up to two unforecasted

surges in demand (to represent a sudden famine, or other emergency) for each country. The demand surges are entered as a peak percentage increase in demand, number of weeks to reach peak, length of peak, and number of weeks to come back down from peak. To allow for different treatment protocols across demand locations, the amount of RUTF (in kg) needed to treat each patient is entered for each demand location. This information is used to convert quantities of RUTF into the number of children that could be treated.

### *Funding*

Monthly funding levels at each demand location for each of the two years are entered into the model. This funding should represent the money available for purchasing RUTF and will be split into weekly buckets in the same manner as RUTF demand. Demand will not be converted into an order unless sufficient funding (to cover both purchase price and transportation cost) is available.

If funding data are not available, or one wants to calculate the funding that would be required to support a given supply chain configuration and demand schedule, there is a place in the tool to indicate that unlimited funding should be assumed. The model will then calculate the monthly funding levels needed to pay for the procurement, transportation, and warehousing of RUTF used in the model.

### *Production/Capacity*

Up to seven production sites can be designated in the model. The data for each production site are the week it can begin satisfying demand (assumed to be 1), the total weekly capacity (in MT), the purchase price to UNICEF at that site (in US \$/MT), and the percentage of the site's capacity that is available to satisfy UNICEF demand from the Horn of Africa. This last data element is necessary to control for the fact that the production sites will also be serving non-UNICEF customers (such as NGOs) and will be providing RUTF to UNICEF and others for countries outside the Horn of Africa. As an example, if UNICEF contracted to purchase 40% of a production site's capacity and 20% of the RUTF purchased by UNICEF from this site typically went to the Horn of Africa, this would imply that 8% (20% of the original 40%) of the facility's capacity is available for UNICEF demand in that region.

The first three production sites are assumed to be local production in each of the three demand locations. Due to the rapid response a local production facility can provide, as well as the economic and development benefits of supporting local capacity for production, any demand from a country will be first met by local production (up to the capacity of the local production facility). The next production sites are France (Nutraset) and up to three additional non-local production sites. An additional input into the model is the indication of the decision regarding which non-local production site(s) will be used to satisfy demand that exceeds the capacity at the local production site. The user will indicate both the primary and back-up non-local production site.

After the local production site, demand will first be ordered from the primary non-local production site. Any remaining unsatisfied demand will be ordered from the back-up production site, provided it has sufficient capacity available. If all three options (local, primary non-local,

and backup non-local) don't have sufficient capacity to meet demand, the unsatisfied demand will be carried forward to the following week.

The final set of inputs related to RUTF production allows the model to assess the impact of price changes in up to five raw materials. For each of these raw materials, the percent of the total cost of RUTF (taking into consideration costs of packaging, labor, equipment, etc.) that is comprised by that raw material is entered. A sixth category is used to capture all remaining cost elements. To evaluate the impact of a change in the purchase price of one or more raw materials, the user would enter a new price as a percentage of the baseline price of the material. For example, entering 120% would indicate that the price of the raw material is expected to increase by 20%. The impact of this 20% increase on the overall cost of producing RUTF is calculated (for example, if the material represented 15% of the cost of RUTF, a 20% increase in the cost of that material would increase the cost of RUTF by 3%), and the cost of producing RUTF at each production location is assumed to be increased by the resulting percentage.

### *Warehouse*

Two potential warehouse sites can be included in the model. The cost of maintaining inventory at each warehouse location (measured in US \$/MT/week) and the cost of moving RUTF in and out of the warehouse (measured in US \$/MT) are entered into the model. Because all weights in the dynamic modeling tool are assumed to be net weight of RUTF, the warehouse costs should be appropriately scaled to reflect this assumption. If either of these warehouse sites are used, they will store up to a fixed maximum level of RUTF, and the cost of this initial investment will be displayed as an up-front investment that would need to be made to facilitate holding such a buffer inventory. The model will use at most one warehouse location (i.e., buffer inventory can be stored in either warehouse location, but not both). If the buffer inventory level at both warehouses is set to 0, the model assumes that warehouses with pre-positioned buffer inventory are not being used, and consequently all demand is being met directly from the production locations. When a warehouse is being used, demand is fulfilled from the warehouse site, and the warehouse inventory is replenished by non-local production.

Additionally, the option for maintaining local buffer inventory is also available for each of the demand locations. Local buffer inventory is assumed to be maintained only if neither of the warehouse locations are being used. In the presence of local buffer inventories, demand is satisfied first from these buffer inventories, with additional demand (and buffer inventory replenishment) coming first from local production, and finally non-local production as a last resort.

### *Transportation*

A transportation cost (US \$/MT) and time (weeks) will be entered for two alternative transportation modes (assumed to be surface or air) between each production site and warehouse/demand site, and between each warehouse and demand site. Because all weights in the dynamic modeling tool are assumed to be net weight of RUTF, the transportation costs should be appropriately scaled to reflect this assumption. The user will specify whether transportation between any pair of locations will be done via surface or air. The user will also specify whether orders placed during times of demand surge (which are interpreted as emergency

orders) should be sent using air shipment, regardless of the designated transportation mode between each pair of locations.

### *Input Format*

Due to the nature of a spreadsheet modeling tool, decisions must be made regarding the way in which data are entered into the model. Assumptions are made about how data are most likely to be available, and specific formulas must be put in place to translate data from their original state into the form needed by the modeling tool. Given an understanding of this translation, it is generally possible to use the formulas that exist in the model, even if it turns out the underlying data is in a different form than expected.

As an example, consider the section where Production/Capacity data are entered to indicate what percentage of a production facility's output can be utilized to satisfy demand from UNICEF for the Horn of Africa. This information is necessary because RUTF from a given production facility is sold to organizations other than UNICEF and/or utilized in countries outside the Horn of Africa. Because the dynamic modeling tool only considers demand from that region, the tool must account for the fact that the facility's entire production capacity will not be available to satisfy UNICEF demand from Horn of Africa countries. When considering the capacity of a facility, it is natural to consider its entire production capacity (e.g., 500 MT/week), so the tool expects this data to be input, as well as an estimate of what percentage of the facility's capacity is available for UNICEF Horn of Africa demand (e.g., 5%). The product of these two numbers (e.g., 5% of 500 MT/week, which equals 25 MT/week) is used by the model as the capacity at that facility that is available each week to satisfy demand from Kenya, Somalia, and Ethiopia. If, on the other hand, it was known directly that a facility had 10 MT/week available to satisfy demand from Horn of Africa countries, this can easily be accommodated in the dynamic modeling tool by entering any pair of capacity and percentage numbers (e.g., 100 MT/week and 10%, or 20 MT/week and 50%) that result in a product of 10 MT/week. Because the model only uses this final number, it does not matter which pair of numbers are entered to indicate the available capacity.

### *Model Outputs (KPIs)*

Several key performance indicators will be provided as outputs from the model. These outputs will measure the impact of different underlying parameters and supply chain design configurations on the performance of the RUTF supply chain. Specifically, the model outputs are:

**Annual Supply Chain Cost**—The total annual supply chain cost, broken down for each demand location and in aggregate, based on procurement, warehouse, and delivery cost.

**Landed Cost**—The average total landed cost per MT of RUTF, for each country and in aggregate.

**Buffer Inventory**—The investment needed to create the buffer inventory at any warehouse or demand location.

**Average Delay (Delivery Time): RUTF**—The average delay measured in weeks, from time of demand until time of delivery at each country's centralized distribution point (Nairobi, Mogadishu, and Addis Ababa), for each country and in aggregate. This measures the responsiveness of the RUTF supply chain.



**Unmet Need: RUTF**—The need for RUTF that the supply chain is not able to meet, measured in MT as the difference between annual demand and annual deliveries.

**Unmet Need: Impact**—The impact of the unmet need on the ability to treat children with severe acute malnutrition. This converts the unmet need for RUTF from MT into number of children for whom the unmet need is depriving treatment.

The large number of performance indicators was deemed necessary due to the wide variety of stakeholders in the RUTF supply chain. Different performance measures are likely to be more important and more meaningful to different constituencies. For example, SD might be most interested in measuring delay as the average weekly delay across all demand locations, whereas a nutrition officer in the Kenya CO would measure delay as the delay in treatment borne by the children they serve.

The first three months are used in the model as a “warm-up” period, which moves the model from its empty starting point at week 1 to an ongoing, steady state. The model outputs will be based on the year running from week 14 through week 65.

In addition to the quantitative performance measures that indicate the absolute performance of any indicated supply chain configuration, the dynamic modeling tool output also indicates the performance of a given configuration relative to the baseline supply chain configuration. The relative performance is indicated as a quantitative change in each of the key performance indicators (current case – baseline case), and a graphical representation of annual supply chain cost and average delay for both the current case and the baseline case.

### Analysis of RUTF Supply Chain Configurations

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Once the dynamic modeling tool has been built and tested, it can be used to investigate the performance of alternative supply chain configurations. The analysis begins with a supply chain configuration that mimics the current RUTF supply chain: forecasted RUTF demand in each of the three demand locations is satisfied by production at the Nutriset facility in France and a local production facility in Ethiopia, and the RUTF is then transported via surface routes (involving transshipment points) from France into the Horn of Africa. The model is used to perform a baseline assessment of the current supply chain along each of the performance measures. Alternative supply chain configurations are analyzed by changing the appropriate data inputs in the decision support tool and measuring the impact on performance (calculated as the change in the model outputs of the new configuration relative to the baseline results). Detailed analysis of several important supply chain configuration options are presented below.

### Pre-Positioned Buffer Inventory

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The current RUTF supply chain operates almost entirely on a build-to-stock basis, with funded demand from the COs triggering the procurement, production, and delivery of RUTF. As discussed earlier, capacity issues at the production site, long physical distances, and multiple transshipment points can all significantly delay the fulfillment of RUTF demand. An alternative is to hold pre-positioned, buffer inventories at a warehouse location closer to the countries where RUTF will be needed. Under this configuration, demand will be satisfied from the warehouse's

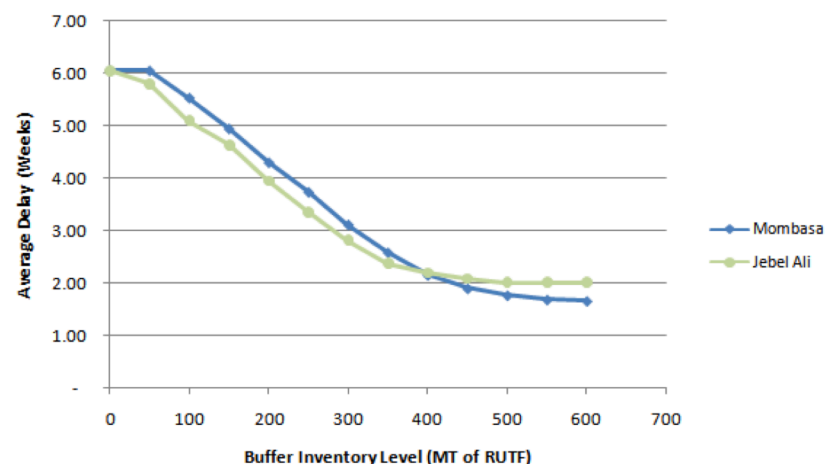


buffer inventory, and the buffer inventory will be replenished by production at a non-local production facility. The hope is that the investment in warehouse buffer inventory will significantly reduce the delays in the current supply chain. Reduction in delays does not come without a price, however, as the buffer inventory at the warehouse location must be originally funded. Beyond this initial funding, the impact on ongoing supply chain costs is not immediately clear, but can be assessed by using the dynamic modeling tool.

To assess the complete impact of using warehouse locations closer to the Horn of Africa to maintain buffer inventories, the tool simulated the performance of the RUTF supply chain with different levels of buffer inventory at each of the two potential warehouse locations: Mombasa and Jebel Ali. The Customs and Excise Act of Kenya restricts to 45 days the length of time product can remain in transit bonded warehouses, which will obviously impact the feasibility of using Mombasa as a long-term storage location for RUTF intended for distribution to other countries. Nevertheless, a warehouse in Mombasa was included in the model to demonstrate the impact of a warehouse in close proximity to the demand locations. A similar benefit could be expected from a warehouse in another location in or near the Horn of Africa, even if it were not Mombasa. Furthermore, the benefits predicted by the model might be used to influence policy of the Kenyan government and secure an exception to the Customs and Excise Act for humanitarian products.

Figure 34 displays the impact of varying levels of buffer inventory on the average delay in the RUTF supply chain, as compared to the baseline. For large quantities of buffer inventory, utilizing a pre-positioning warehouse in Mombasa induces a greater reduction in delay because of its location already in eastern Africa. A Jebel Ali warehouse also provides a significant advantage as compared to the baseline. For low levels of buffer inventory, the efficient, direct transportation lane from Europe to Jebel Ali enables Jebel Ali to outperform Mombasa. Once buffer inventories are sufficiently large that demand is consistently being satisfied directly from a stocked warehouse, the need for a lengthier shipment from Jebel Ali to the demand locations (and customs clearance into all three demand countries) mitigates the benefit to some extent. For both potential warehouse locations, the benefits of pre-positioned inventory stabilize at about 500 MT. For the demand level assumed in the model, investment in additional buffer inventory beyond 500 MT provides little incremental benefit to the RUTF supply chain. The desired level of buffer inventory will change depending on the magnitude of underlying demand in the supply chain that the buffer inventory is designed to support.

*Figure 34: Impact of buffer inventory on average delay in RUTF supply chain*

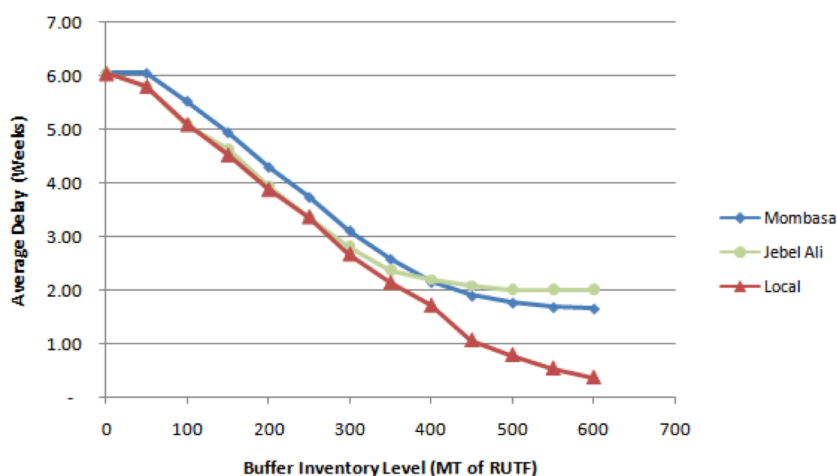


The investment needed to create the buffer inventory is essentially the same at either location. Creating a buffer inventory of 500 MT would require a one-time, up-front investment of approximately \$2,600,000 (\$2.6 M). Alternatively, creating a buffer inventory of 300 MT would require an investment of \$1.6 M, and Figures 34 and 35 indicate that much of the full benefit of a 500 MT buffer inventory could be achieved with only 300 MT. The investment needed to develop a buffer inventory would be a one-time cost; replenishment of the buffer inventory would be funded with the normal money used by the CO to purchase RUTF. Although the model focuses on the impact on the RUTF supply chain within a given year, the benefits of maintaining the buffer inventory would continue year after year (with no additional investment).

An additional consideration for pre-positioned buffer inventories is the added risk that RUTF could be wasted because the time the product spends in the buffer inventory delays the use of the product beyond its shelf life. The 24-month shelf life of RUTF mitigates the risk of product spoilage, but estimating the time RUTF will spend at the warehouse is important. Assuming proper stock rotation procedures (first-expiry-first-out) are followed, the time a typical carton of RUTF spends in the warehouse can be estimated based on the expected monthly demand for RUTF. For the full supply chain benefit that is experienced by a buffer inventory of 500 metric tons, the average carton of RUTF will spend less than two months in the warehouse. For a buffer inventory of 300 metric tons, RUTF will spend slightly more than one month in the warehouse. Either of these storage times account for less than 10% of the product's shelf life.

Another option is to hold buffer inventory locally in each of the three demand locations, rather than one centralized location for the entire Horn of Africa. Given the levels of demand in each location, and considering the local RUTF production in Ethiopia, assigning 10% of buffer inventory to Kenya, 45% to Somalia, and 45% to Ethiopia would be the most efficacious allocation of buffer inventory at the local level. Because most of the cost of establishing a buffer inventory is driven by the purchase price of RUTF, the investment required to fund local buffer inventories is essentially the same as that necessary for a combined buffer inventory of the same total size. Figure 35 compares the impact on average delay of distributed, local buffer inventories as compared to the pooled buffer inventory in either Mombasa or Jebel Ali. For total buffer inventory levels up to 250 MT, the performance of the local buffer inventories is quite similar to that of a

*Figure 35: Impact of local buffer inventory on average delay in RUTF supply chain*



pooled buffer inventory in Jebel Ali. As the buffer inventory level continues to increase, the local buffer inventory reduces the average delay by about one week as compared to Jebel Ali due to the reduced time needed for transportation and customs clearance.

Although local buffer inventories provide some advantages over a pooled resource, at least at high levels of total buffer inventory, there are also some important drawbacks. A distributed, local buffer inventory is consumed only by local demand, and therefore has a much greater chance of product exceeding its expiration date if demand in a single country is lower than anticipated. Additionally, a buffer inventory that is pooled in a single location for an entire region is able to protect the region from unanticipated surges in demand with a smaller amount of total inventory than a buffer inventory that is maintained independently in each country. Local buffer stocks, by definition, must be maintained in each demand location, thereby increasing the administrative burden associated with maintaining inventory records, procedures, and facilities, as well as exposing the supply chain to additional opportunities for shrinkage and pilferage.

When deciding the location and level of buffer inventories, other factors in addition to the output from the dynamic model must be taken into consideration. The level of funding that UNICEF is able to generate to support the investment in buffer inventories will clearly play a role in the size of the inventory. A buffer inventory is also likely to support demand from countries outside the Horn of Africa, so the location and level of demand from these countries will impact buffer inventory decisions. Legal considerations, such as restrictions in Kenya concerning how long material destined for export can remain in bonded warehouses (a maximum of 45 days), will also factor into the final decision regarding warehouse location. By gathering information regarding transportation times and costs for alternative warehouse locations, such as Djibouti, that might be more conducive to the broader needs of UNICEF, the dynamic model can be used to assess the impact of these alternatives on the performance of the RUTF supply chain in the Horn of Africa.

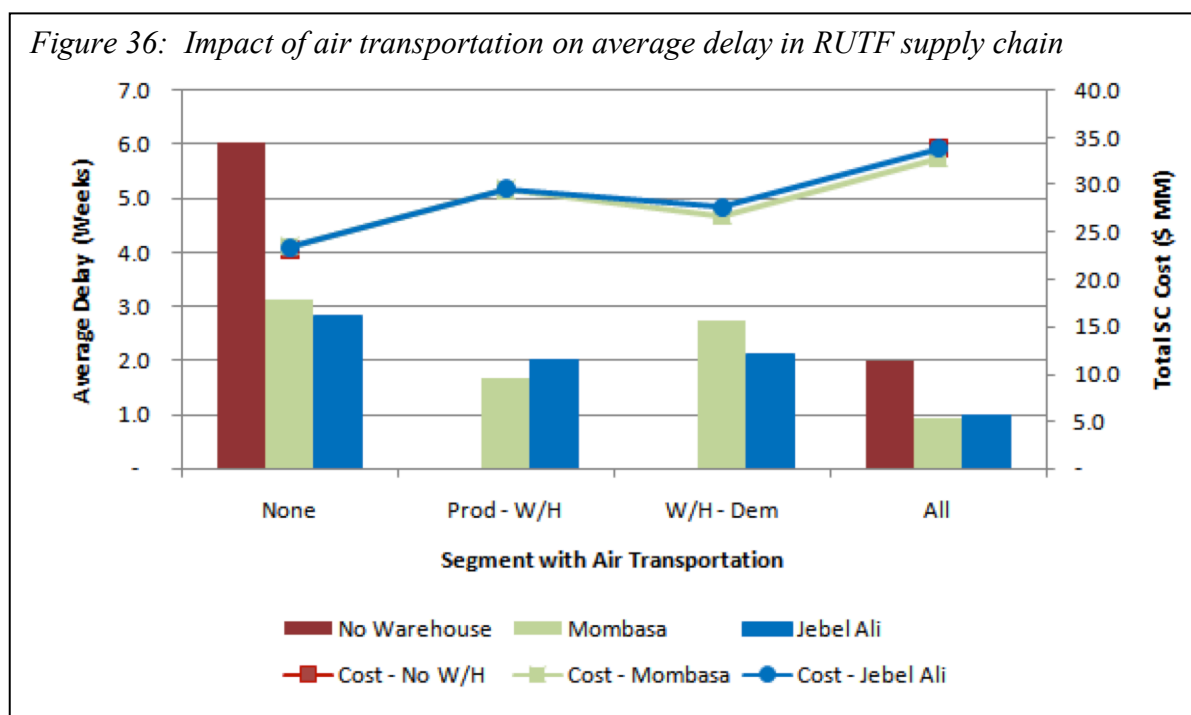
### Alternative Transportation Choices

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Due to the long physical distance that RUTF travels in the current supply chain, choices surrounding the mode of transportation play a significant role in both the time and cost of transporting RUTF. Surface transportation (via a combination of land and sea) is the preferred mode of travel due to significant cost advantages. In times of emergency, however, air transportation is used to rapidly deliver RUTF from the production site into countries that are facing a humanitarian crisis.

Using the model to simulate performance of the supply chain with surface transportation used along all routes, this establishes a baseline level of performance along dimensions of cost and responsiveness. Shifting transportation entirely to air, there is an increase in supply chain cost of 46%, or \$10.7 M per year. Focusing solely on transportation costs (as opposed to the entire supply chain costs of procuring, transporting, and warehousing RUTF), moving from surface to air represents a 14-fold increase in cost. Utilizing the more rapid mode of transportation, however, reduces the average delay in the supply chain from 6.1 weeks to 2.0 weeks, a difference of 4.1 weeks.

When one considers the use of warehouses in the supply chain to store buffer inventories, the option exists to use air transportation from the production site to the warehouse, from the warehouse to the demand location, or both. Figure 36 shows the impact on average delay of each of these three options, assuming that the level of buffer inventory required to achieve most of the benefit (300 MT, see previous section) is maintained at each of the two warehouses, relative to using only surface transportation (labeled “None” in the figure). Using air shipments on the production-warehouse leg (vs. warehouse-demand) has a greater impact on the responsiveness of the supply chain for the Mombasa warehouse, but has an equivalent impact for the Jebel Ali warehouse. For either warehouse location, using air shipments for the production-warehouse leg adds about twice as much cost to the supply chain as using air shipments for the warehouse-demand leg. When air shipments are used on both legs, the responsiveness of the supply chain is reduced from 6.1 weeks in the baseline (no buffer inventory, surface shipments) to 0.9 weeks when the buffer inventory is maintained in Mombasa and 1.0 weeks when the buffer inventory is



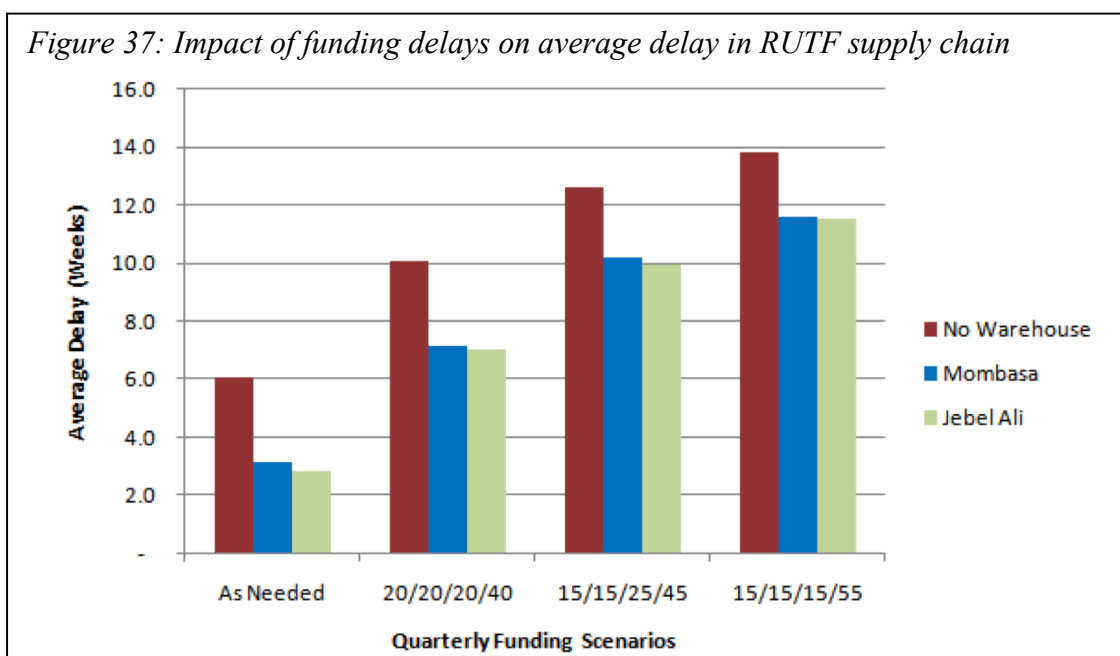
maintained in Jebel Ali. Of this reduction in delay, adding buffer inventory and continuing to use surface shipments accounts for 60% (Mombasa) and 65% (Jebel Ali) of the maximum reduction in delay caused by buffer inventory and air shipments, and the percentages are even larger for a 500 MT buffer inventory. The one-time investment needed to create a 300 MT buffer inventory is also just a fraction of the cost needed for air shipments (17% for Mombasa, 15% for Jebel Ali), and one must remember that the air shipment cost will be an expense that is borne each and every year.

### Availability of Funds

A major factor that impacts the performance of the RUTF supply chain is the availability of funds to purchase RUTF within each CO. Even if RUTF is needed to treat children with severe acute malnutrition (demand), an order will not be released in the supply chain unless necessary

funding is available. A mismatch frequently exists between the availability of funding and the request for RUTF, resulting in significant additional delays from the time the need for RUTF is identified and the time RUTF is delivered in country.

The baseline case examined in this section assumes that funding is always available so that orders can be released to the supply chain at the same time demand is recognized. If the annual budget needed to procure RUTF is not available evenly throughout the year, and is instead backloaded in the third and fourth quarter, significant delays will occur. Figure 37 displays the impact of funding disruptions on the responsiveness of the RUTF supply chain. Different funding scenarios, represented as the percent of annual funding available in each quarter (i.e., 25/25/25/25 represents even distribution of funding across each quarter) are modeled to show their impact on the average delay experienced by the supply chain. This analysis shows that even a moderate slowdown in funding (20/20/20/40) will cause a 66% increase in the length of delays experienced by the supply chain, from 6.1 weeks to 10.1 weeks. A funding schedule that is heavily backloaded (15/15/15/55) will have enormous consequences on the ability of the RUTF supply chain to respond to demand, causing average delays that are 2.3 times the delay experienced in the baseline case.



A delayed funding schedule has little effect on the overall cost of the supply chain. Delayed funding just shifts the production and delivery of RUTF until later in the year, but does not add or remove costs from the supply chain, presuming that the mode of transportation remains the same. If, however, air transportation is used to try to counteract the effects of delayed funding on responsiveness, the cost of operating the supply chain increases. For a moderate delay in funding (20/20/20/40), switching from surface to air transportation will have a disastrous effect on supply chain performance, unless additional funding can be secured to support the air transportation. Without this additional funding, the eagerness to expedite the transport of RUTF will cause the already limited money to be spent on much more expensive air transportation, resulting in even longer delays as funding becomes increasingly scarce and eventually causing a significant percent of the requests for RUTF to remain unfulfilled due to funding shortfalls. Any benefit

from more rapid transportation is outweighed by the decline in RUTF that can be purchased each month due to higher costs.

Even with the addition of buffer inventories at warehouses in Mombasa or Jebel Ali, delays in funding will have serious consequences on the performance of the RUTF supply chain. As seen in Figure 37, a moderate delay in funding (20/20/20/40) will completely erode the supply chain benefits provided by maintaining a buffer inventory of 300 MT. In the case of both Mombasa and Jebel Ali, the moderate delay in funding results in a delay in the delivery of RUTF that is at least 15% greater than the baseline performance before the warehouses were added to the supply chain configuration.

Demonstrating the impact of funding levels on the RUTF supply chain can be a powerful tool to use with potential donors. Showing them the benefit of earlier, more consistent funding on the key performance indicators, not just in dollars and delay, but also in the number of children who can be treated more quickly and treated at all, should help underscore the importance of securing funding as early as possible.

### Demand Surges

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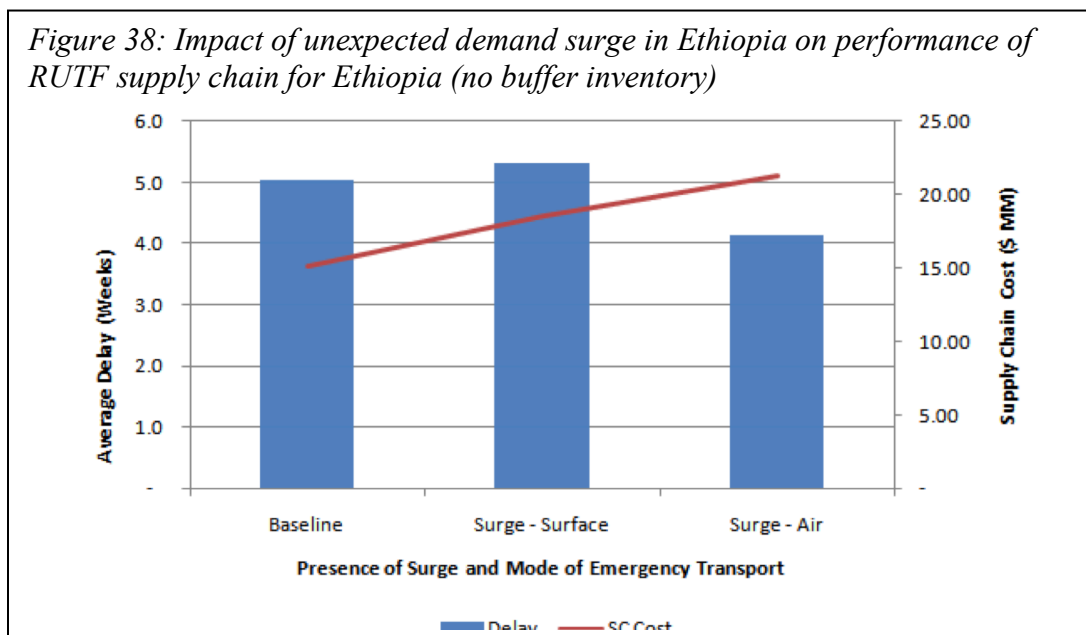
A contributing factor to the challenge in managing the RUTF supply chain is the fact that demand for RUTF is very difficult to predict. Even if treatment protocols were consistent across implementing partners and countries, nutrition crises caused by drought, violence, or other factors can occur rapidly and cause demand for RUTF to increase dramatically. A supply chain that is configured to economically meet steady, stable demand for a product may not be sufficiently responsive to quickly accommodate surges in demand (Fisher, 1997).

The tool can simulate a demand surge within a given country (demand location) by specifying the intensity (percent increase in demand at peak) and duration (weeks to reach peak demand, weeks at peak demand, weeks to return to baseline demand) of the demand surge. Such an increase in demand will cause an increase in cost, as more RUTF must be procured and more rapid transportation modes may be used. Demand surges also may cause a delay in fulfillment if production capacity or funding is insufficient to meet the additional demand.

Figure 38 displays the impact of a surge in demand that affects only one country (Ethiopia), results in demand increasing by 50% over nominal demand, takes 4 weeks to reach peak, remains at peak for 5 weeks, and then takes 4 weeks to return to nominal demand. If surface transportation continues to be used during the nutrition crisis, this surge in demand results in an increase in supply chain cost within the afflicted country (Ethiopia) of 23% and an increase in the average supply chain delay from 5.0 weeks to 5.3 weeks. Because the dynamic model incorporates the significant increase in production capacity that Nutriset is currently implementing, the additional demand from Ethiopia can be accommodated without causing significant congestion at the non-local production site that might also impact lead time performance for countries where demand has not changed (Kenya and Somalia). If air transportation is used to move RUTF from the non-local production site to Ethiopia during the time of crisis, the average supply chain delay for Ethiopia is actually reduced by 0.9 weeks from

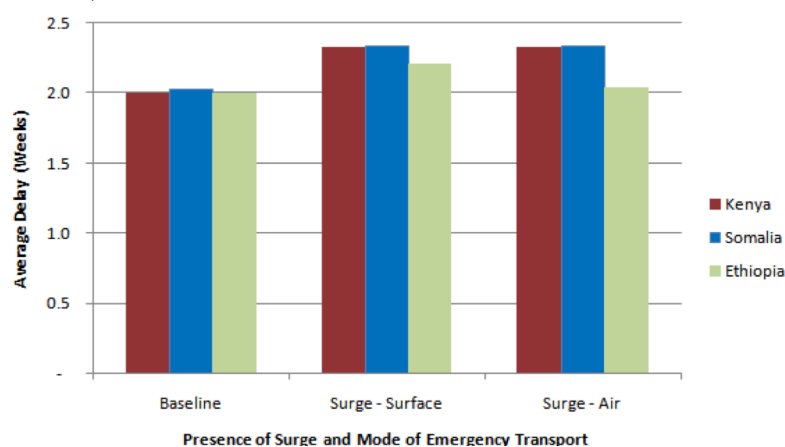


the baseline case, but the cost to the Ethiopia CO has now increased by 40%, representing an additional \$2.7 M above using surface transportation for shipments during this emergency.



Holding buffer inventory closer to the location of a nutrition crisis should allow the supply chain to respond more quickly and cost effectively. Figure 39 shows the impact on supply chain responsiveness of the same surge in demand when a 300 MT buffer inventory is maintained in Jebel Ali. (The results for Mombasa are similar.). As opposed to the case of no buffer inventories, when the emergency causing the demand surge was met with supply chain delays that exceeded 5 weeks, a moderate buffer inventory in Jebel Ali can absorb the surge in demand and still provide response times that average less than 3 weeks for Ethiopia, greatly decreasing the likelihood that expensive air transportation will be needed to appropriately respond to the nutrition emergency. Holding a buffer inventory not only makes the baseline supply chain more responsive, but also equips the supply chain to remain adequately responsive in the face of a nutrition crisis.

*Figure 39: Impact of unexpected demand surge in Ethiopia on average delay in each country (buffer inventory of 300 MT in Jebel Ali)*

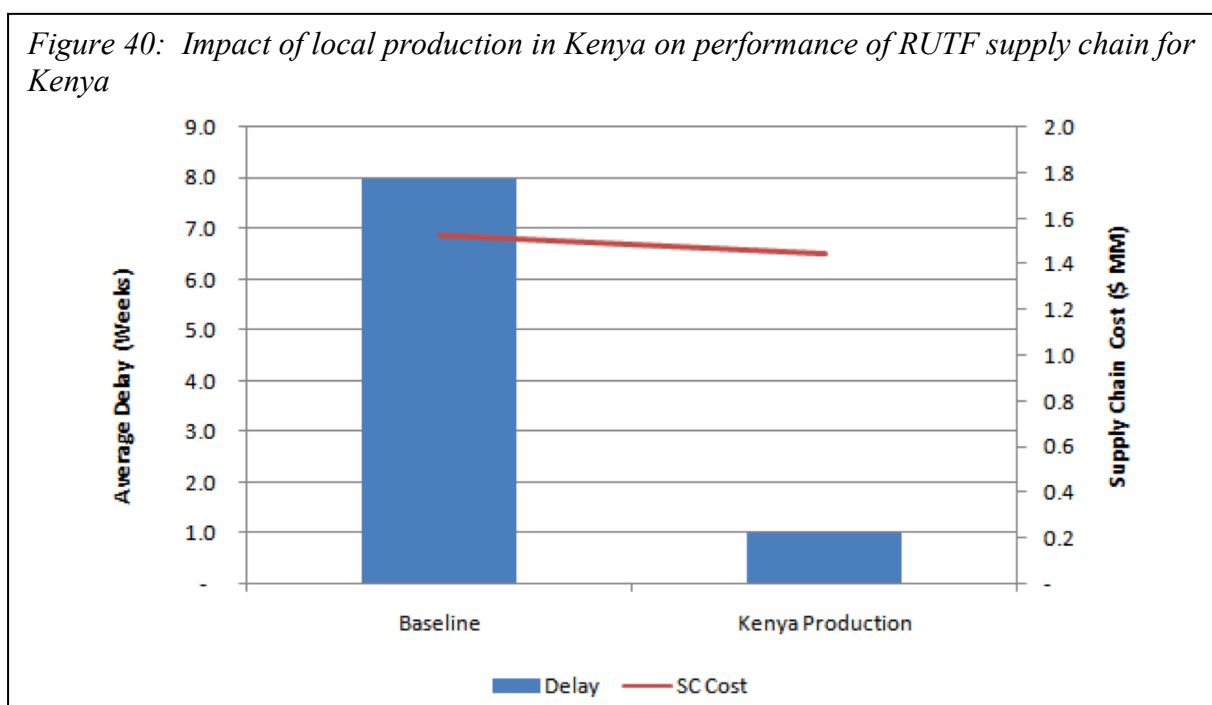




Due to the long transportation times associated with shipping RUTF via surface routes from the primary production source in France to the Horn of Africa, local production capability can provide an opportunity to create a more responsive supply chain. Many challenges, such as locating raw material sources, ensuring product quality, and obtaining necessary approvals must be overcome before a new local production source can be added to the supply chain. The dynamic model tool will allow UNICEF and its supply chain partners to assess the impact that qualifying a local supplier will have on supply chain performance. Since local suppliers will primarily provide products to meet demand within their country, this analysis will likely be especially useful at the Country Office level.

The baseline supply chain model assumes that local production is available in Ethiopia, but not in Kenya or Somalia. Figure 40 displays the impact of adding a local production facility in Kenya (or a country neighboring Kenya that could rapidly satisfy demand from Kenya) with an annual capacity of 3,000 MT. In addition to the capacity of the facility, an assumption must be made regarding how much of the capacity will be available to satisfy demand from UNICEF, recognizing that the production facility will most likely also provide RUTF to other organizations. Given the relatively small UNICEF demand for RUTF in Kenya, however, even 20% of this facility's capacity will be sufficient to meet all Kenya demand from UNICEF.

*Figure 40: Impact of local production in Kenya on performance of RUTF supply chain for Kenya*



Adding this facility to the supply chain will reduce the average supply chain delay for Kenya from 8.0 weeks to 1.0 weeks. Furthermore, supply chain costs for Kenya will be reduced by approximately \$80,000 per year due to savings in transportation costs.

Although adding a local production facility will have a dramatic impact on supply chain performance (especially lead time) for a country like Kenya, which has relatively low demand for RUTF, obtaining similar benefits for countries with higher demand and less production infrastructure will be much more challenging. One alternative for countries like Somalia, for which local production is not a viable option in the near term, is to satisfy RUTF demand from a

facility in a neighboring country. If excess capacity at the modeled production facility in Kenya were available for Somalia, the average delay for Somalia would be reduced from 8 weeks to 2 weeks, and total annual supply chain costs for Somalia would be reduced by approximately \$275,000, again due to lower transportation costs.

### Use of Dynamic Modeling Tool

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Although the dynamic modeling tool was developed to help determine the impact of configuration level decisions on the entire RUTF supply chain for the Horn of Africa, different components of the model provide useful information and analysis to various individual players in the global supply chain.

#### Country Office / Regional Office Level

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Country Offices and Regional Offices are responsible for delivering many of the key inputs into the dynamic modeling tool, but will also find several benefits from the output of the tool. Each CO covered by the model (Kenya, Ethiopia, Somalia) is responsible for providing its monthly demand for RUTF and funding for the purchase of RUTF. Additionally, the CO and/or RO will likely have the best access to data covering the warehouse costs for buffer inventory located within the Horn of Africa, as well as transportation costs from the eastern Africa warehouse location to the demand locations. Appendix 3 outlines some of the key ways in which a CO or RO might utilize the dynamic model tool to support decision-making at that level, including adaptation of the tool for other commodities.

The output from the model is structured such that key performance data pertaining to cost and delay are provided first at the country level, and then aggregated for the entire Horn of Africa. Both COs and ROs will gain insight from the model on the impact of supply chain configuration decisions on the ability of the RUTF supply chain to respond to nutrition needs within their country on a timely and cost effective basis. Furthermore, the impact of funding streams on RUTF supply chain performance can be used by each CO with donors to demonstrate the performance improvement to be gained from a more consistent and timely supply of funds for the purchase of RUTF to treat severe acute malnutrition. The tool is designed to display performance information in a way that is most valuable to supply chain professionals (such as average delivery delay or quantity of unmet need) as well as in a way that will resonate with potential donors (weeks of delay in treatment and number of children who won't receive treatment).

The dynamic modeling tool can also be adapted to address supply chain issues that are faced on a local (CO) level. The three demand locations of the model could be used to represent three different regions within a country, and the production locations could be used to represent different warehouse locations that could support demand for RUTF (or any other product) within each region. By obtaining and inputting the appropriate data on regional demand and transportation options, the model would help assess the impact of using different in-country warehouse locations on supply chain performance within the country.

The buffer inventories in this model, by their nature, are shared resources that will benefit each country within the Horn of Africa, or perhaps an even broader coverage area (especially if a buffer inventory is held in Jebel Ali). The Regional Office is the level at which the aggregate benefits of buffer inventories will be realized, and for this reason may need to be actively involved in seeking the initial funding necessary to support this change in the configuration of the supply chain. The dynamic model will help ESARO paint a compelling picture for the dramatic improvement in supply chain performance that will occur on an ongoing basis in response to the one-time investment in buffer inventory.

### Supply Division Level

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Supply Division will provide data pertaining to the alternative producers of RUTF, as well as the transportation times and costs necessary to move RUTF along any routes from outside to within the Horn of Africa. As managers of the global RUTF supply chain for UNICEF, they also stand to gain the most from using the tool. SD is responsible for implementing many critical supply chain configuration decisions, including negotiating long-term arrangements with production sites, establishing distribution lanes and partners, and implementing buffer inventories that are outside the control of a single CO. The supply chain modeling tool can help guide SD in making these decisions, and can be used as an instructional tool to demonstrate the impact of different supply chain configuration decisions to involved parties throughout the supply chain.

### Global Level

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In addition to organizational entities within UNICEF, the dynamic modeling tool considers and is dependent upon data that originates from other organizations. In particular, production facilities such as Nutriset in France and freight forwarders such as K+N play a vital role in the RUTF supply chain. The dynamic modeling tool allows all the parties that play an important role in the planning, procurement, production, and delivery of RUTF to see how their individual contributions are integrated into a complete supply chain. A change by any one supply chain partner can have ripple effects through the supply chain, and this tool will help each party visualize these impacts.

### Limitations of Dynamic Modeling Tool

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When modeling a complex supply chain, decisions must be made to keep the complexity at a level that can be accommodated by the software in which it is developed and that allows effective use of the model as a decision-making aid. The dynamic modeling tool, as currently developed, has several limitations. First and foremost, the tool is structured to accommodate demand in at most three locations, maintain buffer inventory in at most one (of two possible) locations, and manufacture product in at most seven facilities (of which three are local to the demand locations). The tool would need to be adapted to accommodate more locations for any of the three supply chain stages that it models. The model would also have to be adapted to integrate additional supply chain stages (such as raw material production or in-country distribution).

Outside of demand and funding, most important inputs to the modeling tool (RUTF procurement cost, transportation costs, and lead times, etc.) are assumed to be stable over time. If one wanted to test the impact of fluctuating RUTF prices on supply chain performance, additional complexity would have to be built into the model. In most cases, these inputs were deemed sufficiently difficult to estimate at a constant level that trying to predict the magnitude and timing of changes to these input parameters would be too speculative.

The model was developed to help understand the impact of configuration level decisions on the performance of the RUTF supply chain. As such, the details of RUTF distribution within a country are not incorporated into the model. The tool will help guide the broad supply chain configuration decisions, such as where RUTF should be produced or how it should be transported from production location to demand country, but will not be beneficial for creating detailed distribution plans within a country.

An additional limitation of the model is that it only considers RUTF demand from three countries (Kenya, Somalia, and Ethiopia), which were the focus of this project. In some parts of the supply chain, the performance for these countries is affected by the needs for RUTF from other countries and even by the supply chains of other commodities. The model must make simplifying assumptions to incorporate these interactions into the tool. For example, demand for RUTF from non- Horn of Africa countries may keep a production facility from promptly filling demand from one of the countries (e.g., Kenya) explicitly analyzed with this tool. The assumption that only a portion of a facility's capacity is available to satisfy demand from the Horn of Africa countries is incorporated in the model in order to capture this interaction. Similarly, the human intervention into the detailed management of the supply chain (such as making decisions to divert production from one location to another demand location with a more urgent need) that occurs on an ad-hoc basis can't be effectively incorporated into a model. At best, general guidelines that capture the essence of these tactical decisions can be coded into the model's logic. These assumptions can't possibly incorporate all the richness of the decisions that are made in the actual RUTF supply chain.

Another limitation is that the model only captures one commodity. RUTF is not useful without anthropometric equipment (like scales and measuring boards), feeding kits, vitamin A, and other food products like F75 and F100 milk powder. Beyond RUTF and related materials, humanitarian efforts must also consider supply chains for many other life-saving supplies, including vaccines, mosquito nets, ORS, emergency health kits, diagnostics, anti-retroviral therapies, antimalarials, safe injection devices, emergency shelter, and basic household non-food items (tarpaulins, blankets, cooking sets, etc). In many cases, changes to one supply chain will or should impact the supply chain for other items.

# 5

## Action Plan

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The action plan consists of three parts. The first is a set of Key Performance Indicators (KPIs) that can be used to monitor the performance of the supply chain (landed cost, lead time, quality, and access). The section then lays out recommendations based on the analysis of the RUTF supply chain and describe their context and relevance in the RUTF supply chain. Lastly, the section concludes with a proposed implementation plan that provides guidance on how to operationalize these recommendations. The implementation outline draws on supply chain management best practices to help UNICEF and its partners develop a roadmap to realize these recommendations.

### Key Performance Indicators

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UNICEF should track information on efficiency and effectiveness of the RUTF supply chain in order to measure and improve performance. KPIs help organizations gauge their success toward meeting operational goals. UNICEF currently monitors a few KPIs around the overall performance of their activities as well as for specific supply chains such as ARVs and vaccines. In order to improve performance of this particular supply chain, it is recommended that UNICEF introduce RUTF KPIs on four dimensions: lead time, landed cost, quality, and access.

Monitoring of KPIs can occur at multiple levels. For example, a KPI on lead time should be tracked at each CO but SD should also track the overall data so it can maintain a comprehensive view of the supply chain, including identifying important differences across countries or regions. It is important to note that the success of a KPI is predicated on the availability of reliable data. The descriptions below will note where existing supply chain data might be used (or improved) for analysis. Some KPIs, however, will require new information from partners so UNICEF should take steps to incorporate data reporting requirements into future contracts with relevant supply chain partners. The data currently available on existing KPIs as well as the required information for new KPIs are summarized in Appendix 4.

There are two key considerations in the development and management of KPIs. The first is the importance of the proposed metric. Lead times, for example, can be directly correlated with the cost of the supply chain so the impact might be clear. Although other KPIs might have benefits that are harder to quantify, they can help UNICEF programs check if their goals are being met. The second consideration relates to the frequency of monitoring because not all KPIs can be monitored at the same level of frequency. Those that can help flag problems in the supply chain for which timely and actionable changes might be made should be monitored closely, while others can be monitored less frequently or may require only aggregate measures for tracking purposes.

This section outlines a set of proposed RUTF supply chain KPIs. While it is important that all of these are eventually monitored to gauge overall performance, the project team suggests a subset of critical ones to focus on during the first stage. The second stage of monitoring should involve all KPIs as they provide the necessary details for identifying potential areas for improvement.

The proposed first-stage KPIs are:

- Overall lead time
- TAD delays
- Overall landed cost
- Product regulatory quality
- Customer service response time (*already in use*)
- Forecasting information accuracy (*already in use*)
- Communications on exceptions handling
- Coverage
- Efficacy

These first-stage KPIs were selected because of their relative importance to the successful functioning of a supply chain. This choice is corroborated by results from a recent survey of Kenya, Somalia, Ethiopia, Uganda, and Sudan CO staff. The data indicate that supply and logistics staff in these offices perceive the most important KPIs (for all commodities in those countries) to include overall lead time and performance on order delivery dates. Each of the first-stage KPIs are explained in detail below. The second-stage KPIs are covered in Appendix 4.

### Lead Time Key Performance Indicators

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The project team recommends that lead time KPIs should be split into emergency and non-emergency orders (as in the above Product Flow section on lead time). Emergency orders are prioritized and expedited, resulting in shorter lead times that do not necessarily indicate overall improvements in the supply chain. Separating this KPI into emergency and non-emergency orders will give a more accurate depiction of lead times. Additionally, all lead time KPIs should monitor average time as well as variance.

#### ***Overall Lead Time KPI***

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**Definition:** Overall lead time is an aggregate of four component lead times: production lead time, global transportation lead time, warehousing lead time, and in-country transportation lead time. These component lead times are individual KPIs described later in this section. For emergency orders, overall lead time is the total amount of time (in days) lapsed from when an order for RUTF is placed by a CO until the order is distributed from the UNICEF country or district warehouse to an implementing partner. (Note that non-emergency orders might be planned and sent to the SD in advance. Hence the overall lead time may not accurately reflect the actual time for order processing and production.)

**Purpose:** This KPI will show how long it takes for an order of RUTF to move from the beginning of the supply chain to the end of the supply chain. The purpose of this is to quantify the length of wait that an order experiences from order placement to eventual distribution. In the current RUTF supply chain, lead times are often very long. For example, the overall lead time to



Kenya on average is 78 days (ranging from 44 days to 102 days) for non-emergency orders and 52 days (ranging from 42 days to 62 days) for emergency orders. Long lead times along with high variability in those lead times contribute to difficulties in inventory planning which in turn result in stock-outs, the bullwhip effect, and a general erosion of trust in the delivery system as described in the Product Flow section. Monitoring this KPI on a regular basis will enable UNICEF to incorporate improvements into the supply chain when performance falls below an acceptable threshold. Overall lead time is an important component of RUTF supply chain as it guides order placement decisions as well as highlights areas that cause delay in the eventual distribution. Reduction in overall lead time not only leads to better delivery performance but also indirectly benefits forecasting and planning functions.

*Usage:* This KPI aggregates lead times from each step in the supply chain, so it will involve multiple stakeholders, with SD as a coordinating agent. The RUTF manufacturer manages production lead time, global transporters handle transportation lead time, while local logistics suppliers, as well as COs and distribution partners, influence distribution lead time.

Currently some data for this KPI are already gathered by SD and COs.<sup>22</sup> SD tracks order placement dates, and inputs information from Nutriset and K+N on production and transportation data. These latter data are currently entered manually, so there are sometimes typos or other errors. Once SD begins automated data entry, this may more consistently provide accurate data. There are, however, no formalized data collection methods for in-country distribution dates. As will be discussed in the Recommendations section below, there is no standardized form for monitoring distribution time, and there is little transparency for distribution and local stock level data. Consequently, COs have independently developed ways of collecting and recording these data, but limited local capacity and resources make it difficult to maintain these systems on a reliable and ongoing basis. To mitigate these risks and challenges in data collection, the project team suggests a standardized data collection form to be used by all COs. COs will submit these reports directly to SD, where the data will be aggregated with other supply chain data in SAP.

The project team recommends that Overall Lead Time be monitored on a quarterly basis. This will allow for a sufficient number of orders to be placed between assessments so that meaningful trends can be seen. This should be a first-stage KPI used in the near term. If the overall lead time exhibits significant variation or is too lengthy, component lead time KPIs could then be monitored to ascertain the cause of the problem. Monitoring the overall lead time KPI in conjunction with components will help indicate what supply chain activities can be leveraged for maximally improving performance. For example, transportation time might fall following a change in transshipment port. If this also significantly reduced overall lead time, it might be inferred that changing transshipment ports could improve supply chain efficiency and UNICEF might work with their transportation companies to identify optimal ports of transshipment. However if the overall lead time did not drop significantly, it may be not be the best use of resources to change the port of transshipment.

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<sup>22</sup> At UNICEF Kenya the following KPIs for Logistics are monitored and reported on a monthly or quarterly basis. Goods clearance: Customs release times measured as the time elapsed between date of receipt of cargo documents and date cargo released by customs. (Average figures for air and sea freight are monitored monthly.) Transportation times: Actual transit time versus target transit time (Tracked quarterly). Turnover: Beginning balance divided by dispatches during reporting period, indicating the rate at which supplies are distributed (tracked monthly).



### ***TAD Delays KPI***

**Definition:** This KPI would measure two dimensions of target arrival date (TAD) delays: first, how many orders for RUTF are amended to extend the TAD, as a percentage of all orders amended in that time frame; and second, how the TADs requested by COs compare to true arrival dates for orders of RUTF.

**Purpose:** When COs place orders for RUTF, they indicate a TAD based on when their partners need RUTF. Delays in delivery therefore have a direct impact on the delivery of treatments to severely malnourished children. This KPI would monitor how often global deliveries are delayed as a proxy measure of these downstream effects. As noted in the Product Flow section, a significant number of orders for RUTF were amended in ProMS to extend the TAD (nearly 24% of all orders to Kenya, Somalia, and Ethiopia). This KPI will allow supply chain stakeholders to gain a better understanding of how transportation delays might be impacting program delivery, and therefore what supply chain activities might warrant changes. It also will help COs plan order placements with more realistic delivery estimates. Additionally, if the KPI exceeds a given threshold, it may indicate that the supply chain is not ideally responsive to its CO and implementing partners' needs and that it is operating in a "firefighting" mode.

**Usage:** Original TADs and actual TADs are currently tracked in SAP by SD. Additionally, ProMS amendments are also accessible by SD though they are not regularly monitored. It is recommended that these delays be monitored monthly and reported to the UNICEF supply chain stakeholders (COs and ROs in particular). For the amendments KPI, it is important to note that this measures a proportion against the total set of orders with amendments (not a comparison against the absolute number of orders in that month). This should also be a first-stage KPI to help UNICEF identify subsequent areas that would benefit from supply chain improvements.

This KPI will also indicate the effectiveness of supply chain modifications and the tradeoffs that may be associated with those changes. As an example, if RUTF is procured from a local producer and transportation lead times are reduced but TADs are continually postponed, this may indicate that the new suppliers may be facing challenges around difficulties in scale-up and production prioritization.

<b>KPI</b>	<b>Frequency</b>	<b>Data</b>	<b>Who Monitors</b>
Overall lead time	Quarterly	Data Source: ZSOS, CO Stock Movement Variables: PGM issue date, Dispatch Date	Supply Division; Country Office
TAD Delays	Monthly	Data Source: ZSOS, "Field office format" output for Special Sales Order heading texts	Supply Division; Country Office; Regional Office

### **Landed Cost Key Performance Indicator**

Landed cost refers to the amount of money spent to move RUTF through the supply chain. It is a composite of expenses from procurement, global transportation, warehousing, and in-country distribution. Each activity adds cost, so monitoring across the supply chain is necessary to identify where cost is added as well as the financial impact of delays in the supply chain. The

project team recommends that the overall landed cost KPI be included in the first stage of monitoring.

### ***Overall Landed Cost KPI***

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*Definition:* Overall landed cost is a measure of the cost incurred in the procurement and transportation of a metric ton of RUTF from the producer to the final point of distribution. Thus, it is an aggregate of four component costs: production cost, global transportation cost, in-country transportation cost, and warehousing cost. The KPIs on overall landed cost and its components run parallel to the lead time KPIs.

The project team recommends that the overall landed cost be measured in a common currency (USD). As most of UNICEF's programs are run through donor funds, the overall landed cost metric helps in making more accurate cost estimates. It also helps in highlighting high-cost areas for further improvement.

*Purpose:* The purpose of this is to quantify the costs incurred from order placement to eventual distribution. Monitoring this KPI on a regular basis will enable UNICEF to see the financial impact of improvements in the supply chain through diversification of suppliers, reduction in component lead times, better management of logistics, and better warehouse management practices. An overall landed cost KPI would also help COs and implementing partners make more informed estimates of expected increases in costs due to emergency orders in comparison to non-emergency orders.

*Usage:* This KPI aggregates the costs from each step in the supply chain, so it will involve multiple stakeholders, with SD as a coordinating agent. The RUTF manufacturer manages procurement costs, global transporters handle transportation costs, while local logistics suppliers, as well as COs and distribution partners, influence distribution and warehousing costs.

Currently some data for this KPI are already gathered by SD and COs. For example, data on procurement and global transportation costs are available while data on in-country transportation and warehousing costs would require additional effort. The component costs are explained in each of the individual KPIs below.

The project team recommends that Overall Landed Cost be monitored on a quarterly basis. If the overall landed cost exhibits significant variation or is too high, component cost KPIs could then be monitored to ascertain the cause of the problem. Monitoring the overall landed cost KPI in conjunction with components will help indicate what supply chain activities can be leveraged for maximum impact. As an example, changes in transportation routes might entail additional costs due to different custom and clearance procedures at different ports. In such cases, the extra transportation cost would need to be balanced with the gain in lead time reduction to ascertain if the change is beneficial.

As part of first-stage monitoring, a short term measure on existing data could involve an aggregate of Procurement Costs and Global Transportation Costs as explained in Appendix 4. Procurement cost is a strong driver of total landed cost, so minor changes can have a significant

impact overall. Global transportation costs can point to underlying problems in supply chain efficiency that UNICEF should explore further. Over time, as UNICEF gathers additional data on in-country transportation costs and warehousing costs, these should be incorporated into the overall landed cost measure.

KPI	Frequency	Data	Who Monitors
Overall landed cost	Quarterly	Data Source: Not currently available  Variable: Sum of Procurement Cost and Global Transportation Cost	Supply Division; Country Office

### Quality Key Performance Indicators

There are two categories of Quality KPIs: quality assurance related to the product and quality of information flows. Product quality KPIs help to ensure the efficacy and safety of RUTF. Information quality assesses the accuracy and transparency of data in the supply chain.

The project team recommends that the Product Quality be tracked in the first stage, because any problems with food safety would have strong reverberations on the supply chain and for UNICEF and its partners more generally. Customer Service Response Time is already being tracked at SD so this would easily be included in the first-stage monitoring, as would Forecasting Information Accuracy (which is used currently for supply chains with systematic forecasting, like immunizations and ITNs, so should be expanded soon because coordinated RUTF forecasting began in 2009). It would be helpful to add the Quality of Communications on Exceptions Handling as a first-stage KPI as well, to assess the impact of a recommended supply chain improvement. This KPI also will help prevent bottlenecks in the flow of information through the supply chain and can serve as a check against other KPIs by highlighting problems in planning and delivery.

### ***Product Nutritional Quality and Safety KPI***

*Definition:* The Product Nutritional Quality and Safety KPI would assess progress in meeting regulatory food safety requirements to keep dangerous contaminants out of RUTF. Additionally, RUTF products must meet certain nutritional requirements (as outlined in the 2007 joint statement on Community-Based Management of Severe Acute Malnutrition [WHO, WFP, UNSSCN, UNICEF, 2007] and the inter-agency guidance document on Quality Assurance Standards for Therapeutic Foods).

*Purpose:* Product safety is an important concern for RUTF, as contamination would pose a particularly high risk to the already compromised health status of malnourished children. Contamination of raw ingredients or the finished product could result in severe illness or even death. For this reason, it is imperative that each RUTF manufacturer adhere to food safety standards. High production standards and rigorous testing are the first lines of defense against contamination. Continuous monitoring of product quality is also important to minimize the liability risk to UNICEF and for ensuring that its reputation is not compromised by a lapse in quality. A problem with product contamination could be especially damaging because it may

signal to partners or local communities that there was improper due diligence in sourcing and may indicate that safety is not a priority for UNICEF, betraying hard-won trust.

A recent salmonella crisis that began in a peanut processing facility in the United States caused eight deaths and 19,000 illnesses (Moss, 2009). Major food brands that purchased inputs from the contaminated factory were entirely reliant on the producer to test for toxins and report any problems. State and federal regulatory agencies did not require producers to report contamination at their plants, and the buyers had neither testing procedures of their own nor protocols for the processor to report contamination incidents. Therefore, it went unreported that the producer had faced repeated problems with quality. Similarly the RUTF supply chain relies on producers to conduct quality tests and to discard any tainted product. A reliance on this approach requires trust in the producer, adequate reporting mechanisms, and a potential need for quality checks elsewhere in the value chain. This also may become especially important as additional local producers enter the supply chain.

Additionally, producers are asked to consistently deliver RUTF that meets agreed-upon standards for the nutritional requirements of therapeutic foods (including recommended levels of calories, protein, fat and vitamins), microbiological content and humidity.

It is recommended that a set of product quality KPIs be developed and implemented to provide greater transparency and oversight for UNICEF on the quality process. A detailed study of the current quality assurance processes was beyond the scope of this project, but it is strongly recommended that UNICEF implement quality KPIs because of the very significant role of quality in the RUTF supply chain. There is ongoing and new work by UNICEF's QA department to explore these issues, including the development of supply chain KPIs relevant to product quality.

### ***Information Quality: Customer Service Response Time KPI***

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*Definition:* The Customer Service Response Time KPI measures how many days elapsed from when a complaint about the supply chain was launched to when it was processed. This KPI is already in use by UNICEF and applies to general operations across the organization, including the RUTF supply chain.

*Purpose:* This KPI is already in use by UNICEF to increase quality control and service performance for general operations across the organization. By demonstrating that complaints are taken seriously and handled in a timely fashion, UNICEF can increase stakeholders' confidence in the supply chain.

*Usage:* In the event that a party lodges a complaint, the responding agent should record the number of days that elapse from when a complaint is received to when it is processed. In most cases, the responding agent will be UNICEF's Quality Assurance Office. UNICEF's goal is to process all complaints within 25 days working days. This KPI will measure the percentage of complaints responded to within 25 working days. This KPI should be reported on a quarterly basis. In the event that there is a notable increase in the number of complaints, SD may wish to examine trends to determine what supply chain adjustments might improve performance. If more

than 20% of complaints are not processed within 25 days, SD should investigate the longer times and either reexamine customer service procedures or add staff if appropriate.

### ***Information Quality: Exceptions Handling KPI***

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*Definition:* This KPI has two dimensions: it will measure the speed, in days, with which an exception is communicated to relevant parties, as well as whether or not the information was communicated to all concerned parties (as a dichotomous yes/no).

*Purpose:* The backward flow of information when an order for RUTF has been changed is a constant challenge for the RUTF supply chain. Changes in production or transportation schedules are rarely communicated proactively to all parties affected by the change. Communicating exceptions in a timely fashion would help partners on the ground make better decisions on how to mitigate the impact of delays in supply.

*Usage:* This KPI tracks the percentage of exceptions that are communicated to all affected parties within 24 hours. The party responsible for entering the change should track the date and recipient of the information. Each party should report on this KPI monthly and the information should be shared across the supply chain. This will help partners feel accountable to communicate openly as changes occur. Over time, the results will ideally reach a consistent level (i.e., communications will occur immediately, and all affected parties will be informed) when proper exceptions handling has become a standard practice in the supply chain. Automation of exceptions handling through a centralized system will help to increase performance on this KPI.

### ***Information Quality: Forecasting Information Accuracy KPI***

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*Definition:* This KPI already exists for other UNICEF products that rely heavily on forecasting such as bed nets, vaccines, ARVs and vitamin A, and it should be expanded to include RUTF. It will measure how accurate RUTF demand forecasts were, as a comparison between projected demand and actual order volume.

*Purpose:* It is important to track forecasting accuracy over time as an indicator of how well demand is estimated for the supply chain and where improvements might be most valuable. Forecasting of RUTF has proven challenging, and tracking improvements over time will help UNICEF identify when changes to forecasting methods are working most effectively.

*Usage:* This KPI should be measured by determining the percent error in the annual forecasts from a country. Independent of the forecasting method used, this KPI would compare forecasted need to actual materialized demand as well as forecasted orders versus those actually placed. This KPI should be orchestrated by CO personnel in cooperation with implementing partners, and it should be analyzed and reported annually.

If forecasted and actual numbers do not match, CO staff should discuss this with partners so that UNICEF can gain a better understanding of what improvements to existing forecasting tools and methods might be most efficacious. If these improvements are successful, UNICEF can communicate these practices to other partners and Nutrition Cluster members.

KPI	Frequency	Data	Who Monitors
Product Nutritional Quality and Safety	Not currently available <i>UNICEF is developing a formal process for monitoring product quality.</i>		
Information- Customer Service Response Time	Quarterly	Data location: Manual  Variable: Number of days that pass between complaint receipt date and date complaint is processed; Number of complaints processed within 25 days/ total number of complaints received  <i>Already being collected</i>	UNICEF Quality Assurance Centre (QAC)
Information- Exceptions Handling	Quarterly	Data location: Not currently available  Variable: Number of days that pass between an amendment and communication of the amendment to relevant parties; Number of exceptions communicated within 24 hours/ total number of exceptions  <i>Already being collected</i>	Producer  Freight forwarder  UNICEF SD  UNICEF CO
Information –Forecasting Information Accuracy	Annual	Data location: Not currently available  Variable: Comparison of forecasted need to actual materialized demand to get the % error in annual forecasts for each country  <i>Already being collected for other commodities</i>	UNICEF CO  NGOs/MOH

### Access Key Performance Indicators

Access quantifies both program *coverage* of malnourished children and the *effectiveness* of the treatment. The implementation of these Access KPIs requires a greater mobilization of resources than other proposed indicators. Data on lead time and landed cost are largely already collected by UNICEF, so the implementation of those KPIs requires little more than aggregating, analyzing, and reporting data. The data for these Access KPIs however are not currently monitored in supply chain databases. The necessary data exist, but they must be collected from partners in the field. Effective exchange of information between CTC programs and COs may require additional staff training to ensure that the correct data are being collected and aggregated at each office. Staff may also need training in how to harvest data from CTC databases and how to transfer that data to UNICEF databases. The investment in this training will pay off through more effective monitoring of program effectiveness. It is recommended that the Access KPIs be included in the first stage of monitoring because they help determine if the overarching goal of the supply chain—to meet the needs of severely malnourished children—is being met.

It is also very important to note that these KPIs measure more than just the performance of the RUTF supply chain. The timely, cost-effective, and efficient supply of materials is just one



determinant of program coverage and efficacy. There are a host of programmatic issues that are also highly significant for access performance.

### ***Coverage KPI***

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*Definition:* There are two key areas in the Coverage KPI. First, the KPI measures how many severely malnourished children are served by a nutrition feeding program, as a percentage of the whole. This indicates overall nutrition program coverage for a certain area, and when compared with the second coverage dimension—how many severely malnourished children are actively in treatment with RUTF—indicates whether changes in RUTF demand are based on a fall in need or if other supplementary foods such as RUSF are being substituted for RUTF. On its own the second dimension will provide information on the demand increase of RUTF.

*Purpose:* The Coverage KPI helps UNICEF determine the extent to which nutrition feeding programs are addressing need in a target area. It represents the combined effectiveness of UNICEF program strategy in properly identifying and planning the percentage of overall need to be satisfied by RUTF, harnessing sufficient donor support for the program, and the performance of the supply chain in implementing and executing this strategy. Thus, it acts as an indicator of the effectiveness of the overall program objective. The supply chain exists to serve severely malnourished children, and this KPI will in part help UNICEF determine how well it is serving this primary stakeholder.

*Usage:* These data are currently collected by implementing partners. Country Office staff will need to collect data from the CTC partners and aggregate it into a single data set. Programs generate reports as follows: information from each child receiving RUTF is collected into tally sheets, which are then aggregated into monthly reports. UNICEF will need regular access to these data in order to measure this KPI. Country offices also will need to work with their partners to develop improved estimates of total need for RUTF (total SAM population) that can overcome some of the data shortcomings discussed in the Information Flows section: including national-versus district-level data, excluding children under six months, and capturing seasonal fluctuations.

The Coverage KPI should be monitored by COs in collaboration with implementing partners, and results should be relayed to stakeholders across the entire supply chain. The project team recommends that these KPIs be monitored at least semi-annually, to balance the burden of data collection and analysis against the importance of monitoring supply chain effectiveness on a “real time” basis that allows rapid reactions and adjustments. Additionally, this KPI could be integrated with the earlier Forecasting Information Accuracy quality indicator to develop a systematized program impact review. Together these KPIs could help UNICEF ascertain the effectiveness of its program implementation, through the performance of program coverage and ability to meet need.

It will be important for UNICEF to track performance on this KPI against others: for example, improvements in landed cost may free up funds to purchase more RUTF, which may result in a higher coverage statistic. If the coverage statistic does not increase UNICEF should then investigate the discrepancy; RUTF might be stored in an inaccessible warehouse, for example, or



demand could have grown in proportion to the additional RUTF thereby maintaining the coverage level. Ultimately the Coverage KPI will assist SD and COs in making management decisions regarding how to best cover target areas. This KPI will also provide data for the presentation of program successes, both internally to boost morale and motivate staff, and externally to indicate the impact of invested dollars on treating malnutrition.

### ***Effectiveness KPI***

**Definition:** The Effectiveness KPI looks at readmission and cure rates for CTC programs. Readmission would be calculated as the percentage of children discharged from CTC programs that relapsed and required re-treatment, and cure rates would monitor the percentage of children who were cured and discharged from the program.

**Purpose:** Effectiveness KPIs, when paired with Coverage KPIs, provide a more detailed picture of treatment programs' impact. A nutrition program might have near-complete coverage over a targeted area, but if many of the children are being readmitted, this provides insight on the program's real success. Over time, these might be expanded to also include mortality rates, or impact on health status or disability-adjusted life years (DALYs). This would require additional data collection and analysis, but would significantly enrich UNICEF's understanding of the true impact of RUTF on treating childhood SAM. The Effectiveness KPI will provide an additional metric for the effectiveness of nutrition programs. These data can be used to address problems in programs like a growing trend in relapse rates or low coverage of supplementary feeding programs, and also to identify best practices in successful improvements in the supply chain.

**Usage:** The data needed for the Effectiveness KPI are included in monthly reports generated by CTC programs, including recovery time, discharge rates, discharge reasons, and further treatment requirements. The Effectiveness KPI will be monitored by COs in collaboration with implementing partners. The project team recommends that the Effectiveness KPI be monitored on a semi-annual basis, to balance the benefits of frequent monitoring with the burden of additional reporting requirements.

<b>KPI</b>	<b>Frequency</b>	<b>Data</b>	<b>Who Monitors</b>
Coverage	Semi-annual	CTC Documents CTC Monthly Reports	Supply Division; Country Office; MoH; NGOs
Effectiveness	Semi-annual	CTC Documents CTC Monthly Reports	Supply Division; Country Office; MoH; NGOs

## Recommendations

After conducting a thorough supply chain analysis, the project team recommends the following interventions to help address several of the problems outlined in previous sections of this report. See Figure 41 for a mapping of the supply chain challenges identified in the Analysis section of the report into the recommendations proposed.

*Figure 41: Relationships between challenges, suggested recommendations and KPIs outlined in the Action Plan*

Challenge	Recommendation	KPI
Variable lead time is inefficient and can erode trust	Pre-position buffer stock to decrease lead times and improve delivery of RUTF	Lead time (overall, production, transportation, warehousing, TAD delays); exceptions handling
Extended transportation lead time places further stress downstream in the supply chain		Global transportation lead time; TAD delays
Uneven ordering can cause large increases in global transportation costs		Global transportation cost
One dominant world supplier for RUTF may be an unreliable system	Diversify the supplier base to better serve global needs	Production lead time; procurement cost; TAD delays; regulatory quality; nutritional quality
RUTF prices could remain stable, despite an increase in demand		procurement cost
Mismatches exist in the amount and timing of donor funding and the need for RUTF	Increase collaboration with funding partners and across agencies operating in the Horn of Africa	Forecasting information accuracy; TAD delays; coverage; effectiveness
A lack of consistent, integrated planning among all major donors and partner organizations limits UNICEF's and its partners' ability to execute programs efficiently		
Uncertainty around demand information can undermine the supply chain	Improve data quality for assessments of forecasted need for RUTF	Forecasting information accuracy; coverage
Seasonality is often not captured in forecasts despite its importance in driving malnutrition		
Information in the supply chain is not shared effectively or efficiently between partners	Improve information flow through increased transparency and new information communication mechanisms	Customer service response time; exceptions handling; forecasting information accuracy; wastage; in-country transportation cost; warehousing cost
Absence of a complete set of KPIs prevents information transparency and ownership	Implement the proposed Key Performance Indicators to monitor the supply chain and inform management decisions	

### Pre-position buffer stock to decrease lead times and improve delivery of RUTF

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An investment in the strategic placement of a buffer stock would ease stresses on the supply chain and allow for a more timely treatment of children and effective use of UNICEF's limited resources. Holding buffer stock is a recommended practice when demand forecasts are unreliable, when there may be unexpected changes in demand, when historical data do not accurately reflect future demand, or when production and transportation lead times are long, and as documented in earlier sections, the RUTF supply chain experiences such uncertainties (Simchi-Levi *et al.*, 2003).

A buffer stock could help mitigate the effects of irregular ordering throughout the year by steadying production capacity, provided the initial buffer stock inventory is produced during a low-demand period. The buffer stock would allow producers to have additional production scale-up capacity to meet peaks in demand experienced during the year. It could also help lower landed transportation costs by enabling the choice of more economical modes of transportation while maintaining short and responsive lead times. Buffer stocks also help pool risk in the supply chain: centralized buffer stocks can reduce total inventory by aggregating uncertainty in demand from several locations into one consolidated measure of uncertainty and by postponing delivery until demand materializes at the field level.

In addition, buffer stocks may enable quicker response to emergencies, particularly for the first shipment. Strategic placement of a buffer stock could therefore allow for a smoother flow of product and significant reduction in uncertainty in the supply chain. Lastly, buffer stocks may prove particularly useful in emergency situations where programs must scale-up very rapidly and where supply has been a constraining factor in the past. While UNICEF's first priority is the identification of implementing partners for these settings, it then must quickly locate and procure available stock for distribution. A buffer stock could ease these limitations considerably. The dynamic model tool (as outlined in the Analysis section) clearly demonstrates the time savings of holding a pre-positioned inventory of RUTF. The scenarios modeled show significant gains from buffer stocks, cutting the average delay from 6.1 weeks to 2.8 weeks with a 300 MT buffer stock positioned in Jebel Ali (Dubai).

### *Choosing between centralized or decentralized buffer stocks*

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The decision to centralize or decentralize buffer stock has a powerful impact on the resulting efficiency gains. There are some general guiding principles to assist in this decision. Supply chains with high demand variance see greater benefits from centralized stock. In the case of RUTF, the considerable variation in demand throughout the year implies that centralized stock, possibly at the regional level, might be most effective. There is, however, a reduction in the benefits of centralized stock when several "customers" see simultaneous increases in demand (D. Simchi-Levi *et al.*, 2003). For example, several countries may increase their orders for RUTF at the same time if there is a complex nutrition emergency in the Horn of Africa. This correlated increase in demand would reduce the benefits of centralized buffer stock over decentralized buffer stock, as compared to the case when demand may not increase across neighboring countries (due to localized political instability, for example). Additionally, centralized stock is beneficial when there are likely to be several areas with fluctuations in demand: the assignment

of inventory can be delayed until orders are actually placed, which means unexpected surges in demand can be sourced from unassigned inventory.

A centralized buffer stock held at a regional warehouse would help the supply chain benefit from the risk pooling described above while also decreasing the length and variability of transportation lead times. Regional stock could be held in a number of locations, but ease of transport and delivery might suggest that it be located in either Mombasa or Dubai. Mombasa is already the main port of entry for many shipments to the ESARO region, so those transit routes are already familiar and operations at the port (such as customs and transshipment procedures) are well understood. Regulatory requirements in the Kenyan Customs & Excise Act may constrain the utility of a buffer stock in Mombasa, including a general 45-day limit on stock held in transit bonded warehouses before export, and labeling and packaging requirements that could hinder responsible management protocols. In contrast, Dubai already holds a pre-positioned stock of emergency supplies for UNICEF, so that location offers advantages around experience in buffer stock storage and management. Positioning buffer stock at either of these locations would reduce response time, enabling most countries in the Horn of Africa to receive RUTF from the warehouse within a few days of ordering.

There is also an option to decentralize buffer stock and hold it at the country or district level. Local buffer stocks would enable partners to mitigate the uncertainties that result from current supply chain inefficiencies and may help them deliver nutrition interventions without interruption. Several of UNICEF's implementing partners have expressed enthusiasm for pre-positioning RUTF at the local level, and some have even reported working independently to build a buffer stock, seeking donor funds to purchase directly from Nutriset (sometimes at a significantly higher cost than RUTF purchased by UNICEF).

While pre-positioning RUTF locally may provide greater programmatic stability in the face of current supply chain challenges, local buffer stock may not be the optimal solution for this supply chain. Some areas may end up with a surplus while others may not keep pace with demand. While transshipment between countries has been done, it is not free of complications. For example, the Somalia CO reported lending RUTF to the Sudan CO (transshipping it from Somalia to Sudan) as well as to MSF within Somalia. While this may address urgent needs, repayment may be delayed, which can then impact a CO's ability to purchase its own supplies since they often face cash-flow problems. In addition, variations in local customs authority and regulations when crossing over district or country boundaries, or language-specific package labeling, might limit a product's utility in other settings. These factors can complicate transshipment and render it an unrealistic way to match supply and demand. There is also a risk that, particularly in insecure regions, buffer product could leak from the warehouse onto the market.

It is important to note that there may be advantages to warehousing locations that the dynamic model cannot quantify. For example, by warehousing outside of Africa (such as in Dubai), RUTF could be shipped to demand locations across both Africa and Asia. Although RUTF for the Horn of Africa might be most cost-effectively pre-positioned in Mombasa, it would be a less flexible location for shipments to other parts of the world due to transshipment policies. Additionally, pooling risk works well when not all of the involved countries experience demand

surges at the same time. In a complex humanitarian emergency that impacts multiple countries, such as a natural disaster like drought or flooding, the effectiveness of a single buffer stock serving these countries may be taxed to the limit. To avoid this problem, maintaining a buffer stock for a broader set of demand locations (e.g., not just the Horn of Africa but for all COs in the ESARO region or other African or Asian countries) provides greater assurances of achieving the benefits of risk pooling. The dynamic model indicates that the time savings realized from the use of buffer stock would plateau for Mombasa and Dubai once the inventory size is greater than 500 MT. To protect against the effects of an unexpected demand surge, decentralizing buffer stock to the country level would mean that each country would hold fairly large buffer stock inventories. This may not be a realistic option for the current supply chain.

### *Considerations in operationalizing a buffer stock*

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Creating a buffer stock creates some practical challenges. There are basic management procedures for buffer stock, such as first-expiry, first-out stock rotations (FEFO), that would need to be formalized, especially for a product with a limited shelf life like RUTF. Despite concerns over expired buffer stock, the dynamic model suggests little risk of that happening. The dynamic model shows that a pre-positioned stock of 300 or 500 MT in either Mombasa or Dubai would not have RUTF staying in-stock for longer than two months. There are ways to build a buffer stock to help encourage FEFO systems: stocking pallets from the rear pushes the oldest cartons to the front for easy pick-up.

Additionally, if total demand could not be met by warehouse stocks, protocols to prioritize the available stock to various COs need to be in place. The priority system would have to be transparent to all parties to avoid creating new sources of distrust in the supply chain. Products with language-specific instructions would need to be labeled at the buffer stock location, so that the RUTF could be exported to multiple countries.

A centralized buffer stock serves as a shared resource that can benefit multiple countries, but this may raise questions about who actually “owns” RUTF before it is assigned to a country. This may be mitigated by delegating buffer stock fundraising and procurement to a central authority within UNICEF, such as SD or the Programme Department, or a RO if the buffer stock will only be used by one region. The buffer inventory could be purchased with a one-time allocation of centralized funds, raised by a single UNICEF office. Once the stock is pre-positioned, COs would then place orders to the warehousing facility. These orders would be paid from CO accounts, and ownership over that allotment of RUTF would transfer to the specific CO. As orders are placed and the stock is consumed, new production would be initiated to replenish supply and maintain appropriate buffer stock levels.

An RUTF buffer stock would require a substantial up-front investment. The return on this investment will come over time in cost savings through reduced transportation costs and increased supply chain efficiency, but funds for the initial purchase will require a long-term view of the return on investment. Although some donors earmark their funds for emergencies only, other donors do set aside monies for strategies that are not in response to an acute emergency but can help prevent the worsening of a crisis. A buffer stock might be a clear example of such an activity. Alternatively, UNICEF might choose to leverage its own core funds to build this buffer

stock. No matter who chooses to invest in the buffer stock, UNICEF could use the dynamic modeling tool to develop clear evidence that demonstrates the increased efficiencies afforded by the buffer stock, as well as ultimate improvements in delivering RUTF to those in need. An RUTF supply chain enhanced with a buffer stock will treat more children and generate more impact per dollar than is possible with the existing reactive supply chain.

**Summary Recommendations:**

- Position a 300 MT buffer inventory in Jebel Ali (subject to final validation of location), to be used for satisfying demand in the Horn of Africa.
- Increase the size of the buffer inventory if it will be used for additional countries.
- Investigate alternative centralized buffer stock locations that could reduce transportation costs/times without sacrificing flexibility.

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**Diversify the supplier base to better serve global needs**

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While buffer stock would help mitigate uncertainty in demand in terms of timing and volume, it does not completely correct for uncertainties in the supply process. Single sourcing of RUTF poses significant supply chain risks related to disruptions. Any problem at the manufacturer can have cascading downstream effects on the supply chain. Expanding the supplier base can help mitigate this risk, but it introduces new challenges into the supply chain. Although multi-sourcing can stabilize the supply chain by increasing product availability, it also risks a tradeoff between ease of supply coordination and level of competition (Robinson, 2003). Working with a single producer simplifies coordination, but it does not encourage the competition that can lead to price reductions and innovation. Managing relationships with and coordinating multiple suppliers can become complex and may increase costs. In general, multi-sourcing is recommended when product demand is high enough to justify these increased transaction costs and the reduced economies of scale (such as bulk order discounts) from sole sourcing.

UNICEF has already made significant headway in evaluating new sources from which to procure RUTF. The introduction of new production facilities will directly impact the production and delivery landed cost of RUTF as well as delivery lead time. Additionally, UNICEF should encourage the development and production of new product formulations, which would allow individual demand sites (or COs) to choose a “best of breed” solution customized to their needs and best aligned with their goals. These new products might use less expensive or locally produced inputs, and might expand local production opportunities around inputs that are unique to a specific region.

Local production could be used strategically to advance UNICEF’s goal of building local capacity for emergency response. It could also be used as a tool to provide economic opportunity for communities where UNICEF and its implementing partners work. There is a trade-off, however, between working closely with specific producers to foster local economic development, and encouraging multiple producers to enter the space to foster competition. It will be important for UNICEF to gauge whether it wants to invest in local producers—through up-front capital funds, preferential bid conditions in international tenders, and/or exclusive purchasing contracts—and/or if they want to deliberately widen the supplier base in hopes that competition will bring down prices and foster a wider, more stable supply chain.



In addition to improving the ability of the RUTF supply chain to meet demand, relieving capacity constraints may help to solve other supply chain concerns. The strategic placement of new production facilities could reduce transportation lead times, particularly facilities that are close to high-demand sites. Of course, sometimes the conditions creating surges in the demand for RUTF, such as civil unrest, may similarly affect the sourcing and stability of these local production facilities. Additionally, increased capacity would allow the supply chain to be more proactive (by building up some buffer stock) while simultaneously providing additional surge capacity for production. Nutriset is currently doubling its production capacity for RUTF to ease supply constraints and is expanding the number of licensees eligible to produce RUTF, including through its December 2007 license agreement with Valid Nutrition<sup>23</sup>. But it would still benefit UNICEF to increase the number of suppliers globally in order to gain the benefits that arise from competition. As demonstrated in the Dynamic Model section, the availability of local supply for Kenya would reduce its overall supply chain delay from 8 weeks to only 1 week, and would decrease transportation costs by approximately \$80,000 per year.

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*New management protocols must accompany this expansion in production capacity*

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There will be important management activities to accompany the expanded production base. A multi-supplier arrangement will require COs to allocate their orders to specific producers. When demand exceeds available supply at a given location, some orders may need to be spread across multiple sources, which may include local production facilities, foreign production facilities, or buffer stock sites. Protocols should clarify the processes and party responsible (which UNICEF office) for coordinating procurement across multiple facilities. An instructive example was seen in Ethiopia, which has a local production facility, but which faced immense increases in demand for RUTF in 2008. UNICEF's demand of approximately 28,000 MT far exceeded the 1500 MT annual production capacity for the local producer, so the Ethiopia CO placed orders through SD to Nutriset in France to fill the gap. While this succeeded in providing RUTF to meet Ethiopia's need, it constrained supply for other COs' orders of RUTF and incurred significant air freight costs to meet the surge in demand. It will not be sufficient just to share aggregated annual demand projections. With more sites added to the system, UNICEF will require a refined approach to estimating the level of demand it expects to fulfill from each individual production site. When such estimates are provided, the suppliers would become more comfortable in undertaking investments for capacity expansion.

As UNICEF brings new suppliers into the network, it should dedicate resources to putting in place a strong supply chain governance structure. UNICEF should take primary responsibility in coordinating suppliers and holding them accountable for consistent service and quality levels. Coordination and buy-in from other major RUTF procurement agencies would also be important. As the number of suppliers increases, the risk of product contamination or compromised nutritional quality also increases. When working with several suppliers, it becomes more risky to distribute responsibility for quality and service monitoring. To ensure accountability and high levels of quality control, UNICEF should increase the number of product inspections it performs and closely track the service levels of RUTF suppliers. Proposed Key Performance Indicators

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<sup>23</sup> Valid Nutrition. (2008). "Supporter Newsletter." Available online at: [http://validnutrition.org/index.php?option=com\\_docman&task=doc\\_download&gid=22&Itemid](http://validnutrition.org/index.php?option=com_docman&task=doc_download&gid=22&Itemid)



can facilitate this increased attention to supply chain governance (see the Key Performance Indicator section below).

**Summary Recommendations:**

- Seek to qualify Kenya production facility to satisfy demand in Kenya (and possibly nearby countries).
- Seek to qualify additional non-local production facility to enhance flexibility of worldwide RUTF supply chain.

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**Increase collaboration with funding partners and across agencies operating in the Horn of Africa**

Orders for RUTF in eastern Africa fluctuate throughout the year: demand in some months is much greater than demand in other months. So-called lumpy demand can cause delays in production and transportation, ultimately risking stock-outs or shortages at the local level. The availability of funds ultimately determines when demand can be fulfilled, so improving flexibility in funding would permit UNICEF to more rapidly and efficiently get RUTF to malnourished children. There are a variety of funding mechanisms that might be altered to improve the RUTF supply chain.

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*Advance funding could help smooth ordering behaviors.*

First, it would be helpful for funds to become available in anticipation of a nutrition emergency. Most donors currently provide funding for RUTF on an as-needed basis: in a non-acute emergency situation, UNICEF develops annual work plans with governments and/or NGOs, and then seeks funding for that nutrition program. By guaranteeing funds further in advance, ordering behaviors would be smoothed. This would help stabilize the supply chain and facilitate more efficient production planning and shorter production lead times. It could also help reduce the need to resort to unexpected expedited shipping methods. Nearly 10% of amended RUTF orders between 2005 and 2008 saw the mode of shipment change (mostly from sea to air). This shift can have a considerable impact on transportation costs: sea freight from France to Mombasa costs \$185/MT, compared with \$2100/MT for air transport.

Removing the uncertainty in fundraising could be one factor in smoothing ordering behaviors and shipping choices. This same approach might be used to convince UNICEF to use its own core funds or thematic funds as a way to stabilize against the uncertainties in other donor sources. There are indicators in the dynamic model instrument that can help UNICEF COs demonstrate the clear effect that advance funding agreements could have on children treated with RUTF as well as impact per dollar. For example, if orders for RUTF are uneven over the course of the year (even slightly, with an end-of-year rise as when distributed 20%/20%/20%/40% across the quarters of the year), the RUTF supply chain would see delays increase from 6.1 weeks to 10.1 weeks. If back-loading of funds is greater, even more dramatic delays—up to 2.3 times compared to the baseline case—might be experienced. These figures should be shown to funders to demonstrate the harmful effects of funds and orders distributed unevenly throughout the year.

*Donor funds may be used to build the buffer stock*

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Additionally, UNICEF should work with donors to allow funding for buffer stocks (as mentioned above). While some donors may be limited by an emergency-only mandate, others may be able to mobilize mitigation and preparedness funds or regionally allocated funds for a buffer stock effort. An entirely different class of agencies might be available for funding the reconfiguration of the supply chain brought on by adding a buffer stock. The dynamic model provides clear data outputs to demonstrate the benefit of a buffer stock. It would be important to work with donors both to guarantee the necessary funding to build the initial stock level, but also to communicate how their funds will be used to place orders against the buffer stock inventory in the future.

*Multi-year funding could improve stability of nutrition programs*

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Several supply chain partners mentioned the improvement that multi-year funds could have on their programs. Nutrition emergencies are rarely isolated events. Those that are predictable (due to seasonal hunger gaps, for example) are bound to recur regularly, and those that are exceptional (caused by natural or man-made disasters) are unlikely to be resolved in a single year. Implementing partners could have much greater confidence in their long-term ability to deliver nutrition programs if they had multi-year funding.

It will be also important for UNICEF to clearly demonstrate that CTC programs are not exclusively relevant for emergency situations. Nutrition programs are needed in areas with high levels of severe acute malnutrition, including non-emergency situations. In order to secure multi-year funds, it will be important to educate partners on the importance of CTC in non-emergency settings, an awareness that may also help UNICEF secure donations more generally for non-emergency nutrition programs. Additionally, such an effort might demonstrate to donors the complexity of delivering RUTF to malnourished children. Funding for RUTF commodity must be matched by funding for its program delivery.

*Collaborations among agencies could improve the delivery of nutrition programs*

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UNICEF might encourage the coordination of multi-agency groups in the Horn of Africa to improve awareness of and response to nutrition emergencies in the region. One such effort might focus on uniting major nutrition donor agencies. Several donors (USAID/OFDA, ECHO, DFID) have officers in the region to gain more intimate knowledge of their potential grant recipients and of the most significant issues they face. If donors could be organized into a group to discuss nutrition issues in eastern Africa, for example, this might have benefits across the supply chain. It could create a more robust early warning system for nutrition emergencies that would span multiple funding agencies. Donors would also gain a greater understanding of one another's priorities and activities, which could help coordinate their funding approaches in a more constructive manner. Through communication with UNICEF and other agencies, the donors could also learn more about the supply chain for RUTF which might help them adopt some of the flexibilities outlined above. A regional group would be particularly well positioned for this; for example, they might see the benefit in collectively funding an initial buffer stock of RUTF

for their region. Resources like the Global Nutrition Cluster and USAID's Famine Early Warning System (FEWS NET) already exist to assist with such coordination, so they should be more formally leveraged to increase the impact of a regional coordination of donors.

Likewise, UNICEF should strive for more interagency discussions about the nutrition supply chain. Stakeholders have reported that local health facilities face difficulties in implementing treatment protocols from different agencies. As an example, projects for malnourished HIV-positive children funded by the Clinton Foundation sometimes operate at the same health centers where UNICEF provides RUTF to non-HIV-infected children. This can pose challenges in record-keeping since both agencies require different monitoring forms. The projects also have different programmatic approaches. In Malawi, for example, the Clinton Foundation uses locally procured RUTF while UNICEF uses Plumpy'Nut® from France. All moderately malnourished, HIV-positive children in these programs also receive RUTF, but some projects may not consistently have access to supplementary foods. Implementing partners can, therefore, face difficulties in administering the mix of programs from different agencies. UNICEF should work to improve coordination with organizations whose activities dovetail into the RUTF supply chain.

**Summary Recommendation:**

- Seek advance funding for baseline treatment of severe acute malnutrition and pre-commitment of funds for an escalation in incidence.
- Strive for multi-year funding agreements from donors.
- Promote multi-agency collaboration to improve response to nutrition emergencies.

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**Improve data quality for assessments of forecasted need for RUTF**

Accurate and actionable information underpins any supply chain. Without this, supply chains can experience data distortions such as the bullwhip effect: erroneous or insufficient information becomes magnified as it travels upstream in the supply chain, ultimately resulting in production inefficiencies and higher price distortions. The RUTF supply chain would be strengthened with improved data quality.

There are two important improvements that could be made to forecasting for RUTF: forecasting forms can be harmonized across COs to help ensure consistency, and the quality of forecasting data itself can be improved. More consistent and accurate forecasting data could help prevent congestion in the supply chain, which in turn can improve production decisions and transportation choices, saving money that might otherwise be wasted on expedited shipping.

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*Improve consistency of forecasting data through standardized collection and entry*

The data used in RUTF demand analyses should be consistent and accurate. Harmonized data input forms across the supply chain could help improve consistency. This has already been undertaken by UNICEF SD and PD, with an improved forecasting tool for all COs to project demand for inpatient and outpatient care for malnutrition. Once everyone uses the same form, there is a decreased risk of data errors or inconsistencies due to formatting or human error. Standardizing forms will also help clarify and standardize the underlying assumptions for

different forecasting approaches. Using the same forms, year-to-year comparisons might indicate what method best predicts program needs. As other agencies and Nutrition Cluster partners begin to develop their own forecasting tools, UNICEF might also encourage a cross-agency harmonization across these groups for the same reasons.

*Accuracy might be improved through recommendations on how to best use statistics for demand forecasting*

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The new forecasting tool must include accurate information in order to have a strong impact upstream in the RUTF supply chain, to inform decisions about production and transportation. UNICEF should encourage its partners to choose appropriate and uniform data input types and sources for their nutrition baseline information. The Global Nutrition Cluster has endorsed the use of Standardized Monitoring and Assessment of Relief and Transitions (SMART) methodology for emergency nutrition surveys, but some partners may still be using Demographic and Health Survey (DHS) or MICS data before SMART is fully operational in their setting, and these may well result in entirely different calculations of need. The Information Flow section provides more detail about the strengths and weaknesses of different approaches to nutrition forecasting. It is crucial that UNICEF develop guidance for its partners in selecting which approach to use. While harmonizing the nutrition survey methods used across the world would be difficult, doing so at the regional level would, at a minimum, improve data interoperability. Data sources and types should be selected for relevance for the nutrition supply chain. Additionally, factors not consistently measured may influence the accuracy of forecasts: the counting of internally displaced persons, the availability of supplementary and complementary foods, differing amounts of RUTF required per child in programs, the failure to factor in seasonal changes in nutrition status and in transporting RUTF to field locations, and the use of incidence figures, as opposed to prevalence, in these calculations.

**Summary Recommendation:**

- Evaluate effectiveness of new RUTF forecasting tool across Country Offices.
- Share forecasting tool best practices throughout UNICEF and entire Nutrition Cluster.

**Improve information flow through increased transparency and new information communication mechanisms**

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The RUTF supply chain is made more complex by the fact that the circles of accountability, responsibility, and funding authority by a stakeholder over the operations in the supply chain do not fully coincide. Each member of the supply chain has a certain circle of accountability that encompasses its range of choices and decisions. Unfortunately, in the case of RUTF, these circles of accountability do not always correspond well to the information available to that stakeholder. Sometimes this situation is worsened by the failure to deliver or use information where it is needed to make the optimal decision for the overall supply chain.

Consider this example: A program or logistics officer decides that RUTF should be airlifted into the country due to an impending nutrition emergency. Once in country, the RUTF is delivered to the MOH for local distribution. In some cases, due either to lack of distribution capability by the

MOH or differences between UNICEF and the MOH on the perceived, immediate need for RUTF, the product is placed in a government warehouse where it spends significant time before being dispatched to local communities. This could lead to a situation where one part of the supply chain spends considerable funds airlifting RUTF into a country while another part of the supply chain places the RUTF into a warehouse where it may reside for a considerable period of time.

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*Strive toward interoperable information systems that can be easily queried across the supply chain*

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One approach to resolving this challenge is to increase data communication: with easier access to data, all partners can gather the information needed to make their decisions. The first way to approach this is to promote interoperability between information systems, either through automated data entry—as the SD has currently introduced for freight information—or via software interfaces that allow data cross-referencing. If license agreements for software packages prevent the latter, then UNICEF might consider ways to develop web interfaces or new software bridges between the programs. This would help reduce errors due to manual data entry (which were found to occur not infrequently) as well as provide linkages between data fields that provide critical operational information to stakeholders. By enabling the tracking of information across data fields, they might adjust their actions in the supply chain accordingly. A web-based interface might be particularly useful as other stakeholders in the supply chain (NGO partners or District Nutrition Officers, for example) could more easily seek information on their orders. Access to such information might help them avoid some of the stock-outs or unexpected reductions in orders that they currently experience. Also building in backward information flows will alert those upstream in the supply chain how their actions impact the program delivery of RUTF.

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*Increase data transparency at the district and local levels*

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There is also a need for improved data sharing on stock levels after RUTF product leaves the national warehouse. Data on local stock levels must now be manually queried for each request. Upon receiving a purchase request, Somalia or Kenya CO staff ask the local warehouse about current stock levels, and, depending on their response, adjust the order amount accordingly. It would smooth information flow and improve accountability if the stock level data could be queried automatically at the CO level.

The RapidSMS program discussed in the Information Flow section is one potential way to resolve the lack of information on the RUTF supply chain after product leaves the national warehouse. It would allow districts to relay data on their activities and stock levels to UNICEF, thereby improving projections of need, increasing data quality on program coverage and impact, and facilitating the ordering process. It should be noted that the RapidSMS program is still in pilot phase, and its true efficacy and cost have yet to be demonstrated on a large scale. Additionally, there are a number of enhancements that might increase its relevance and effectiveness. The program, therefore, requires an additional investment of time and resources, so other options should also be explored for increasing data transparency at the local level.

Should UNICEF decide to proceed with the RapidSMS system, the project team proposes some additional features to enhance it:

- *Leveraging the scalability of a mobile phone application to expand use beyond field monitoring staff:* The barrier to entry for new users into a RapidSMS system is relatively low. The use of mobile phones requires minimal training and no specialized equipment. If the system could therefore be scaled to include data from individual NGO CTC sites as well as from District Nutrition Officers and districts, it could provide much richer data on the supply chain. Missed deliveries, mismatches between requested and delivered amounts, canceled food distribution days, storage conditions and stock levels at district and local points, and program impact statistics could be better tracked. Quality assurance endpoints, such as product damage or leakage, could also be added.
- *Combining nutrition survey data collection with RUTF information:* As more organizations adopt less resource-intensive methods for collecting data on nutrition status and program coverage, more frequent monitoring in the field might become practical. Such data might also be transmitted through a RapidSMS system. More regular and frequent communication about nutrition conditions at the local level could point out seasonal trends that are now washed out in annual surveys. Such a system could also serve as part of an early famine warning system, which might help mobilize more timely donor and NGO responses to nutrition emergencies.
- *Visualizing trends:* The visualization of some RapidSMS data might provide feedback that result in actionable program changes. Seeing how this backward information flow makes a difference might motivate the continued collection of this information. These could include checks against forecasts made by COs or NGOs, data on local-level KPIs such as lead time or quality, or information to support requests to donors.
- *Establishing lending networks at the local level:* Improved data transparency and information at the district or local level could help establish RUTF lending networks at the sub-national level. If a district has reported a stock-out of RUTF, it could be relatively easy for that district to identify neighbors who might be able to lend RUTF on a short-term basis. The RapidSMS alert system could be set up to automatically send requests for RUTF to feeding sites within a certain distance from a shortage, allowing for feeding sites to assist one another in redressing local supply and demand mismatch issues.

Implementing the RapidSMS system may require working with mobile phone carriers, designing how to communicate information effectively in a single text message, or printing reminder prompts for reporting on the RUTF cartons. By building in checks to the system, the accuracy of field reports could be verified. This might involve audits by others in the immediate network (e.g., by the District Nutrition Officer or the NGO warehouse).

*Automate exceptions handling and communicate such data meaningfully with partners to increase trust in the supply chain*

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In addition to facilitating access to data, it would be important to consider reassessing how data are presented to partners. As evidenced by areas in the current supply chain where partners do circulate information (for example, K+N reportedly supplies COs with regular reports, including stock levels and updates on customs clearances), the mere provision of information does not ensure that the data are actionable by supply chain stakeholders. Information on exceptions



handling is not presented separately in these reports, and COs may not review the entire report upon receipt to discover that the exception has occurred.

One way to improve this is to provide more easily usable data outputs. For example, dashboards that COs can understand at a glance might change the way the supply chain responds to exceptions. The proposed KPIs will help shape what exceptions warrant highlighting on these dashboards, but UNICEF will need to work with its stakeholders to identify the ideal content and approach for this data sharing.

Partners in the RUTF supply chain should be actively informed when an order did not go according to plan, and reporting systems could be set up to push the relevant information to these actors when this occurs.

**Summary Recommendation:**

- Use web-accessible systems to share inventory and order status across supply chain.
- Utilize mobile technology (such as RapidSMS system) to provide timely information from the field.
- Automate exception reporting to relevant supply chain participants.
- Shift circles of accountability to align information and control.



## Steps for Implementation

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This section discusses the different steps to implement each of the recommendations outlined above for the product, funding, and information flows. A timeline is proposed for implementation, based on both the impact of the recommendation and the time/effort needed to complete the implementation.

Short term recommendations include diversifying the supplier base, improving data transparency, automating exceptions handling, and standardizing forecasting methods. Short term recommendations should be implemented over a six-month period. Medium term recommendations are placement of buffer stock and greater collaboration with funding partners. Medium term recommendations could be implemented within 6 to 18 months. Planning for these can begin immediately. UNICEF and partners should begin assessing the alignment of information and decision-making powers in the near future, and work to align circles of responsibility as a long-term strategy, to be completed in 18-36 months. In some cases, recommendations have been divided into multiple components to reflect differences in implementation timing.

UNICEF should establish a cross-functional team to oversee implementation of these proposed improvements to the RUTF supply chain. The team should have members from all parts of the supply chain and should include personnel from SD, Country Office Nutrition Program, Country Office Supply and Logistics, ESARO Nutrition Program, ESARO Supply & Logistics, Program Division and EMOPS, and the primary producer and freight forwarder. A cross-functional team will help ensure buy-in from all parts of the supply chain and help to communicate the purpose behind each of the recommended changes to the system.

## Short-Term Recommendations

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Several of the proposed interventions are immediately actionable and UNICEF should begin organizing all relevant parties in order to execute these recommendations over a six-month period.

### *Implement the proposed KPIs to monitor the supply chain and inform management decisions*

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There are very few current measures to assess performance of the RUTF supply chain. The project team recommends introducing a set of Key Performance Indicators (KPIs) that will help UNICEF determine what supply chain improvements might have maximum impact. The full set of KPIs was outlined earlier; suggestions for their implementation follow.

- 1) Using the outline provided in this report, UNICEF should **develop a detailed plan for introducing the new KPIs**, including responsibilities for collecting and analyzing data, schedules for monitoring, and systems for information-sharing, as well as indicator benchmarks.
- 2) It is essential that UNICEF **develop supply chain improvements based on KPI results**. Suggestions for these are outlined in the KPI section. Briefly, for long lead times this may include creating buffer stocks, attempting to change points of transshipment or coordinating orders to smooth production volumes; for landed cost

interventions might include improved prioritization between sea and air freight, or more informed use of existing stock levels. These recommendations may vary by country based on individual circumstances. For example, local transportation lead time does not vary greatly within Kenya; rather, interventions to improve performance on this KPI might be targeted at a country like Ethiopia, which has demonstrated long and variable local transportation times. As RUTF demand increases in different countries, there may be tailored recommendations for those settings on how to optimize RUTF delivery.

- 3) The RUTF supply chain is not a stand-alone system; rather, it is part of a wider network of nutrition programs. It is important that UNICEF consider this larger context during the implementation of these KPIs. As an example, in-country logistics for RUTF rarely exist alone—trucks are filled with multiple nutrition products and transport decisions are made for multiple programmatic objectives. It can, therefore, be challenging to optimize some aspects of the supply chain based on KPIs for RUTF alone. In such cases, while it will be important to monitor the KPI for identifying outliers, corrective action based on those KPI measures may not be easy. Joint consideration of multiple products under a product category may be necessary and UNICEF might consider including additional nutritional products in the KPI data to be collected.

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#### *Diversify the supplier base to better serve global needs*

Given the expected surge in demand for RUTF and associated products in the upcoming year, it is important for UNICEF to ensure sufficient supply capacity in the network. Data indicate that the supply chain is currently operating near-capacity for many months of the year, causing long order production times and delays in order delivery dates, as well as stock-outs and reduced deliveries at the local level. There is also little room for surge capacity in the case of an emergency. UNICEF should expand and diversify the supply base worldwide. It is beyond the scope of this report to suggest the optimal sites for these new plants. However, there could be additional factories in Europe, Africa, or elsewhere provided that new facilities are optimally positioned to be responsive to surges in demand. While expansion in the supply base will increase the capacity and reduce the risks associated with disruption, it will require greater oversight and constant monitoring of new suppliers. Here are steps that can help UNICEF accomplish this target:

- 1) **Identify potential suppliers capable of producing RUTF and associated products.** UNICEF should use existing internal processes to solicit proposals from new suppliers.
- 2) Explore **opportunities for UNICEF to assist in the development of potential suppliers**, such as collaborative capital funding, sharing of technical expertise, guaranteed contracts, or intellectual property provisions (such as patent pooling or humanitarian access licensing) to enable new producers to enter the space.
- 3) **Qualify suppliers based on their technical performance, cost, quality, and process conformance.** UNICEF must devise a set of criteria for producers so they can identify those that fall within an acceptable range of performance on these dimensions. Cooperation with other procuring partners (like MSF or Clinton

- Foundation) might ease the burden of executing this activity, as is already being done for quality assurance checks for new RUTF producers.
- 4) **Contract with suppliers based on their potential contributions to the RUTF supply chain in terms of capacity, cost, time, and access.** Depending on various factors, such as location, ability to scale up, and capacity to consistently adhere to quality and nutritional standards, some producers will be more beneficial to the value chain than others. UNICEF might work to guarantee certain conditions in the LTAs with these new suppliers, including opportunities to renegotiate prices and volume discounts.
  - 5) **Work with suppliers as they ramp up their production.**
  - 6) **Monitor their performance using KPIs on an ongoing basis.** UNICEF should work to ensure that all new producers are collecting and reporting data on production lead time, changes in TADs, landed costs, product quality, and communications on exceptions handling.
  - 7) Over time, work to **qualify new formulations and products** that can be used to treat severe and moderate malnutrition. UNICEF might work with Nutrition Cluster partners to identify promising formulae and encourage research (including trials) to help these products move toward viability.

The dynamic model can help UNICEF in the decision-making process related to supplier diversification. It can simulate the impacts of changing the number and location of suppliers on landed costs, lead times, and timely availability of RUTF.

*Improve information flow through increased transparency and new information communication mechanisms*

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The current state of information flow in the supply chain is choppy at best. Issues with accuracy, consistency, and communication of data are all impediments to supply chain performance. Integrated data systems would provide greater controls on information quality and would facilitate information flow between partners. Standardization of data collection methods would improve UNICEF's understanding of supply chain dynamics and allow cross-country comparisons. Additionally, data transparency would help all stakeholders within the RUTF supply chain have ready access to accurate information. Although complete transparency and interoperability of data systems is likely to take a long time, some areas of integration could be accomplished in the short run.

- 1) **Start collecting field-level data using mobile technology.** Kenya and Somalia could introduce the RapidSMS system that is currently being piloted in Ethiopia, Malawi, and Uganda. The data would be collected at the field level and then aggregated by COs and shared with other partners (ROs, SD, Programme Division). As a first step, the RapidSMS system would only collect data on program utilization (i.e., number of children admitted and discharged) and RUTF consumption (i.e., packets distributed and stock level remaining). This would allow supply chain partners to have a clearer view of the local use of RUTF, which could help optimize production and transportation routing.
- 2) Over time, the **RapidSMS system could be expanded to include value-added features** such as delivery dates and quantities, quality data (e.g., damage reports and

- product leakage onto the marketplace), nutrition and food security demographic information, and perhaps ultimately systems to promote lending between nearby partners.
- 3) **Automate the exchange of data between systems to reduce human error.** SD has begun to automate data linkages between their SAP system and Scan Logistics' and K+N's databases. This will help improve the consistency and accuracy of supply chain information.
  - 4) This information integration between global logistics suppliers and UNICEF will provide significantly more thorough data on the supply chain, so UNICEF should explore the possibility of **developing a web-based portal** to provide easier access to these data for its partners. Particularly as more standardized data are collected (ranging from the new forecasting tool to the proposed RapidSMS expansion), it would be helpful to improve the accessibility of the data. To this end, UNICEF might work with its communications and IT departments, and outside vendors as needed, to develop an online point of access for supply chain information. This might be particularly valuable if it included a presentation of the KPIs.
  - 5) **Design and implement standardized protocols for information collection and dissemination across the supply chain.** Particularly as UNICEF implements KPIs on the RUTF supply chain, it will be necessary to aggregate and communicate data on a regular basis. SD could oversee the development of standard data entry tools (again, a web-based platform might render the tools accessible to all partners, decrease the risk of manual entry errors, and ease the burden of data analysis) for supply chain partners to use for inputting their data. It would then be most useful to have good data presentation templates for presenting this information back to stakeholders. (See the next recommendation for more details on this.)
  - 6) UNICEF should also work to introduce a communications **feedback mechanism** for partners in the supply chain. This monitoring device would encourage stakeholders to provide a regular flow of comments back up the supply chain, which in turn might foster a more dynamic and collaborative approach to problem-solving. This might integrate with the recommended data web portal so that partners would have one easy place to enter information on the supply chain, assess performance, develop advocacy tools to use with donors and other agencies, and provide ongoing feedback. Additionally, it might include information collected from a mobile system so that partners in the field could add their perspective as well.

*Automate exceptions handling and communicate such data meaningfully with partners to increase trust in the supply chain*

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The current process for relaying order information down through the supply chain is reactive: exceptions are obtained by CO personnel once they seek out information on delayed orders. Stakeholders are given periodic reports on the flow of products, but they are expected to search out the exceptions within the report. Orders are frequently delayed and this information is sometimes difficult to see in the reports sent to COs, which means that implementing partners may not receive status updates on their orders. UNICEF should move to an automated approach for exceptions handling for critical supply chain processes, such as delivery of shipments, truck schedules, inventory status, order processing, and funds transfer.

- 1) **Consult with stakeholders to determine which key processes should incorporate automated exceptions.** Earlier sections of this report, in particular the Product Flow section might be instructive in this process.
- 2) **Identify which stakeholders** are most significantly affected for each process and, consequentially, who should receive exceptions information. This would help UNICEF develop a crosswalk of key supply chain processes and associated stakeholders (for example: production delays should be communicated to the global logistics supplier, SD, and the CO; delays at customs at the port of entry should be relayed to COs, who in turn should notify implementing partners).
- 3) **Create an alert in the information system whenever an exception has been entered** that will affect the completion date of that activity. When a change occurs, **record updated changes to the planned completion times** of each activity in the process, while keeping the original dates on record.
- 4) Using the process-stakeholder matchup, UNICEF should develop an **automated e-mail distribution** that is triggered by exception alerts in the system.
- 5) The list of suggested KPIs also includes a **“communication on exceptions handling” KPI**, which UNICEF should measure and report to all supply chain stakeholders.

Additionally, UNICEF should work to develop improved data presentation approaches for supply chain information. Particularly with the introduction of new KPIs and the above recommendation to develop web-based portals for supply chain information, it would be a prudent time to review visualization methods for supply chain information. There are some suggested data output renderings in Appendix 5, but UNICEF should work closely with its own communications group to develop intuitive, usable, and actionable representations of supply chain information.

#### *Improve data quality for assessments of forecasted need for RUTF*

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Improving demand forecasting across implementing partners (NGOs and MOHs) is a complicated yet necessary undertaking. Without standardized methods and accurate data, demand planning is limited in its relevance and utility, which impacts the efficient delivery of RUTF to malnourished children. This process is intended to build upon the efforts already begun at UNICEF to introduce a new forecasting tool for COs.

- 1) UNICEF should leverage its leadership role in the Nutrition Cluster to **create a work group** that can develop harmonized forecasting approaches across agencies and recommendations for data use. Some efforts are already under way as there is a planned meeting between key procurers (UNICEF, MSF, and Clinton Foundation) to discuss developing a consistent approach to forecasting.
- 2) **Hold a series of work sessions with work group members to arrive at best practices for demand forecasting in the field.** This would address data entry and formatting standards, as well as recommendations for demographic statistics (including the counting of infants, issues of prevalence versus incidence, addressing seasonal fluctuations, transitioning to the new WHO reference standards, and consistencies in metrics such as weight-for-height versus MUAC).

- 3) **The larger organizations should work in tandem to disseminate new best practices and organize trainings** for implementation to other main procuring partners and implementing partners where needed. The Nutrition Cluster could be used as a venue for these discussions, and also as a way to share feedback from the field on the new approaches.
- 4) Tracking performance along the **forecasting accuracy KPI** will help UNICEF determine if the new approaches are working well.
- 5) UNICEF should then work to **incorporate this feedback and refine the recommended forecasting approaches accordingly**. The working group should be tasked with a periodic review of feedback (perhaps quarterly at first, and then semi-annually or annually once the process is smoother) that results in modifications to tools and recommendations, and a report back to the Nutrition Cluster.

### Medium-Term Recommendations

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UNICEF and partners should attempt to implement medium-term targets within the next 6 to 18 months. Planning for these recommendations should begin sooner.

#### *Pre-position buffer stock to decrease lead times and improve delivery of RUTF*

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Currently the RUTF supply chain operates on a pull system, where only funded demand can trigger the procurement, production, and delivery of RUTF, and it is subject to a myriad of delays and disruptions. Pre-positioned stock held in a centralized regional warehouse would help reduce delivery lead times. A buffer stock will also enable the RUTF supply chain to respond more efficiently in emergency situations by relieving the supply constraint on rapid response. The Dynamic Modeling and Recommendations sections explored the impact on the supply chain of using either Mombasa or Dubai as buffer stock locations. Creating a buffer stock of 300 MT in either location would dramatically reduce the average lead time in the supply chain. At projected demand rates and with appropriate stock rotation, the 300 MT buffer stock would turn over approximately once per month, so such an inventory could be maintained without seriously increasing the risk of product expiration. Regulatory restrictions on use and duration of buffer stock held in Kenya suggest that Dubai would be a more appropriate location to hold buffer stock. The following steps should be completed to create an RUTF buffer stock for the Horn of Africa.

- 1) **Finalize decision regarding buffer stock location.** Some alternatives, like Dubai, may be available with minimal investment while others may require further investment to become operational. One important criterion is the ability of the shippers as well as K+N to get product in and out of the location.
- 2) **Determine scope of buffer stock.** If the buffer stock is used only to support demand in the Horn of Africa, a level of 300-500 MT is recommended.<sup>24</sup> If additional COs will also utilize the buffer stock, the quantity must be scaled up accordingly.

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<sup>24</sup>Inventory holding policies should be adjusted periodically to account for seasonal increases and decreases in demand.



- 3) **Secure funding for initial buffer stock.** It would be easiest and most efficient to operate if UNICEF is able to secure dedicated funding for creating the buffer stock.
- 4) **Work with producers to determine when the initial buffer stock inventory could be produced.** Orders for RUTF fluctuate throughout the year, so UNICEF should speak with Nutriset and other producers to schedule buffer stock fulfillment during times of ample capacity.
- 5) **Establish procurement procedures for how COs will obtain RUTF from buffer stock location.** Before the buffer stock becomes operational it would be important to devise protocols related to allocation procedures and order frequency. One simple way to manage inventory allocation would be to designate priority to requisitions in the order they were received (or first in, first out [FIFO]). However, more complicated priority allocation should also be considered if necessary. Ordering should be placed on a regular schedule to replenish warehouse stock, but with an exception in the case of a large-scale emergency that requires immediate replenishment.
- 6) **Assess performance of the buffer stock through monitoring of KPIs,** including lead time and landed cost. The buffer stock should clearly improve overall performance on these dimensions. If not, UNICEF should investigate the root cause for such lingering inefficiencies and work to resolve them, including relocating or eliminating the buffer stock if necessary.

#### *Increase collaboration with funding partners in the Horn of Africa*

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The current reactive “pull” system for RUTF risks inefficiencies around lead time and landed cost that threaten the supply chain’s impact on severely malnourished children. A significant limitation is a dependency on funds that can be insufficient and unpredictable. To this end, UNICEF should use its influence as a major purchaser of RUTF and as lead of the Nutrition Cluster to raise awareness with donors around the importance of advance funds, monies for buffer stocks, and multi-year funding.

- 1) Using the dynamic model tool, **UNICEF should develop materials to advocate with donors** for more flexible funding arrangements. This might include evidence of the importance of investing in buffer stock, the potential impact of advance funding versus staggered monies throughout the year, and the stability that multi-year funds could provide.
- 2) The Nutrition Cluster would be well positioned as a vehicle for relaying these ideas to donors. UNICEF might position key stakeholders in the Nutrition Cluster, including implementing NGOs and other major procurers of RUTF, to **develop a strategy for communicating these important issues to donors**. This might include a regional task force on malnutrition that brings together agencies and donors to discuss these key issues, or a series of strategic meetings with donors to gain their buy-in.
- 3) This would ideally result in a new **multi-donor commitment** for the region that would include provisions to permit more flexible funding for the RUTF supply chain.
- 4) UNICEF should then include donors among those stakeholders who receive **updates on the most significant KPIs demonstrating the impact of these new funding arrangements**, such as lead time and landed cost.

- 5) UNICEF might also develop standardized protocols for bridge funding using core or thematic funds in the event that donor funds are unlikely to be forthcoming.

### Long-Term Recommendation

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Long-term targets should be implemented within an 18- to 36-month period. This recommendation will require significant groundwork for UNICEF as well as obtaining consensus from other parties. Planning for this initiative can start immediately.

### *Collaborations among agencies could improve the delivery of nutrition programs*

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Cooperation among stakeholders—namely other procurement and implementing partners as well as donors—can help improve communication and coordination across the supply chain.

Implementing this recommendation will mostly involve setting up new systems for communication and developing ways to monitor them.

- 1) UNICEF should first work to **organize a new feedback and communications tool for organizations and donors in the nutrition community**. This might extend from recommendations earlier in this section (including using its leadership in the Nutrition Cluster to build new supply chain data portals, as well as new systems for communicating forecasting recommendations), but should at minimum provide a way for partners to work collectively on supply chain challenges. This might include collaborative forecasting approaches, pooled pricing data, or the structure for a lending program.
- 2) As a component of this system, donors should be encouraged to create **a database of their funded proposals and projects**. Although they try to informally coordinate their efforts, there is no systematic way for donors to share information on what projects they are funding in a region. Over time, this may have value for the implementing organizations too as it increases transparency in the funding process.

In composite, these proposed implementation steps should significantly enhance the reliability and effectiveness of the RUTF supply chain for the Horn of Africa. The recommendations may also have implications that apply more broadly to UNICEF's and the Nutrition Cluster partners' supply of RUTF to other parts of the world.

## 6

### Future Opportunities

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There are a number of areas in which this study, or others like it, might be expanded or improved for greater significance and impact. First, the focus of this project was exclusively on the Horn of Africa, with the majority of data coming from Kenya and Somalia. Although these two countries have significant differences that impact their respective supply chains—ranging from logistic differences in importing goods as well as in-country distribution, to a supply chain that delivers directly to implementing partners versus one that works through the government—framing the project this way forces the analysis to have some shortcomings.

For instance, neither country currently has the capacity to produce or procure RUTF from a local source. Secondly, both Kenya and Somalia have experienced humanitarian emergencies in recent years which may limit the relevance of these findings to more stable countries. Additionally, both Kenya and Somalia are served by sea transport; over-land transshipment of RUTF to land-locked nations may experience challenges that this study could not address. More generally, the limited focus on only two countries also reduced the available data on the supply chain to a very small set: Kenya only had 9 RUTF orders fulfilled in 2008. A wider look at the RUTF supply chain—for an entire region served by an RO, for example—might shed light on new issues or indicate different priorities than this relatively narrow focus could ascertain.

Future nutrition commodity supply chains might also analyze a wider range of products. Treatment for SAM does not use RUTF in isolation, and the supply chain that moves RUTF for UNICEF also serves these other products. An understanding of accessibility and availability of supplementary foods, for example, might have enhanced this analysis. It may also have increased the study's relevance for implementing partners who experience daily challenges at the interface of these supply chains. UNICEF might initiate a look at these interconnected nutrition supply chains, alongside partners such as WFP or the FAO.

Similarly, although UNICEF's top priority is to gain an understanding of its supply chain, there are a number of other partners who operate parallel (and sometimes intersecting) supply chains for RUTF. In addition to the other significant purchasers of RUTF, a range of smaller NGOs, including some UNICEF partners, occasionally operate stand-alone RUTF supply chains sometimes in response to the shortcomings in UNICEF's supply chain management. These major buyers, namely MSF and Clinton Foundation, along with the smaller partners, might shed some new light on the overall RUTF supply chain. Especially for a product with constrained production capacity, a robust supply chain analysis would require inputs from these other partners.

Lastly, this analysis focused on developing recommendations to improve the configuration of the RUTF supply chain. UNICEF might be interested in further explorations of coordination decisions for the supply chain, particularly focused on optimizing for efficiency. While this project took a broader perspective on the supply chain by building a dynamic model to help inform choices on overall supply chain structure (expanding the supplier base, building a buffer

stock, stabilizing funding flows, etc.), it could not also provide recommendations on optimization. For instance, it does not assess whether over-land transport to regions of Somalia is preferable to shipment by sea to Mogadishu and then by land to the district, or how to ideally pack and ship containers of RUTF. Gaining this type of coordination understanding would require an additional data analysis on the supply chain.

# 7

## Conclusion

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All supply chains are complex and dynamic systems, with networks of activities and stakeholders that together work to effectively and efficiently deliver a product. UNICEF handles especially challenging supply chains because of the humanitarian circumstances under which these commodities are delivered. Supply chains are typically optimized for cost or time, but the success of UNICEF's RUTF delivery is also measured by the impact it has on children's lives. Configuration and coordination decisions cross continents and institutional barriers and involve a range of partners from governments to private industry. However, control over essential supply chain components (including production and funding) is not held by UNICEF.

This report aims to provide all stakeholders with an understanding of the current RUTF supply chain: its activities, who performs them, what it does well, and where it faces challenges. There were several areas identified in this report where miscommunication or mistrust due to misinformation may be eroding faith in the supply chain, and this report may serve as a first step in rectifying this. Some identified challenges are within UNICEF's purview to improve while others will require multi-institutional efforts. The report provides recommendations on how to improve the delivery of RUTF in the Horn of Africa. Some of these recommendations can be employed in the near future while others may take years to implement fully. Even short-term improvements should have marked effects on the RUTF supply chain.

Although UNICEF's mission does not explicitly include efficient supply chain management, good program-supply integration is indeed vital to delivering health services to children in need. RUTF is only one of many products procured and delivered by UNICEF, but many principles from this report are applicable to a range of commodities. It is our hope that the recommendations provided in this report will provide benefit to countries beyond the Horn of Africa, to products in addition to RUTF, and to members of the Nutrition Cluster in addition to UNICEF.

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## **APPENDIX I: PROJECT METHODOLOGY**

### **STEP 1: COLLECT QUALITATIVE AND QUANTITATIVE DATA**

#### *REVIEW OF KEY DOCUMENTS*

The team spent the first few weeks of the project reviewing key documents supplied by UNICEF and articles of interest identified by the team. These documents included UNICEF procedural manuals, annual reports, and other internal documents, as well as research on RUTF and nutrition. A list of these documents can be found on the following page.

#### *SUPPLY CHAIN SURVEY*

The project team designed a survey to gain insight into the stakeholders' perceptions of several aspects of supply chain performance. The survey was sent to staff members of UNICEF SD, ESARO Nutrition and Logistics Offices, CO Nutrition and Logistics Offices (Kenya and Somalia), Nutriset, Kuehne + Nagel, and ACF. We received 11 responses from 21 possible respondents. The team used these survey results to gain insight into stakeholders' impressions of where the strengths, areas for improvement and bottlenecks lie in the current RUTF supply chain.

The survey queried respondents about several dimensions of the supply chain, including efficiency and cost, forecasting, budgeting and other planning processes, procurement processes, timeliness and availability of RUTF, levels of wastage, the alignment of objectives among stakeholders, the resilience and responsiveness of the supply chain, and whether the supply chain is effective in meeting UNICEF's goals. Several open-ended questions asking respondents to describe current challenges in the supply chain, risks and threats to the supply chain, indicators of supply chain effectiveness, supply chain issues unique to the Horn of Africa, and what other nutritional products may be effective in the Horn of Africa.

#### *FIELD VISITS*

Members of the project team traveled to Nairobi and Copenhagen to conduct an on-the-ground investigation and meet with participants in the current RUTF supply chain. Before the visit, the team sent partners a questionnaire in order to help fill gaps in the understanding of supply chain activities. During the visits they conducted interviews with UNICEF staff and partners and held workshops to gain feedback on project progress and findings, and to further explore the supply chain processes. These sessions in the field helped the team to solidify its understanding of the supply chain and identify major challenges facing the RUTF supply chain both now and in the future.

The list of participants to these data collection activities can be found on the following page, and the survey instrument is at the end of Appendix I.

Key documents:

- Book G from Supply Division
- UNICEF Program, Policy & Procedure manual
- Interagency quality standards for RUTF
- Forecasting tools from SD for RUTF, bednets, vitamin A, immunizations
- Monthly and annual KPIs from SD
- Kenya and Somalia CO Annual Reports and Consolidated Emergency Thematic Reports

List of participants in data collection activities:

- Kenya Ministry of Health: Francis Wambua
- ACF: Maggy Tiemdjo
- Concern: Erin McCloskey, Charles Mutunga, Mueni Mutunga
- Merlin: Afeworki Abraham, Onno Van Manen
- USAID: Georgianna Platt
- ECHO: Torben Bruhn, Roselyn Mullo
- Nutriset: Adeline Lescanne, Francois Lescanne
- InstaFoods: Stewart Alison, Rolf Campbell
- Kuehne+Nagel Copenhagen: Søren Christensen, Daniel Mira
- Kuehne+Nagel Nairobi: Tariq Arain
- UNICEF Kenya CO: Kiriti Chowdhury, Peter Krouwel, Noreen Prendiville, Ruth Situma, Elizabeth Waitha
- UNICEF Somalia CO: Fitsum Assefa, Suraya Dalil, Emma Maspero, Olivier Mulet, Unni Silkoset, Tom Ziraguma
- UNICEF ESARO: Peter Hailey, Lars Jensen, Suvi Rautio
- UNICEF HQ: Tanya Khara, Ted Maly
- UNICEF SD: Francisco Blanco, Jurgen Hulst, Paul Molinaro, Giogia Paiella, Peter Svarrer Jakobsen, Jan Komrska, Josephine McCloskey

### *SUPPLY CHAIN DATA*

The research team sent each of the project partners (UNICEF offices, Nutriset, and Kuehne + Nagel) a data request for necessary descriptive documents and spreadsheets. Using supply chain data supplied by both UNICEF and the RUTF supply chain partners, we conducted a number of quantitative analyses. During the course of our analyses, we looked at:

- Quantity of RUTF ordered per year (globally and by country)
- Ordering patterns for RUTF v. other nutritional commodities
- Modes of transport for RUTF orders for Kenya, Somalia, and Ethiopia
- Lead time length
- Lead time variability (2<sup>nd</sup> and 3<sup>rd</sup> quartiles for lead-time variability with outliers)
- On-time delivery for original TAD
- On-time delivery for extended TAD
- Order weight's effect on production lead time
- Order weight's effect on global transportation lead time
- Nutriset capacity and its effect on production lead time
- Reasons for order amendments
- Potential effects on order lead time of strike at Le Havre and Kenya's post-election violence
- Contribution of air freight and sea freight to total landed cost of RUTF
- RUTF demand and capacity over time
- Percentage of global RUTF demand produced by Nutriset
- The effect of increased demand on the price per carton over time

Findings from these analyses confirmed some of the challenges supply chain participants had identified in interviews and survey responses, and revealed additional challenges that had not yet been identified. The results of these analyses are described in detail in the Analysis portion of the report. For a thorough list of methodologies used for the Flows Section, see Appendix II.

### **STEP 2: MAP RUTF SUPPLY CHAIN**

The project team then used data gathered through the mechanisms listed above to map the supply chain. The supply chain mapping exercise focused specifically on Kenya and Somalia, due to data availability. The supply chain mapping was carried out in three phases, defined as follows: 1) Identified all supply chain participants and outlined their activities, 2) Categorized partners' activities into the four processes (Plan, Produce, Procure, Deliver) 3) Mapped the detailed supply chain flows (product, funding, and information). At each phase, the information was confirmed by UNICEF partners. Mapping the supply chain helped identify points of leverage for improving supply chain performance.

### **STEP 3: DEVELOP DYNAMIC MODEL**

A dynamic simulation model was developed to understand the impacts of certain decisions on the performance of the supply chain. This model simulates various "what if" scenarios that might arise due to changes in the RUTF supply chain. Scenarios were chosen based on feedback from UNICEF on what would be the most likely and helpful circumstances to simulate. The model was used to illustrate the impacts of variables that could be adjusted to affect supply chain performance, and demonstrated the impacts of some of the key recommendations put forth by the team.

### **STEP 4: DEFINE KEY CHALLENGES AND CREATE AN ACTION PLAN**

Using the quantitative and qualitative analyses described above, we identified some major challenges facing the supply chain both now and in the future. After defining the challenges, the team explored ways to mitigate risks and challenges, and take advantage of opportunities identified during the investigation. An action plan was formulated consisting of three components: 1) proposed key performance indicators for important dimensions of the supply chain, 2) actionable recommendations that will help to improve supply chain performance, and 3) a timeline and implementation plan for putting recommendations and KPIs into operation.

The KPIs were developed using best practices in supply chain management. They also were tailored to track performance on the challenges uncovered in our analyses. Similarly, recommendations were developed using industry best practices. The dynamic simulation tool was used to assess the potential impact of some of the recommendations on lead time, cost, and the number of children treated for SAM in a given timeframe. The results from the model aided in refining some key recommendations.

The final step was to create an implementation plan through which each of the KPIs and recommendations could be acted upon. A timeline and next steps for implementation were generated, wrapping up the RUTF Supply Chain Analysis project.

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### **RUTF Supply Chain Project Survey**

Name, organization, and role within the supply chain

Using a scale of Strongly disagree/Disagree/Neither agree nor disagree/Agree/Strongly agree, questions were asked in the following categories:

Cost	<ul style="list-style-type: none"><li>· The RUTF supply chain is run efficiently</li><li>· The transportation/logistics costs have been reduced as much as possible</li><li>· The production costs have been reduced as much as possible</li><li>· The procurement costs have been reduced as much as possible</li></ul>
Planning	<ul style="list-style-type: none"><li>· Forecasting for demand for RUTF works fairly accurately across all seasons</li><li>· The budgeting control for purchasing RUTF is localized where it should be</li><li>· Information needed for effectively planning for RUTF delivery in the field is available</li><li>· A deeper understanding of the supply chain is urgently needed</li></ul>
Time	<ul style="list-style-type: none"><li>· RUTF is available at the time when it is needed</li><li>· Order fulfillment time for RUTF is optimal</li><li>· RUTF is procured on time</li><li>· RUTF is delivered on time</li><li>· Raw material for RUTF is procured on time</li><li>· Raw material for RUTF is delivered on time</li></ul>

Alignment	<ul style="list-style-type: none"> <li>· The objectives of various players in the RUTF supply chain are perfectly aligned</li> <li>· All players in the RUTF supply chain have been adequately trained to perform their functions</li> <li>· All players in the RUTF supply chain are prepared for the functions that they are required to perform</li> </ul>
Resilience and Responsiveness	<ul style="list-style-type: none"> <li>· The RUTF supply chain can respond quickly to shortages of supply</li> <li>· The RUTF supply chain can respond quickly to surges in demand</li> <li>· The responsiveness of the RUTF supply chain varies with the season</li> <li>· The RUTF supply chain can expedite orders effectively when needed</li> <li>· The RUTF supply chain has the ability to replace or reroute shipments in case of in case of damages or shortages of supply</li> </ul>
Procurement	<ul style="list-style-type: none"> <li>· The procurement process for RUTF ingredients is well planned</li> <li>· The ingredients for the RUTF product are available in adequate supply</li> <li>· The ingredients for the RUTF product are affordable</li> <li>· The RUTF product is available in adequate quantity</li> <li>· Changes in demand can be effectively handled</li> </ul>
Wastage, Damage and Theft	<ul style="list-style-type: none"> <li>· The pilferage of the product is minimal</li> <li>· Pilferage is not a major hindrance in ensuring adequate supply of the product</li> <li>· The wastage of the product due to damage is minimal</li> <li>· The wastage of the product due to expired shelf life is minimal</li> <li>· The wastage of the product is a cause for concern</li> <li>· The wastage of the product is not accounted for in the supply calculations</li> <li>· Wastage creates shortages in RUTF provision</li> </ul>
Meeting Humanitarian Needs	<ul style="list-style-type: none"> <li>· The RUTF supply chain is well suited to meet UNICEF's goals of delivering RUTF to treat severe malnutrition</li> <li>· All stages in the supply chain are able to effectively meet UNICEF's goals of delivering RUTF to treat severe malnutrition</li> </ul>

Using open-ended essay format, questions were asked in the following categories:

- What issues are currently presenting the greatest challenge to the performance of the RUTF supply chain?
- What risks/threats to the RUTF supply chain are the most concerning in the near future?
- What would make you feel that the RUTF supply chain was working effectively?
- Are there issues specific to the RUTF supply chain in the Horn of Africa compared to elsewhere? If possible, please offer specific examples or contrasts.
- What are other food commodities, besides RUTF, that you see as key in ensuring the nutrition supply chain in the Horn of Africa?

## **APPENDIX II: METHODOLOGY FOR ANALYSES**

### **Introduction**

*Table 1: Description of method used for analyses in the Introduction section*

<b>Data Description</b>	<b>Data Source</b>	<b>Column Headings Used</b>
Cartons of RUTF ordered by UNICEF per year	ZSOS Plumpy spreadsheet	PO Create Date (aggregated by year) v. Quantity delivered
Quantity of Plumpy’Nut® Delivered by Country 2005	ZSOS Plumpy spreadsheet	PO Create Date (aggregated by year) v. Quantity delivered (with Receiving Country Name as key variable)
Quantity of Plumpy’Nut® Delivered by Country 2006	ZSOS Plumpy spreadsheet	PO Create Date (aggregated by year) v. Quantity delivered (with Receiving Country Name as key variable)
Quantity of Plumpy’Nut® Delivered by Country 2007	ZSOS Plumpy spreadsheet	PO Create Date (aggregated by year) v. Quantity delivered (with Receiving Country Name as key variable)
Quantity of Plumpy’Nut® Delivered by Country 2008	ZSOS Plumpy spreadsheet	PO Create Date (aggregated by year) v. Quantity delivered (with Receiving Country Name as key variable)
Nutrition Commodities ordered by UNICEF country offices in kcal	ZPOD F75, F100, Plumpy spreadsheets	PO Delivery Date (aggregated by year) v. Quantity delivered, standardized against KCal values
Mode of transport for RUTF sent to Kenya	UNICEF SD ZPOD spreadsheet	Del Mode of Shipment
Mode of transport for RUTF sent to Somalia	UNICEF SD ZPOD spreadsheet	Del Mode of Shipment
Mode of transport for RUTF sent to Ethiopia	UNICEF SD ZPOD spreadsheet	Del Mode of Shipment

### **Product Flow**

#### ***Description of data sources***

Data used for analyses were provided by UNICEF Supply Division, UNICEF Kenya Country Office, UNICEF Somalia Country Office, Kuehne + Nagel and Nutriset. The data sets used are listed below in Table 2 along with their place of origin.

*Table 2: Data sources for lead time and landed cost analyses in Product Flow section*

<b>Information gathered</b>	<b>Data Source</b>	<b>Data Source Supplier</b>
Description of orders as related to time dates of orders	UNICEF SD ZPOD spreadsheet	UNICEF Supply Division
Description of orders from the initial	UNICEF SD ZSOS spreadsheet	UNICEF Supply Division



contracts		
Completed orders listed with total freight cost	UNICEF SD Freight Analysis spreadsheet	UNICEF Supply Division
Stock movements of RUTF in and out of Somalia warehouse	Somalia CO Dispatch Report spreadsheet	Somalia Country Office
Stock movements in and out of Kenya warehouse	Kenya CO Stock Movements spreadsheet	Kenya Country Office
Kuehne + Nagel file listing completed shipping reports	Nutriset	Kuehne + Nagel

### ***Methodology of Analyses***

Table 3 lists data points calculated (such as production lead time), the source of the spreadsheet that provided these variables, and the column headings from that spreadsheet that were used to determine the data point.

*Table 3: Description of methods used for lead time and landed cost analyses in Product Flow section*

<b>Data Point</b>	<b>Data Source</b>	<b>Column Headings Used</b>
Lead time: Total	UNICEF SD ZSOS spreadsheet	SR End Date - PGM issue date
Lead time: Supply Division	UNICEF SD ZSOS spreadsheet	PGM issue date - PO release date
Lead time: Production	UNICEF SD ZSOS spreadsheet	SN delivery date - PO release date
Lead time: At port	UNICEF SD ZSOS spreadsheet	SR sailed date - SN delivery date
Lead time: To Mombasa	UNICEF SD ZSOS spreadsheet	SR sailed end date – SR sailed date
Lead time: Customs and transport	UNICEF SD ZSOS spreadsheet and: for Kenya, KEN_RUTF_StockMovements and for Somalia, Receipt Dispatch Report	Arrived (date order arrived in warehouse) – SR sailed end date
Lead time: Warehouse	For Kenya, KEN_RUTF_StockMovements, and for Somalia, Receipt Dispatch Report	Out (date order distributed from warehouse) – Arrived (date order arrived in warehouse)
Lead time: To Addis	UNICEF SD ZSOS spreadsheet	SR sailed end date – SR sailed date
Amendments for TAD	ZSOS_Plumpynut_notes-amendments	No calculation necessary
Late orders	UNICEF SD ZSOS spreadsheet	Comparison of “First Date” (final TAD) and “SR sailed end date

Freight cost	Freight Analysis Spreadsheet	No calculation necessary
UNICEF RUTF orders	UNICEF SD ZSOS spreadsheet	No calculation necessary
Production capacity for Nutriset	Data point supplied by Nutriset	No calculation necessary
Order weight and production lead time	UNICEF SD ZSOS spreadsheet	No calculation necessary
Transport delays sea v. air	UNICEF SD ZSOS spreadsheet and Freight Analysis spreadsheet	Comparison of lead time by sea and lead time by air
Method of shipment per order	UNICEF SD ZSOS spreadsheet and Freight Analysis spreadsheet	No calculation necessary
Cost of order	UNICEF SD ZSOS spreadsheet and Freight Analysis spreadsheet	No calculation necessary
Shipment cost per order	Freight Analysis spreadsheet	No calculation necessary
Demand for RUTF	UNICEF SD ZSOS spreadsheet	No calculation necessary
Double production capacity	Data point supplied by Nutriset	No calculation necessary
Portion of RUTF produced by Nutriset	Data point supplied by Nutriset	No calculation necessary

The component spreadsheets were combined into a master spreadsheet, titled RUTF Master Data. Individual orders were matched by linking PO numbers, transportation dates, order volume and weight, and country of destination. All analyses were executed from this spreadsheet. Analyses for lead time were separated into emergency and non-emergency orders to account for the expedited nature of emergency orders. Note that Lead time: Total was calculated using the PGM Issue Date and the SR Sailed End Date. For these analyses, total lead time does not include lead time after the port-of-arrival, because there were not enough reliable data points available for meaningful analyses. Graphs that show time at customs and transportation time from Mombasa to Mogadishu used anecdotal estimates collected during the field visits, and are not tied to data provided in spreadsheets.

### ***Limitations of Analysis***

***Data Discrepancies:*** There are possible questions of data consistency and reliability that affect these analyses. Data discrepancies may have limited the scope of these analyses; for example, UNICEF's listed departure and arrival dates sometimes conflicted with Kuehne + Nagel's data (See **Figure 1a, Appendix II**). In addition, discrepancies were found between order arrival dates in Somalia and the arrival date for the same order in Mombasa. For example, **Figure 1b (Appendix II)** shows an instance where a specific RUTF shipment was listed in the Somalia warehouse 4 months before the shipment was listed as arriving in Mombasa. Data discrepancies such as these were resolved whenever possible by comparing information between multiple spreadsheets.

*Figures 1a, 1b: Examples of data discrepancies*

**Data discrepancies-  
UNICEF & K&N shipping dates**

Shipping Report Sailed End Date  
\*  
Actual Time of Arrival

SR Sailed date	SR Sailed End Date	SO Rou	Desc	ETA	ATA
9/14/2007	10/14/2007	ombasa b	07 07/14/07 07/17/07 07/17/07 08/12/07 08/13/07		
10/5/2007	11/11/2007	ombasa b	07 09/14/07 09/17/07 09/26/07 10/14/07 10/13/07		
11/9/2007	12/18/2007	ombasa b	07 10/06/07 10/08/07 01/11/07 11/17/07 11/01/07		
12/18/2007	1/13/2008	ombasa b	07 10/29/07 10/29/07 11/05/07 11/30/07 11/22/07		
			07 11/09/07 11/09/07 11/14/07 12/16/07 12/08/07		
			07 12/18/07 12/20/07 12/27/07 01/13/08 02/04/08		

\* Source: combined IPOD/ESOS spreadsheet, from 01 July 07 – 03 Oct 08

Shipping Report Sailed Date  
\*  
Actual Time of Departure

**Data discrepancies-  
K&N and Somalia Warehouse Arrival Dates**

Arrival in Mombasa: Oct. 13<sup>th</sup>, 2007

Arrival in Mogadishu: June 19<sup>th</sup>, 2007

PO number	ATA	DATE ENTRY day/month/year	PGM/SRQ#	IO/PO#
45081429	13/08/07	7/10/2006	SOMA/08/000096	N/A
45083561	08/11/07	19/06/2007	SOMA/07/0218	45083747
45083747	13/10/07	19/06/2007	SOMA/07/0262	45085041
45085041	22/11/07	07/11/07	SOMA/07/226-1	45083561
45085360	08/12/07	30.09.08	SOMA/08/0133	45090961

\* Source: "Nutriset" spreadsheet from K+N Data Set

\* Source: Nutrition feed items stock October 2008 (Somalia CO)

Same PO#

Order arrives in Mogadishu 4 months before it arrives in Mombasa

*Limited Orders to Kenya:* RUTF orders to Kenya are relatively few in number: nine orders in 2008, one in 2007, six in 2006, and three in 2005. It must be acknowledged that a total study sample of 19 limits the generalizability of the findings in the analysis. Analyses for Kenya are therefore meant to be illustrative of general trends in RUTF shipments to Kenya. Data for Somalia and Ethiopia were more substantial, with total orders between 2005 and 2008 numbering 33 and 64, respectively.

*Lack of Available Data:* In some instances, requested data were unavailable. For instance, delays in ports of transshipment were suspected as possible reasons for high transport time variability, but currently these data are not monitored.

## Information Flow

### Description of data sources

Table 4 lists the information gathered for the information flow section, where the information came from, and the method for collecting that information.

*Table 4: Description of data sources used for Information flow analyses*

Information Gathered	Data Source	Data Source Supplier
Supply Chain Diagram: UNICEF activities	Stakeholder interview	UNICEF SD, CO, PD, RO
Supply Chain Diagram: Partner Activities	Stakeholder interview	UNICEF SD, CO, PD, RO; partners
RUTF supply chain information tracking systems	Stakeholder interview	UNICEF SD; K+N
Forecasting Data: Implementing NGO	Stakeholder interview	NGOs (Concern, Merlin, ACF)
Forecasting Data: Ministry of Health	Stakeholder interview	MOH in Kenya
Forecasting Data: UNICEF Country Office and Regional Office	Stakeholder interview	UNICEF RO, CO

Forecasting Data: UNICEF Supply Division	Stakeholder interview	UNICEF SD
Forecasting Data: Multilateral Groups	Stakeholder interview	UNICEF SD, PD
Forecasting Data: Donors	Stakeholder interview	Donors (USAID, ECHO)
RapidSMS program	Stakeholder interview; Rapid SMS Ethiopia document; Rapid SMS User Guide	UNICEF SD, PD

### ***Limitations of analyses***

Many of the limitations of information flow analysis have been outlined above. These include uncertainties in information, including questions about data quality (such as mismatches in forecasting data methods and analyses, transitions to more accurate reference standards for malnutrition indicators, discrepancies between district- and national-level data) as well as operational challenges in information flow, including lack of data visibility downstream in the supply chain.

There also may be data integrity concerns for nutrition information. Although NGOs are often the only source of information on emergencies and nutrition status at the sub-national level (particularly IDPs and insecure areas) their methods and analyses have been shown to have some shortcomings (Degomme and Debarati, 2007). In an analysis of surveys conducted by NGOs and international agencies submitted to the UN SCN database, only slightly more than one-third of the nutrition surveys were found to be valid, precise, and meet standard criteria for quality of measurement, definitions of outcomes, and calculations, in particular those surveys conducted during complex emergencies. This also was seen in an analysis of surveys conducted during the Somali famine in the early 1990s (Prudhon and Spiegel, 2007; Boss *et al.*, 1994).

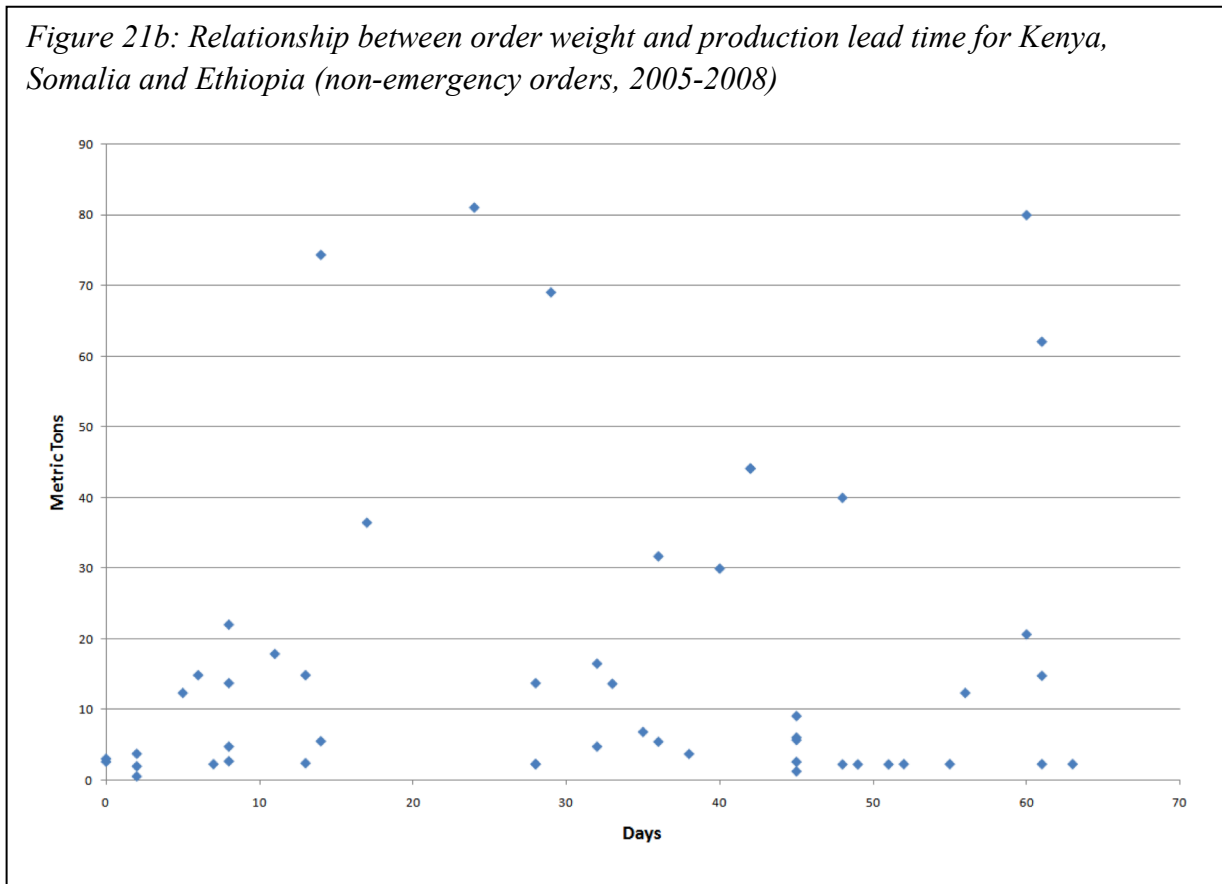
### **Funding Flow**

*Table 5: Description of methods used for lead time and landed cost analyses in Product Flow section*

<b>Analysis</b>	<b>Data Source</b>	<b>Column Headings Used</b>
Price per carton of RUTF v. quantity ordered by UNICEF Country Offices	ZPOD spreadsheet	Sum of quantity delivered, sorted by PO create date (per year) v. amount paid for orders in that year (value in local currency divided by quantity delivered)

## Other charts and data from the Analysis section

*Figure 21b: Relationship between order weight and production lead time for Kenya, Somalia and Ethiopia (non-emergency orders, 2005-2008)*



### **APPENDIX III: ADDITIONAL USES FOR THE DYNAMIC MODEL**

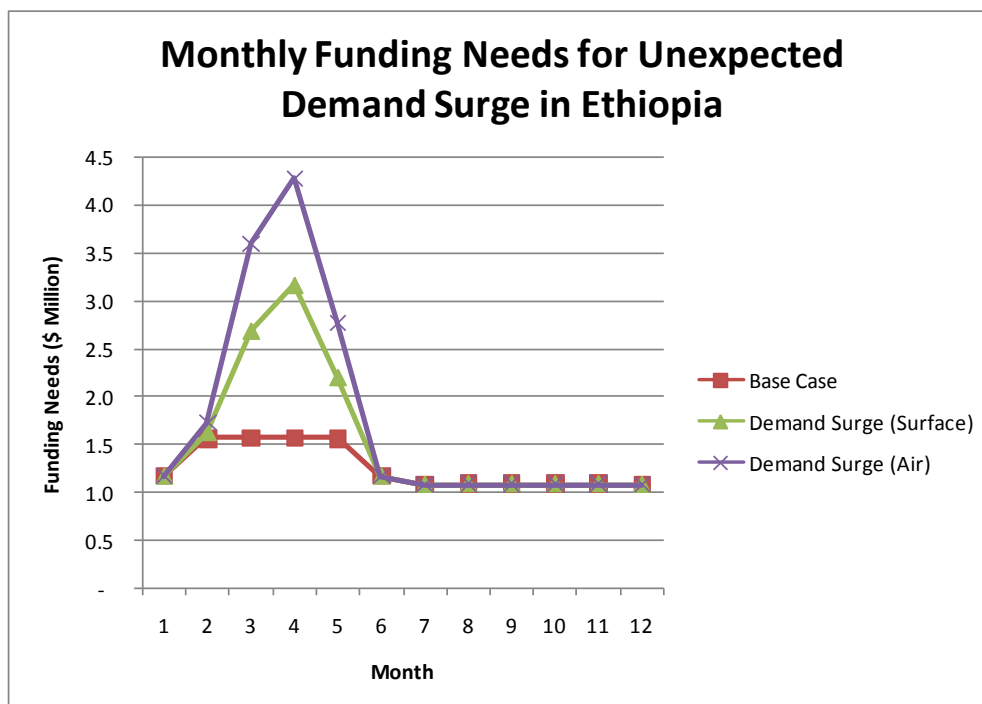
#### **i. COUNTRY OFFICE USE OF DYNAMIC MODEL**

The dynamic modeling tool can be used to help guide planning and decision making activities at multiple levels within the supply chain. Although it was designed to model supply chain activities across multiple countries, the tool can be used for a variety of purposes at the Country Office level. The purpose of this Appendix is to illustrate some of these options.

The focus of this analysis will be on the Ethiopia Country Office, but the same parameter changes could be made for any other country. In the base case model, Ethiopia has a local producer with a capacity of 30 MT/week, 75% of which is available to satisfy UNICEF demand within Ethiopia. Any additional need is satisfied by a non-local producer in France (Nutrisset). The price UNICEF pays for RUTF is assumed to be \$5,000/MT from either producer. Given forecasted demand for RUTF and assuming that funding will be available to order RUTF as demand materializes, the baseline performance of the RUTF supply chain for Ethiopia results in a total annual supply chain cost of \$15.1 MM, a total landed cost of \$5,150/MT and an average delay of 5.0 weeks. The dynamic model can then be used to test the impact of various alternatives on performance of the RUTF supply chain for Ethiopia.

1. **Transportation.** The baseline assumption is that all transportation in the supply chain will occur via surface routes. Changing to air transportation will speed the delivery of RUTF, but increase the annual supply chain cost and landed cost. Since there is some local production in Ethiopia, switching to air transportation will not affect all demand, but only the demand met by the non-local producer. The dynamic model shows that switching to air transportation will reduce the average delay from 5.0 to 2.0 weeks, but will increase the landed cost to \$6,333/MT and increase the total supply chain cost by \$3.5 MM per year.

2. **Demand Surge.** The effect of an unexpected surge in demand will vary depending on how the country office is able to accommodate the extra demand. To demonstrate how the dynamic model can be used to help assess some of the trade-offs, we model an unexpected demand surge that begins in week 22, peaks at double the standard level of demand, takes 4 weeks to reach peak demand, stays at peak demand for 5 weeks, and takes 4 weeks to recede back to normal demand. Assuming that surface shipment continued to be used and that extra funding was available to meet the unexpected increase in demand, this surge would cause a slight increase in average delay to 5.3 weeks (a higher percentage of RUTF would have to be supplied by the non-local producer) and require an additional \$3.4 MM in funding. The month-by-month funding levels needed to support the demand increase can also be determined from the model (see chart below). If orders during the unexpected surge in demand were to be air shipped, the average delay would be reduced to 4.1 weeks, but the total additional funding required (relative to the base case) would be \$6.1 MM. If there was no additional funding (i.e., only the original funding needed to support the base case was available), the impact on the supply chain for Ethiopia would be dramatic. Without sufficient funding to place orders large enough to meet entire demand, the average delay will rise from 5.0 weeks to 13.2 weeks. Even more troubling, the dynamic model calculates that there will be shortfall of 560 MT of RUTF, which translates into nearly 45,000 children with severe acute malnutrition who will not receive treatment. Needless to say, these numbers can help tell a compelling story to potential donors.



**3. Expansion of Local Production Capacity.** Expanding the capacity of the local production facility, even if the added scale doesn't result in cost/price reductions, should benefit the RUTF supply chain for Ethiopia by reducing the average time needed to satisfy demand and eliminating some of the transportation expense. For the base case, a doubling of the local production capacity (from 35 MT/week to 70 MT/week) would reduce the average delay from 5.0 to 2.3 weeks, while trimming \$350,000 from the annual supply chain cost and reducing the total landed cost from \$5,150/MT to \$5,030/MT. Should an unexpected surge in demand occur, expanded local production serves as a much lower cost alternative to air shipment to still provide reasonable supply chain responsiveness during a hunger crisis. The average delay for this scenario is 2.9 weeks, even while assuming that surface transportation is still used for all shipments. This compares favorably to the 4.1 week average delay when air shipments are used without local capacity expansion during the unexpected surge in demand, and the annual supply chain cost is over \$3.0 MM less. By using air transportation during the surge in conjunction with expansion of local production capacity, the average delay can be reduced from 2.9 weeks to 2.0 weeks, at an annual cost to the supply chain of slightly less than \$2.0 MM.

**4. Production Capacity Expansion Reduces Price of RUTF.** The final local scenario we analyze calculates the impact of a reduction in RUTF price that is driven by economies-of-scale based cost reductions to the local producer. We investigate the impact of a 10% reduction in RUTF price (from \$5,000/MT to \$4,500/MT) from the local producer that coincides with a doubling of the local producer's capacity. Compared to the case when capacity is expanded without a resulting decline in price, this scenario results in annual supply chain cost savings of \$1.2 MM and a reduction in total landed cost of \$447/MT (the reduction in landed cost is not \$500/MT because some RUTF is still supplied by the non-



local producer, from whom the price remains at \$5,000/MT). Should an unexpected surge in demand occur, the additional funding, above the original base case funding, needed to fulfill demand from the surge is only \$1.75 MM (as compared to \$3.4 MM without an increase in capacity and reduction in price).

## **ii. ADAPTATION OF DYNAMIC MODELING TOOL TO OTHER COMMODITIES**

Although this tool was developed to help guide configuration decisions in the supply chain used by UNICEF to supply RUTF to the Horn of Africa, it was designed to be sufficiently flexible to also help model supply chains for virtually any product. As currently constructed, the model can accommodate up to three demand locations, up to two warehouse locations, and up to six production locations. The model is designed to use at most one of the two warehouse locations in any scenario. The first three production locations are assumed to be local production sites aligned with the three demand locations (i.e., they are the first option for satisfying demand from their country, and they never provide product to other demand locations). As long as no more than the indicated number of demand, warehouse, and production locations are needed, the model can be used with little or no modification to the model logic. If fewer locations are needed, one or more locations can be “zeroed” out (i.e., if you don’t need one of the production locations, you can just specify that it has a capacity of 0 and it will be ignored within the model). Demand locations don’t need to be countries; the tool could be used to model demand and the resulting supply chain in specific territories within a country (a more micro level) or entire continents (a more macro level).

Transportation between any two nodes in the supply chain is accommodated using one of two possible transportation modes. These are labeled in the tool as surface and air, but the model can be used to investigate the different impact of any two transportation modes. For example, if one wanted to consider sea transport vs. land transport, one would just enter the appropriate transportation times and costs for each of these alternatives in the transportation data section of the tool.

Adapting the tool to analyze supply chain performance for another commodity that has a similar structure to the RUTF supply chain is simply a matter of inputting the appropriate data for the new commodity. This includes the names of the demand, warehouse, and production locations, the demand and funding levels for the commodity in the three demand locations, transportation costs and times between each pair of nodes for up to two transportation options, warehouse costs if buffer inventory will be considered, and capacity and production cost information for each production site.

If the supply chain has a different structure than the RUTF supply chain (e.g., five demand locations that must be considered), the dynamic modeling tool will need to be enhanced. This will require a reasonably sophisticated knowledge of Microsoft Excel to ensure that the logic built into the model is accurately extended to any new design elements. The underlying logic, however, is already present in the model and only needs to be replicated for the additional features. Changing the underlying logic of the dynamic modeling tool will require a still greater familiarity with Microsoft Excel.

## **APPENDIX IV: SECOND-STAGE KPIS**

### **Lead Time Second-Stage Key Performance Indicators**

#### ***Production Lead Time KPI***

*Definition:* This KPI measures the length of time (in days) to produce an order of RUTF. It begins when the order is received at the producer from Supply Division, and ends when the RUTF is ready for pickup by the global logistics supplier.

*Purpose:* Uneven ordering activity coupled with insufficient production capacity and delays of information can lengthen production lead times, as was demonstrated in the Product Flow section. The purpose of this KPI is to monitor the time between the placement of orders and the eventual delivery of products, so that UNICEF can assess the cause of the delay early in the supply chain and then take remedial actions. For example, there was an increase in RUTF demand in 2008 that ultimately led to production delays due to insufficient capacity. Fortunately, UNICEF's responsive oversight of the RUTF supply chain allowed them to proactively manage this shortage. When it became apparent that demand might exceed capacity, SD worked closely with Nutriset to compare order requests and production capacity, and they actively planned order schedules accordingly. This was an effective approach to managing the supply chain in this acute emergency situation. However, under more typical circumstances, and especially as more entities produce and demand RUTF in the coming years, such close supervision may not be realistic. This KPI would therefore serve to catch such problems and trigger Supply Division to act quickly to stage orders in a way that did not bump up against constraints of production capacity. This does not preclude UNICEF from continuing its informal oversight of orders, which can serve as an early sentinel warning of lead time problems, as it did in 2008. Rather, the KPI would provide a reliable base check on the system.

Order production time was found to be one of the most variable steps in the RUTF supply chain and a potential major contributor to an erosion of trust in the supply chain. In the current LTA with Nutriset, there is a commitment to deliver RUTF within one week from receipt of purchase order, but it allows for negotiation in the case of limited supply or inability to meet order specifications. Production dates for RUTF are, in fact, frequently delayed. Monitoring production lead time will allow UNICEF to assess how well producers are meeting these agreed-upon timelines, as well as give an idea of how order volume might be affecting production. Trends in the findings from this KPI will indicate which stakeholders hold the most influence over order processing time and should, therefore, warrant the most attention when trying to permanently reduce this processing time.

Production lead time is affected by multiple stakeholders in the supply chain. The RUTF manufacturer is central to production lead time because it has control over materials procurement, order scheduling and prioritization, and production capacity (including surge capacity in case of emergency). It is significant to note, however, that Country Offices also have a high degree of leverage over production lead time. The variability in their order volumes lead to spikes in demand that push production capacity to its limit, ultimately creating delays in production that then cascade into delays across the supply chain.

*Usage:* Currently these data are available and already monitored by UNICEF at Supply Division, so no new data collection is required. Production lead time should be monitored by Supply Division on a monthly basis. This frequency will allow UNICEF to notice a long production lead time, to implement a change to mitigate this (for example, coordinate order amounts placed by COs to smooth demand), and then to see the effect of its intervention.

Information from this KPI can serve several supply chain management purposes. First, trends in the data will enable Supply Division to proactively lower production lead time by coordinating across offices and working with RUTF producers to prioritize orders. Second, the KPI can provide information to COs help make strategic decisions about shifting orders across suppliers. UNICEF may choose to divert orders from producers that have consistently long or variable production times to those with shorter lead times.

### ***Global Transportation Lead Time KPI***

*Definition:* Global transportation time represents how long it takes (in days) for an order of RUTF to travel from point of export (i.e., when it is picked up by a global logistics supplier) to port of arrival. It includes time spent at any points of transshipment, as well as obtaining necessary documents for customs clearance at the port of departure and port of arrival.

*Purpose:* A global transportation lead time KPI can help assess the impact of changes in transportation methods and procedures. Recalling the earlier Product Flow section, global transportation time is one of the longest and most variable steps of the supply chain. The wide variability in transportation time, combined with the lack of automated exceptions handling and backward information flow, erodes confidence in the supply chain. Although SD currently provides tools to help ROs and COs make informed shipping time estimates, these are inaccurate and infrequently adjusted. The shipping calculator data are updated no more frequently than annually, even when there are known events that affect transportation time (for example, congestion at points of transshipment or ports of entry). When a CO compared the actual shipping times for their RUTF orders with numbers generated by the supply calculator, it was significantly off: the shipping calculator gives the time from Le Havre to Mombasa as 34 days, but they found that their orders took an average of 56 days (range: 50 to 63 days). In addition to being unreliable, the supply calculator also does not have its performance checked. There is no regular comparison of real transit times to the calculator, so partners have no way of estimating a reasonable margin of error on the results. A transportation time KPI would help resolve some of these challenges.

This KPI significantly impacts multiple stakeholders, but they have little leverage over influencing the transportation time. The global logistics providers are the main stakeholders with influence for this KPI, but they have little control over transportation times because these are mostly dependent on port congestion as well as government regulation and paperwork. A range of other partners--from ROs and COs to implementing NGOs and governments—also are affected by global transportation time, but they have no leverage over this step in the supply chain.

*Usage:* Currently these data are available and tracked by UNICEF through SAP as well as by the freight forwarding companies themselves. The new automated synchronization between UNICEF and transporters' databases will significantly ease data analysis for this KPI and will remove some of the current uncertainty due to manual data entry errors. In the meantime, the UNICEF database should be the primary data set referenced, with individual freight companies' databases used for cross-reference when verification is needed.

The project team recommends that global transportation time be monitored by Supply Division on a monthly basis. Changes to transportation procedures can be quickly realized so a KPI monitored monthly would provide near real-time information on the effectiveness of these interventions. As changes are made to transportation procedures and this KPI monitors those changes, trends in the data will provide insights on how to make transportation more efficient and less variable. As an example, the theoretical transport time from Le Havre to Mombasa by sea is approximately 34 days, but transshipment delays can extend this significantly. This KPI would quickly capture whether a change in transshipment port, for example, reduced global transportation lead time. Trends in the KPI could indicate whether a particular port of transshipment experiences longer congestion during certain parts of the year and UNICEF could then work with their transport companies to route shipments through alternate ports based on seasonal changes.

### ***In-Country Transportation Lead Time KPI***

*Definition:* In-country transportation time measures the number of days from when an order clears customs at the port of arrival to when it is picked up or delivered to an implementing partner. This includes transportation time to the UNICEF country or district warehouse, as well as time spent in storage and any relevant transport time to an implementing partner's storage facility.

*Purpose:* The purpose of this KPI is to track the flow of goods within the country. This KPI can be used to analyze the implications of country level decisions made related to transportation. For example, how changes in local distribution partners may impact distribution time, how changes in transportation and routing routines impacts the distribution time, and the extent of delays caused by seasonable and environmental conditions such as floods. The ability to monitor this is significant because local distribution is logistically the most difficult part of the supply chain. The involvement of multiple in-country stakeholders, political and social unrest, obstacles to local trucking routes, and a range of other variables make distribution particularly challenging. While this final leg of in-country transportation poses perhaps the greatest challenge, the Country Office also holds the most control over this part of the supply chain and is deeply vested in ensuring its performance. For example, long local distribution times impact country offices, but country offices also hold a high degree of leverage because they can shift transportation routes, change shippers, or move warehouse locations, where possible, to improve local transportation time. For this reason, we believe that changes made at this end of the supply chain should be more quickly realized, and the data gathered by the KPI will help to quickly identify best practices which can be exported to other country offices.

*Usage:* Currently there are some data available to track in-country transportation lead time, but they are spread across multiple sources and in various formats. In order to implement this KPI

we recommend the creation of a standard data collection method, such as SMS messages and an in-country program officer who will collect dates on when orders arrive in country and when they eventually leave the warehouse. If a product moves into multiple warehouses (country to district level), then all of the movements should be captured. Ideally this method is one which can be used by all country offices. Once the data have been collected, the next step will be to aggregate the data into one source, so that the monitoring of this KPI will become less challenging. The team recommends that these data be integrated in the Financial and Logistics systems (SAP-FLS, PROMS, Unitrack) currently used by Supply Division and Country Offices to monitor other key elements of the supply chain.

In-country Transportation Time will be monitored by the country office, and the project team recommends that this be done on a monthly basis. As seen in the previous KPI, this will allow for real time monitoring of the effect of changes made to local distribution.

Data collected by this KPI will provide more insight into the dynamics of interaction among different in-country stakeholders and their relationship to local distribution time. For example, efficient in-country transportation may exist, but country offices may be seeing excessive local distribution time because in-country distribution partners are having difficulty reaching the in-country warehouse. Action can then be taken to assist the in-country distribution partners, either by transporting RUTF directly to them, shifting the warehouse location to a more strategic location, or helping distribution partners gain access to better distribution systems. When such an action is taken, the impact of this decision will be reflected in the KPI. Over time, trends in these data will allow for better decision making and more informed strategic planning. In addition, the monitoring of distribution times can provide new insights as to how to make the distribution process more efficient. For example, one local distribution partner may have consistently shorter lead times than its competitors. If this is the case, that partner can be more closely examined for best practices to improve distribution lead time.

### ***Warehousing Lead Time KPI***

*Definition:* This KPI would measure the amount of time that an order of RUTF would spend in each of the UNICEF warehouses within the country from the time the order enters a country to the time it reaches its final point of delivery.

*Purpose:* Warehousing lead time is part of transportation lead time mentioned above. Separate tracking of this measure would help UNICEF work in collaboration with supply chain partners to improve the delivery performance and help in monitoring both the amount of stock in the warehouse and the time it spends in the warehouse. This KPI is complementary to the warehousing landed cost KPI; they offer different lenses (temporal versus monetary) on the same question of warehousing efficiency.

Long warehouse lead time not only indicates that the RUTF order is being held up at specific locations, but also indicates poor warehouse management (like not following the principle of first expiry, first out) or highlight accessibility problems (if a security threat prevents orders from being shipped from a warehouse). The time that an order of RUTF spends in a warehouse could also affect downstream execution and subsequent planning. For example, if a planned order experiences long warehouse lead times just before the point of distribution, the field officers

might not realize that the order is on its way and instead might place emergency orders to meet a perceived shortage. When this order finally reaches the destination point, it may have very less useful shelf life remaining and hence may be pushed over other scheduled deliveries. Thus, a ripple effect of delays and shortages is created which could derail the original plan.

*Usage:* Warehousing lead time should be tracked by Country Offices on a monthly basis. This lead time also ties into the calculation of Warehousing Cost KPI, mentioned later. Currently there are no data collected for this KPI. The utility of this KPI will be maximized if COs can track orders as they arrive and leave the warehouse.

*Table 6: Second-Stage Lead Time KPIs*

<b>KPI</b>	<b>Frequency</b>	<b>Data</b>	<b>Who Monitors</b>
Production lead time	Monthly	Data source: ZSOS Variable: PGM Issue date and PO delivery date	Supply Division
Global Transportation Lead Time	Monthly	Data Source: ZSOS Variable: PO delivery date, SR Sailed End date	Supply Division
In-country Transportation Lead Time	Monthly	Data Source: ZSOS, Kenya – Stock Movement, Somalia – Receipt Dispatch Report Variable: SR Sailed End date, Arrival Date, Date In	Country Office
Warehousing Lead Time	Monthly	Data Source: Not currently available  Variable: number of days spent by an order of RUTF in each warehouse	Country Office
Overall Lead Time	Quarterly	Data Source: ZSOS, CO Stock Movement Variables: PGM issue date, Dispatch Date	Supply Division; Country Office
TAD Delays	Monthly	Data Source: ZSOS, “Field office format” output for Special Sales Order heading texts	Supply Division; Country Office; Regional Office

### **Landed Cost Second-Stage Key Performance Indicators**

#### ***Procurement Costs KPI (Cost of goods)***

*Definition:* This KPI monitors how the cost paid per metric ton for RUTF (in US dollars) compares to historic cost data. This would be calculated as total cost per net weight, in metric

tons. In addition to using raw currency values in this KPI, it should include a second dimension that standardizes the price against exchange rate fluctuations.

*Purpose:* The cost of product is the strongest driver of total landed cost for the RUTF supply chain. This KPI will allow UNICEF to monitor this cost, to assess changes in pricing trends and anticipate increases or decreases in RUTF price per metric ton. This will allow for more effective planning and budgeting for RUTF by COs, particularly if there is an expanded supplier base with a range of price offerings. It may also help track the efficiency of these suppliers by correlating the price charged by a producer with the costs of raw materials for RUTF. Although the current LTA with Nutriset ensures prices for UNICEF orders for each 2-year period, this KPI may become especially relevant as COs begin to place orders with multiple RUTF suppliers.

*Usage:* Currently this information is collected in SAP. The project team recommends using a weighted average (based on the metric ton of the order) of worldwide orders for this KPI, which will help to quantify volume discounts from suppliers. It is suggested that this KPI be measured in US dollars so there is a common currency across the supply chain but it will be important to normalize this KPI against currency rate fluctuations. Since 2005, the dollar-to-euro exchange rate has ranged from 1.168 to 1.599, which has a significant impact on how much RUTF can be purchased but for reasons outside the supply chain. So it would be important include this standardization in the KPI.

Procurement costs should be monitored by Supply Division on a quarterly basis. Raw material costs for RUTF can rapidly shift, as was recently seen in a worldwide rise in milk prices, so quarterly monitoring will help identify price shifts in a timely manner and will help to inform price projections and budget planning. As data are collected, COs can incorporate anticipated changes in price into fundraising efforts and Supply Division can help manage price increases (for example, through negotiating prices in contracts or searching for less expensive suppliers).

### ***Global Transportation Cost KPI***

*Definition:* The Global Transportation Cost KPI measures the total cost per metric ton of RUTF (in US dollars) to transport an order of RUTF from point of export to port of entry, whether by sea freight, over-land transport, or air shipment. This KPI compares transportation cost per method over time (in other words, sea freight expenditures per MT from one annual quarter to another) as well as a cross-sectional comparison across methods (within an annual quarter, the price of shipping via air, sea or land). It would also include a metric to assess global transportation cost as a percentage of total landed cost for RUTF orders per time period.

*Purpose:* Monitoring global transportation costs will help UNICEF determine the impact of expedited transportation on the supply chain. A strong supply chain includes accurate planning that reduces the need for unexpected expedited shipping to meet demand peaks, thereby reducing the global transportation landed cost. As discussed in the Product Flow section, 12% of all orders placed to Kenya, Somalia, and Ethiopia since 2005 have been amended to increase the amount needed to cover freight costs. Since air freight can cost more than ten-fold per metric ton that of sea freight, even shifting a few orders to expedited air shipment can cause a significant impact on the total landed cost of the RUTF supply chain. The comparison of cost across transport methods will help UNICEF understand the true impact of its planning decisions on landed cost.



Additionally, the historic trends in pricing will be of particular interest to ROs and COs as they are responsible for raising funds to cover the purchase and transport of RUTF. The data will also help COs and Supply Division better prepare and plan for upcoming budget cycles.

*Usage:* The data for this KPI are already collected by Supply Division. Global transportation cost should be monitored by Supply Division on a monthly basis and reported out to the COs and ROs. This KPI will help UNICEF assess the root causes of change in RUTF transportation costs; frequent monitoring is important for the early observation of cost trends, which can help UNICEF respond rapidly with supply chain improvements. As an example, an increasing global transportation landed cost should prompt inquiry into what modes of transportation have been used for RUTF orders. Such an increase is likely to be associated with a rise in the utilization of expedited air freight, which UNICEF could try to address through improved forecasting and demand smoothing. Alternatively, if there is a rising cost trend but no evidence that air transport has increased, there may be other factors driving this cost that are outside UNICEF's purview (for example, rising fuel costs).

### ***In-Country Transportation Costs KPI***

*Definition:* This KPI quantifies the cost in US dollars for transporting orders of RUTF from the port of arrival to UNICEF warehouses at the country or district level. It includes multiple dimensions: first, a historic comparison of standardized transportation costs (for example, the cost per kilometer for truck transport in Kenya in January 2008 compared to January 2009); second, an assessment of real variance within a period (e.g., the range of costs for truck transport in Somalia between October and December 2008); and lastly, a percentage of total landed cost per quarter for in-country transportation.

*Purpose:* This KPI will help UNICEF monitor the effect of in-country transportation on the cost of the supply chain. Road conditions, social or political unrest, delays in orders and inefficient backward information flow combined to make in-country distribution one of the most logistically difficult steps of the supply chain. This can in turn influence landed cost, and careful monitoring can be used to provide evidence of the overall impact of this on the supply chain. If flooding renders roads inaccessible and deliveries must be rerouted, this can drive up transportation costs as trucks take longer itineraries and greater logistical oversight is required.

Country Offices are most significantly impacted by these in-country transportation costs and also hold the most control over the supply chain activities that impact this KPI. It is, therefore, important to communicate performance on this indicator so that changes can be rapidly implemented and assessed.

*Usage:* Currently there is no systematized monitoring of the cost of in-country transportation. While the data can be inferred from contracts with local transporters, this would not take into account any deviations from the agreed-upon norm. Due to the relatively small number of orders per month, these transportation costs should be monitored on a quarterly basis and reported by the Country Office to ROs and Supply Division.<sup>25</sup>

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<sup>25</sup> This KPI may be complicated by the fact that trucks do not always exclusively carry RUTF, so it is recommended that the COs devise an allocation model to divide transportation costs across various items shipped on a truck, so that individual transportation costs can be obtained and this KPI can track RUTF specifically.

The monitoring of these costs and change trends will help UNICEF more accurately budget and fundraise. In addition, this KPI will allow COs to make better strategic decisions regarding in-country transport. Cost of transportation can vary from transporter to transporter, so these data can help COs monitor differences in price and change suppliers as needed. When coupled with lead time KPIs, trade-offs between transportation cost and time can become clear. As an example, a Country Office may find that the most expensive local logistics supplier has the shortest and least variable lead time, so a decision may be made to prioritize efficiency over cost. Likewise these KPIs might demonstrate that the most expensive transporter has a highly variable and lengthy lead time, and UNICEF might decide to change suppliers.

### ***Warehousing Cost KPI***

*Definition:* This indicator assesses the total cost (in US dollars) required to store RUTF at each UNICEF warehouse (country and district level) per length of time. UNICEF COs have LTAs with local warehousing facilities that indicate parameters for pricing. This KPI would measure how much it truly costs to store RUTF at those facilities. Similar to other landed cost KPIs, it should include several dimensions, including what percentage of total landed cost was allocated to warehousing for a fixed length of time and a variance measure for warehouse costs in that period.

*Purpose:* Demand for RUTF has recently begun to outpace supply, and it is also a product with a limited shelf-life, so warehousing costs should be low as product moves quickly to malnourished children. Increasing costs indicate inefficiency because orders are lingering in the warehouse. Country Offices are most affected by warehousing costs since this expense incurs against their project budgets. Data from this KPI will help establish more accurate budget planning and may also help encourage more proactive use of current RUTF stock. As noted in the warehousing lead time KPI, these two metrics are complementary views on the same issue of storage efficiency. While some supply chain partners may primarily judge efficiency in terms of time, others may better understand monetary costs--and these two lenses accommodate these different perspectives.

*Usage:* Currently there are no data collected for this KPI. The utility of this KPI will be maximized if COs can track orders as they arrive and leave the warehouse. Inventory holding costs should be monitored by COs on a quarterly basis. Monitoring inventory holding costs will serve as a diagnostic of problems in RUTF distribution. For example, if unit costs of warehousing remain steady but inventory holding costs are increasing as a percentage of the total landed cost of RUTF, this suggests that orders are sitting longer in the warehouse. This could be due to challenges around distribution such as an inaccessible warehouse, an excess of orders causing more supply than demand in a region, or the result of inefficient warehouse management. Once the root cause of the long warehouse time has been identified, UNICEF can take the necessary action to fix the problem.

Table 7: Second-Stage Landed Cost KPIs

KPI	Frequency	Data	Who Monitors
Procurement Cost	Quarterly	Data Source: ZPOD Variable: Value in USD	Supply Division
Global Transportation Cost	Monthly	Data Source: Freight Analyses Variable: Freight Value	Supply Division
In-Country Transportation Cost	Quarterly	Data Source: Not currently available  Variable: transportation cost (local contracts) * truck load volume/wt.	Country Office;
Warehousing Cost	Quarterly	Data Source: (Not currently available) Variable: Warehouse unit cost (from contracts) * Warehousing Lead time	Country Office
Overall landed cost	Quarterly	Data Source: Not currently available  Variable: Sum of Procurement Cost and Global Transportation Cost	Supply Division; Country Office

### Quality Second-Stage Key Performance Indicators

#### **Product Quality: Wastage KPI**

*Definition:* This KPI would monitor what percentage of RUTF is wasted, from the point that product is released by manufacturer's QA department until the RUTF leaves the UNICEF country warehouse, due to damage, theft, loss or expiration.

*Purpose:* Product loss caused by damage (faulty packaging or damage during transport), theft or loss in insecure settings, or expiry, affects the timeliness of treatment of malnourished children on the ground. While wastage was reported to be an insignificant problem in the current supply chain, increasing the scale of RUTF use may introduce more problems if the situation is not closely monitored. Wastage at any point in the supply chain, from production to warehousing, could introduce time or cost inefficiencies. UNICEF should begin tracking these measures at all sites to establish a baseline and to take a proactive approach to preventing an increase in wastage in the future. Implementing this KPI will help UNICEF work cooperatively with partners to ensure a consistent level of oversight in the quality of packaging and delivery and security of the supply chain.

*Usage:* Wastage should be tracked by various supply chain partners for three different dimensions: the amount of product damaged, the amount lost or stolen, and the amount that had to be discarded due to spoilage or expiry.<sup>26</sup> Damage should be tracked by producers, freight

<sup>26</sup> Many of the practices described below are already in place, as discussed in product flows section, although they may not be practiced consistently in all countries or across all districts. By mandating tracking of these KPIs for regular reporting to a centralized authority, such as Supply Division, each Country Office will be held accountable for closely monitoring wastage.

forwarders, and Country Offices. The first point of inspection would be a packaging quality inspection that should be performed before the product leaves the production facility. Freight forwarders, both global and local, as well as the UNICEF warehouse staff should also perform visual inspections for damage; this would include checking for dented or crushed boxes and looking for oil stained cartons (suggesting broken sachets). Implementing partners, including MOH staff and NGOs, should also continue to check for damage upon final receipt of the product. UNICEF has established KPIs for inspection of ARVs and vaccines upon arrival in-country, and it is recommended that similar protocols be implemented for inspection of RUTF.

Detailed information on any observed damage should be relayed rapidly to supply chain partners. If the packing materials were insufficient (sachets, pots, cartons, pallets), UNICEF Quality Assurance officers can work with the supplier to improve packaging. If the damage was caused by rough handling during transport, monitoring across the supply chain should allow partners to identify at what precise stage the damage occurred and therefore work on improving the handling process at that point.

Wastage due to theft or loss should continue to be tracked at the country level by noting quantity loaded for transport and quantity delivered on a corresponding order. These counts should take place any time the product is transported in country transit and should also be assessed periodically during warehouse storage. Counts for products undergoing transit should be taken by UNICEF or NGO personnel. Inventory counts can be performed by UNICEF personnel or by the party that manages the warehouse facility. If it appears that loss or theft occurs repeatedly at a specific location or transit route, UNICEF Country Offices can use this information to assess whether an alternate route or increased security might help them to limit losses.

Product expiration should continue to be monitored by Country Offices by inspecting sachets of RUTF held in storage. Dispensing locations (warehouses or other facilities that store RUTF, such as clinics, hospitals, etc.) should use a first-expiry-first-out system to manage inventory and avoid expiration. When expired product is identified, this would likely indicate that the FEFO system is not being effectively executed. In this case, Country Office personnel or implementing partners could work with the storage facility to improve their ability to practice FEFO inventory management.

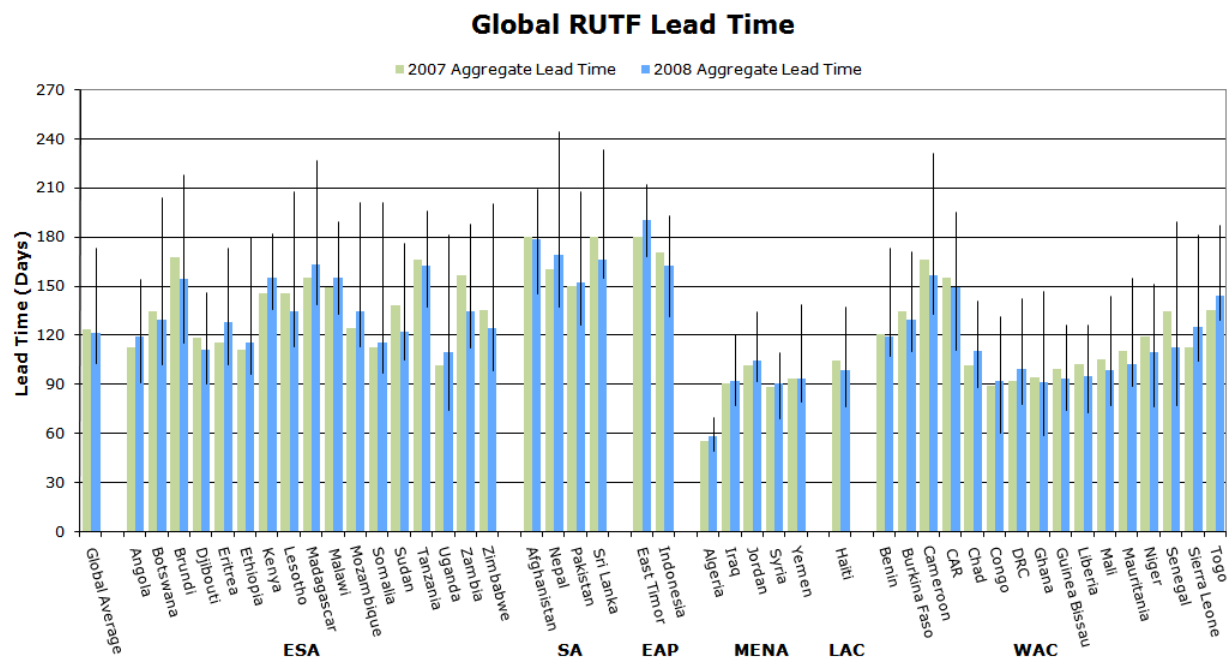
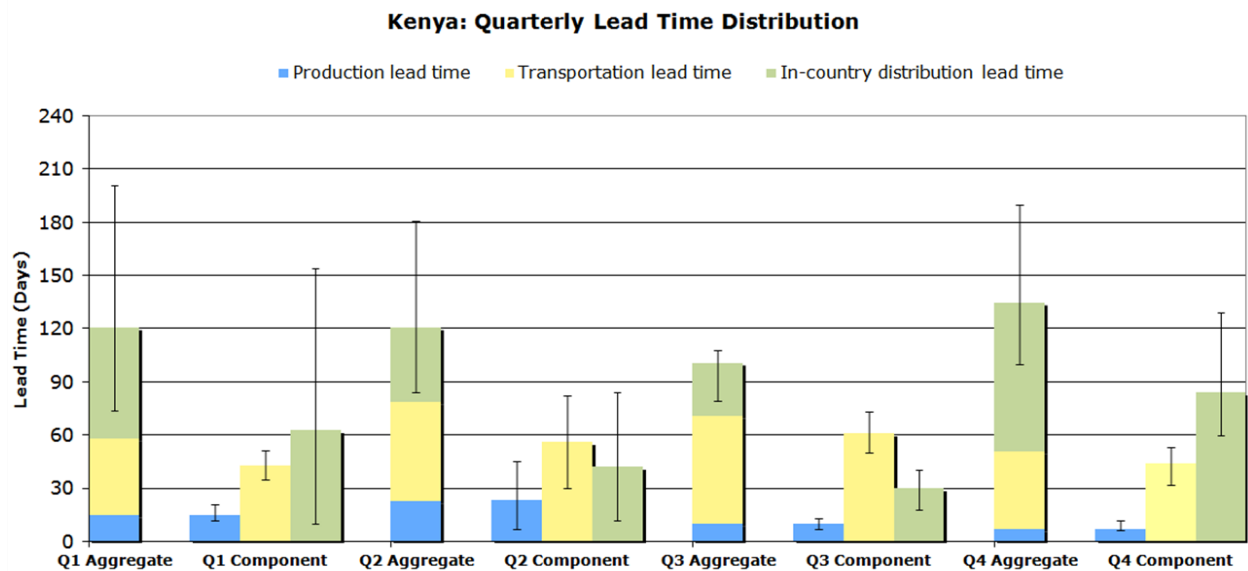
All data on wastage should be compiled for quarterly reporting to Supply Division and Country Office logistics personnel. Frequent reporting will allow UNICEF to identify any continual problems. If problems persist at a particular node in the chain, SD should address the issue with that partner, possibly offering training assistance to employees on product and package handling. If wastage appears to be particularly problematic late in the supply chain, UNICEF might seek to introduce a KPI to assess performance by its implementing partners. In cases where they cannot quantitatively track wastage, a qualitative assessment should be incorporated to indicate the amount of wastage (e.g., “none, a little or a lot” of RUTF was wasted due to damage, loss, theft or expiration).

*Table 8: Second-Stage Quality KPIs*

<b>KPI</b>	<b>Frequency</b>	<b>Data</b>	<b>Who Monitors</b>
Product - Wastage	Quarterly	<p>Data Source: Not currently available</p> <p>Variables:</p> <p>Damage-Number of cartons that are dented, broken, or display oil stains (indicating broken sachets)/ total number of cartons</p> <p>Loss/ theft-Number of cartons loaded for transport- number of cartons that arrive at country warehouse; number of cartons that should be in the warehouse- actual number of cartons present/ total number of cartons</p> <p>Spoilage or Expiry- Number of cartons that must be discarded due to expiry/ total number of cartons</p>	<p>Producer, Freight Forwarder, Supply Division, UNICEF-CO, Distributors, NGOs/ MOH</p> <p>Supply Division, UNICEF-CO, Distributors, Warehouse Facility Managers, NGOs/ MOH</p> <p>Supply Division, UNICEF-CO</p>

## APPENDIX V: SUGGESTIONS FOR DATA REPRESENTATION

Graphical representations of data can be highly effective in communicating a large amount of data in a small period of time. UNICEF should use graphical representations in order to communicate information to supply chain partners to ensure that the information is accessible and will be easily interpreted and acted upon by the relevant partners. Below are some suggested representations of data, however, these are just a few examples. UNICEF should work with their communications department to come up with representations that work best for their purposes. (Minimum and maximum values for each category are represented by the thin vertical lines on each plot.)



## Glossary

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**Backloaded funds:** a funding cycle where a majority of monies is available toward the end of a project period or fiscal year.

**Buffer stock:** a level of extra stock that is maintained to help avoid stockouts or excessive lead times.

**Bullwhip effect:** an observed phenomenon in forecast-driven distribution channels where an oscillating demand magnification is observed as one moves upstream in a supply chain.

**Community therapeutic care (CTC):** a new model for the treatment of severe malnutrition that delivers care in the home, rather than in a hospital-based setting.

**Component cost:** the monetary cost associated with each activity in the supply chain.

**Exceptions handling:** a process for handling and communicating unexpected events in the supply chain.

**First Expiry First Out (FEFO):** when products are utilized in the order of their expiry date (as compared to First In First Out, or FIFO, which prioritizes in order of arrival).

**Fiscal year:** the period used for calculating annual financial statements and for making annual projections and budgets (also called financial year or budget year).

**Formula-75 and Formula-100 (F75 and F100):** therapeutic milks to treat severe malnutrition, used primarily at in-patient feeding centers.

**Key Performance Indicators (KPIs):** financial and non-financial measures used to help an organization define and evaluate how successful it is.

**Lead time:** the period of time between the initiation of any process and the completion of that process.

**Logistics:** the management of the flow of goods, information and other resources, including energy and people, between the point of origin and the point of consumption in order to meet the requirements of consumers.

**Ready-to-use supplementary foods (RUSF):** portable and shelf-stable products that meet the supplementary nutrient needs of those who are not severely malnourished.

**Ready-to-use therapeutic foods (RUTF):** portable, shelf-stable, single serving foods that are used in a prescribed manner to treat children with severe acute malnutrition.



Severe acute malnutrition (SAM): “a very low weight for height (below -3 z scores of the median WHO growth standards), by visible severe wasting, or by the presence of nutritional oedema” (WHO, WFP, UNSSCN, UNICEF, 2007).

Supply chain: the system of organizations, people, technology, activities, information and resources that moves a product or service from supplier to customer.

Supply chain analysis: the study of how a product reaches a consumer, from the time when demand is anticipated until goods are delivered.

Total landed cost: the sum of all monetary costs associated with making and delivering products to the end customer.

Transshipment: the transport of goods to an intermediate location en route to its final destination.

Underweight: an indication for children who exhibit low weight-for-age measurements.

Wasting: an indication for children who exhibit low weight-for-height measurements.

### **Acronyms**

CAP: Consolidated Appeals Process

CHAP: Common Humanitarian Action Plan

CO: Country Office

DFID: UK Department of International Development

ECHO: European Commission’s Humanitarian Aid Office

ESARO: Eastern and Southern Africa Regional Office

LTA: Long-term agreement

RO: Regional Office

SD: Supply Division

TAD: Target Arrival Date

USAID: United States Agency for International Development

## References

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- Action Against Hunger, Ministry of Health, and UNICEF. "Nutritional Anthropometric Surveys Final Report: Pastoral, River Bank and Urban Communities of Garissa, Lagdera and Fafi Districts (Formally Garissa District) North Eastern Province, Kenya." ACF International Network. (2008). Available at <http://www.actionagainsthunger.org/sites/default/files/resources/surveys/Garissa%202007.11.pdf>
- Andert, Christoph, and Onesmus Muinde. "Three Nutritional Anthropometric Surveys Final Report: Mandera East and West Districts, North-Eastern Province Kenya." ACF International Network. (2008). Available at: [http://www.actionagainsthunger.org/sites/default/files/resources/surveys/Mandera\\_2008\\_03.pdf](http://www.actionagainsthunger.org/sites/default/files/resources/surveys/Mandera_2008_03.pdf).
- Boss, Leslie, et al. "Assessments of mortality, morbidity, and nutritional status in Somalia during the 1991-1992 famine. Recommendations for standardization of methods." *JAMA* 272.5. (1994).
- Central Bureau of Statistics (CBS) [Kenya], Ministry of Health (MOH) [Kenya], and ORC Macro. *Kenya Demographic and Health Survey 2003*. Calverton, Maryland: CBS, MOH, and ORC Macro. (2004).
- Collins, Steve. "Changing the way we address severe malnutrition during famine." *The Lancet*. 358.9280: 498-501. (2001).
- Collins, Steve. "Overview of CTC." *Operational Challenges of Implementing Community Therapeutic Care (ENN Report on an Inter-Agency Workshop, Washington DC)*. (2005). Available at: [http://www.aed.org/Publications/upload/CTCreport\\_ENN\\_06.pdf](http://www.aed.org/Publications/upload/CTCreport_ENN_06.pdf).
- Collins, Steve, et al. "Key issues in the success of community-based management of severe malnutrition." *Food and Nutrition Bulletin*. Ed. Claudine Prudhon et al. 27.3: S49-82. (2006).
- Degomme, Olivier, and Debarati Guha-Sapir. "Mortality and nutrition surveys by Non-Governmental organisations. Perspectives from the CE-DAT database." *Emerging Themes in Epidemiology* 4.11. (2007).
- Doyon, Stéphane. "What are the different strategies to reduce price?" Presentation at MSF/Columbia "Starved for attention: The neglected crisis of childhood malnutrition" Conference. New York, NY. (2008). Available at: <http://doctorswithoutborders.org/events/symposiums/2008-nutrition-starvedforattention/assets/files/presentations/wg-presentations/Doyon.pdf>

- Fisher, Marshall L. "What is the Right Supply Chain for Your Products?" *Harvard Business Review*. March-April 1997: 105-116. (1997).
- Grobler-Tanner, Caroline, and Steve Collins. "Community Therapeutic Care (CTC): A new approach to managing acute malnutrition in emergencies and beyond." *Food and Nutrition Technical Assistance (FANTA)*. Technical Note No. 8. (2004).
- Jarrett, Steve. "RUTF (Ready to Use Therapeutic Foods): Addressing the situation of children with severe acute malnutrition." Presentation at PIH/Tufts "Integrating Health, Nutrition, and Food Security: Making the Case" Conference. Cambridge, Mass. (2007). Available at: [http://pih.org/inforesources/Food\\_Conference\\_2007/Friday\\_PM\\_Jarrett.pdf](http://pih.org/inforesources/Food_Conference_2007/Friday_PM_Jarrett.pdf).
- Kaminsky, Phillip, David Simchi-Levi, and Edith Simchi-Levi. *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*. Boston, USA: McGraw-Hill/Irwin. (2003).
- Moss, Michael. "Peanut Case Shows Holes in Safety Net." *The New York Times*. (2009). Available at: [http://www.nytimes.com/2009/02/09/us/09peanuts.html?\\_r=1&hp](http://www.nytimes.com/2009/02/09/us/09peanuts.html?_r=1&hp).
- Prudhon, Claudine, and Paul Spiegel. "A review of methodology and analysis of nutrition and mortality surveys conducted in humanitarian emergencies from October 1993 to April 2004." *Emerging Themes in Epidemiology* 4.10. (2007).
- Seal, Andrew. "Adopting the WHO Growth Standards for Diagnosis and Classification of Acute Malnutrition in Emergencies: An Assessment of Resource Implications." London, England: University College of London Centre for International Health and Development. (n.d.) Available at: <http://www.humanitarianreform.org/humanitarianreform/Portals/1/cluster%20approach%20page/clusters%20pages/Nutrition/Resource%20Implications%20of%20WHO%20Growth%20Standards%20-%20Final.pdf>.
- Simchi-Levi, David, et al. *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*, 2nd ed. Boston, USA: McGraw Hill/Irwin. (2003).
- Swaminthan, Jayashankar. "Supply Chain Management." *International Encyclopedia of the Social and Behavioral Sciences*. Oxford, England: Elsevier Sciences. (2001).
- World Health Organization, World Food Programme, United Nations System Standing Committee on Nutrition, and United Nations Children's Fund. "Community-based management of severe acute malnutrition." Geneva, Switzerland: World Health Organization. (2007).
- Yang, Hong, and Mercedes de Onis. "Algorithms for converting estimates of child malnutrition based on the NCHS reference into estimates based on the WHO Child Growth Standards." *BMC Pediatrics* 8.19. (2008).

Zeilani, Mamane. "Scaling up Production of RUF." Presentation at the "International Workshop on the Integration of CMAM." Washington, DC. (2008). Available at: <http://www.fantaproject.org/downloads/pdfs/D3.S8.Zeilani.pdf>.

"Multi-sourcing: A better way?" Allens Arthur Robinson. (2003). Available at: <http://www.aar.com.au/pubs/pdf/cmt/fotecnov03.pdf>.

"Kenya Food Security Update: November 2008." Famine Early Warning System Network and USAID. (2008). Available at: [http://www.fews.net/docs/Publications/Kenya\\_2008\\_11\\_final.pdf](http://www.fews.net/docs/Publications/Kenya_2008_11_final.pdf).

"Seasonal Calendar for Food Security and Assistance Planning." Famine Early Warning System Network and USAID. (2008b). Available at: <http://www.fews.net/docs/Publications/Food%20Sec%20%20Assist%20Calendar%2011-17-08.pdf>.

"Impact of WHO Growth Standards on programme admissions in Niger." Field Exchange 34:6. (2008).

"Post Gu 2008 Nutrition Situation and 2008 Jan Post deyr 2007-08 Current Range Estimates of Malnutrition." Food Security Analysis Unit - Somalia. (2008). Available at: <http://www.fsausomali.org>.

"Monthly Nutrition Update: July-August 2008." Food Security Analysis Unit - Somalia. (2008). Available at: <http://www.fsausomali.org/fileadmin/uploads/1354.pdf>.

Ready-to-use therapeutic foods for malnutrition." Editorial. The Lancet. 369.9557: 164. (2007).

"Kenya Nutrition Bulletin: January-June 2008." Ministry of Public Health and Sanitation, Kenya National Bureau of Statistics, and Ministry of Medical Services. (2008).

"Paris Declaration on Aid Effectiveness: Ownership, Harmonization, Alignment, Results and Mutual Accountability." Organization for Economic Co-operation and Development (OECD). (2005). Available at: <http://www.oecd.org/dataoecd/11/41/34428351.pdf>.

"UNICEF National Committees." United Nations Children's Fund (UNICEF). Available at: [http://www.unicef.org/about/structure/index\\_natcoms.html](http://www.unicef.org/about/structure/index_natcoms.html).

"UNICEF Humanitarian Action Report 2009." UNICEF. (2009). Available at: [http://www.unicef.org/har09/files/HAR\\_2009\\_FULL\\_Report\\_English.pdf](http://www.unicef.org/har09/files/HAR_2009_FULL_Report_English.pdf).

"Multiple Indicator Cluster Surveys: Round 3, Somalia." UNICEF. (2006). Available at: [http://www.childinfo.org/files/MICS3\\_Somalia\\_FinalReport\\_2006\\_eng.pdf](http://www.childinfo.org/files/MICS3_Somalia_FinalReport_2006_eng.pdf).

"Thematic funding as a financial instrument in support of the UNICEF medium-term strategic plan." UNICEF Executive Board. E/ICEF/2008/22. (2008). Available at:

- [http://www.unicef.org/about/execboard/files/08-22-Thematic\\_funding\\_-\\_HR\\_-\\_29\\_July\\_-\\_final-to-UN.pdf](http://www.unicef.org/about/execboard/files/08-22-Thematic_funding_-_HR_-_29_July_-_final-to-UN.pdf).
- “Consolidated Emergency Thematic Report, 2007.” UNICEF Somalia Country Office. (2007).
- “Annual Report 2008.” UNICEF Somalia Country Office. (2008).
- “Central Emergency Response Fund.” United Nations Office for the Coordination of Humanitarian Affairs (OCHA). Available at:  
<http://ochaonline.un.org/FundingFinance/CERF/tabid/1109/Default.aspx>.
- “Humanitarian Financing Workshop Report.” United Nations OCHA - Ethiopia. (2007). Available at:  
<http://ocha.unog.ch/humanitarianreform/Portals/1/Financing%20page/OCHA%20Humanitarian%20Financing%20Workshop%20Report.pdf>.
- “Dairy Data: Milk price.” University of Wisconsin Dairy Marketing and Risk Management Program. Available at: [http://future.aae.wisc.edu/data/annual\\_values/by\\_area/10?tab=prices](http://future.aae.wisc.edu/data/annual_values/by_area/10?tab=prices).
- “The Essential Nutrition Actions: Now More Than Ever.” USAID and BASICS. (2009). Available at: [http://www.basics.org/event\\_nutrition\\_11feb.htm](http://www.basics.org/event_nutrition_11feb.htm).
- “Community-Based Therapeutic Care (CTC): A Field Manual.” Oxford, England: Valid International. (2006). Available at: <http://www.fantaproject.org/ctc/manual2006.shtml>.
- “Transitioning to the WHO Growth Standards: Implications for Emergency Nutrition Programmes IASC Nutrition Cluster Informal Consultation. Geneva: World Health Organization. (2008). Available at:  
<http://www.humanitarianreform.org/humanitarianreform/Portals/1/cluster%20approach%20page/clusters%20pages/Nutrition/WHO%20growth%20standards%20meeting%20report%20FINAL.pdf>.
- “Principles and Good Practice of Humanitarian Donorship.” (2003). Available from:  
<http://www.goodhumanitariandonorship.org/background.asp>.