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Technical and Market Innovations in the Ready-to-Use Therapeutic Food (RUTF) supply chain

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Introduction

In 2022, 148 million children under 5 suffered from stunting, 45 million from wasting, and 37 million children under 5 years were overweight[1]. Most of these children were in South Asia, Sub-Saharan Africa and South America[2]. Malnutrition in children under 5 is a complex issue, impacted by immediate, underlying, and root causes[3]. The consequences of malnutrition can be severe, with both short-term and long-term impacts on an individual's health and well-being. Unfortunately, progress to combat malnutrition has eroded in recent years due to conflict, climate change and weather-related events, poverty and economic downturns, food systems disruptions, persistent gaps in essential health services and the Covid-19 pandemic[4].

Ready to Use Therapeutic Foods (RUTFs) consist of an energy dense, micronutrient paste made from peanuts, groundnuts, sugar, dairy milk powder, oil, vitamins and minerals, given to infants using simple preparation procedures[5], to combat severe acute malnutrition (SAM) in children between 6 to 59 months of age. However, UNICEF estimates that only one in three children in need of RUTF treatment receive RUTFs[6].

In this study I will highlight the current market status of RUTFs, along with the challenges of supply and innovation which can impede progress on 'the last mile' of delivery. I also consider potential cost savings of alternative RUTF formulations and some of the challenges facing such innovation.

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[1] UNICEF, WHO, World Bank Group. Levels and trends in child malnutrition: UNICEF / WHO / World Bank Group Joint Child Malnutrition Estimates: Key findings of the 2023 edition. New York: UNICEF and WHO; 2023.
[2] FAO, IFAD, UNICEF, WFP and WHO. The State of Food Security and Nutrition in the World 2023. Urbanization, agrifood systems transformation and healthy diets across the rural–urban continuum. Rome, FAO; 2023.
[3] UNICEF Nutrition and Child Development Section. UNICEF Conceptual Framework on the Determinants of Maternal and Child Nutrition, 2020. A framework for the prevention of malnutrition in all its forms. New York, UNICEF, 2020.
[4] Carducci, B., Oh, C., Roth, D.E. et al. Gaps and priorities in assessment of food environments for children and adolescents in low- and middle-income countries. Nat Food 2, 396–403 (2021).
[5] Awuchi, C.G., Igwe, V.S., Amagwula, I.O. Ready-to-use therapeutic foods (RUTFs) for remedying malnutrition and preventable nutritional diseases. IJAAR 6, 47-81 (2020).
[6] UNICEF Supply Division. Ready-to-Use Therapeutic Food - Current Outlook. March 2021. Denmark, UNICEF; 2023. Available from https://www.unicef.org/supply/reports/ready-use-therapeutic-food-market-and-supply-update

Supply chains and RUTFs: a market model

The supply chain business model of RUTFs differs from typical 'supply and demand' market models. For RUTFs 'demand' is determined by the available funding by donors and/or governments to buy RUTFs which may grossly underestimate its 'social demand' for all children with SAM. Additional factors can reduce this demand, including access to health facilities, availability of health workers to admit and treat vulnerable children, parents' knowledge of the service, and timeliness of bringing children for treatment.

UNICEF is the primary buyer of RUTFs in the global market, procuring approximately 49,000 metric tons (MT) per year between 2017 and 2020, approximately 80 per cent of global sales during this period. However, 49,000 metric tons of RUTFs is only sufficient to treat approximately 3.5 million children, thereby reaching only a quarter of the under-fives estimated to be suffering from severe wasting.

Between 2008 to 2011, UNICEF's Supply Division worked to establish a sustainable and responsive supply base system for RUTFs, expanding from a single European supplier to a network of suppliers[7]. In 2001, the European company Nutriset secured the first long-term RUTFs supply agreement with UNICEF to produce RUTFs at its facility in France. Since then, the production of RUTFs has witnessed significant market growth, with UNICEF now purchasing RUTFs from approximately 22 vendors, 18 of which are situated in nations with a high prevalence of malnutrition[6]. Despite the involvement of multiple suppliers of RUTFs, the production costs for RUTFs remain high, possibly due to difficulties in sourcing sufficient quality and quantity of ingredients, energy prices, inflation, and labour costs. Innovation in RUTF formulations to diversify both ingredients and markets for small local producers are needed to reduce these challenges.

A major obstacle to scaling up production of RUTFs to meet social demand relates to the need for dairy protein ingredients. The World Health Organization (WHO) review on dairy protein content of RUTFs in 2021 (updated from a Joint Statement in 2007), recommends that 50% of the protein content of RUTFs should be derived from dairy products[8]. Yet research suggests that the cost of RUTFs is influenced by the reliance on dairy products. Hence, identification and scaling of effective alternatives to dairy proteins in RUTFs is an important aspect of reducing the cost of production, to enable the production of more RUFTs and better meet the social demand.

Innovation in RUTF formulations

According to UNICEF, USD 100 is required to treat a severely malnourished child and bring them toward recovery. This is typically comprised of: USD 42 for the cost of the RUTF; USD 8 for logistics and customs; and USD 50 for program-running costs. The RUTF ingredients account for 60-72 per cent of total costs, while production accounts for 17-33 per cent of total cost[9]. There is an opportunity to explore technological innovations in RUTF formulations and along the supply chain system to reduce RUTF costs.

Although the nutritional efficacy of milk powder has been demonstrated, quality standards for milk powder remain a challenge for sourcing locally. In many instances, importation lead times for milk powder are long and costly, negatively affecting the final cost of delivery. A review by Valid Nutrition, a non-profit RUTF producer, in 2022 suggests that milk powder is the primary driver of

[7] Komrska, J., Kopczak, L.R., Swaminathan, J.M. When supply chains save lives. Supply Chain Management Review, 17(1), p. 42 (2013).
[8] FAO, WHO. Guidelines for ready-to-use therapeutic foods. Codex Alimentarius Guideline No. CXG 95-2022. Codex Alimentarius Commission. Rome, FAO; 2022
[9] WHO. WHO guideline on the dairy protein content in ready-to-use therapeutic foods for treatment of uncomplicated severe acute malnutrition. Geneva: World Health Organization; 2021.

high costs associated with overall production[10]. Innovative formulations or alternative source of proteins for therapeutic foods may be needed to reduce the cost of RUTF and make RUTFs more available for children suffering from SAM.

In recent years alternative RUTF formulations, some of which have significantly less or no dairy constituents, have been explored, including through a systematic review on the topic. The review identified 6 studies that investigated low to no dairy recipes for RUTFs. The most promising no/low dairy formulation identified was Valid Nutrition's "amino-acid enhanced" plant-based RUTF formulation. The ingredients of the formulation are soybean, maize and sorghum, supplemented by essential amino acids and micronutrients, all of which can be grown and sourced locally, in turn lowering costs relative to imported equivalents. Anecdotal reporting from RUTF suppliers such as Valid Nutrition indicate that there may be cost savings in terms of capital when utilizing amino acid enhanced plant-based RUTFs over traditional peanut-based recipes. In terms of environmental sustainability, Valid Nutrition also reports that the greenhouse gas footprint of their plant-based RUTF formulation is half that of a milk-peanut based recipe[10].

How to analyse the cost-effectiveness of different RUTF formulations

An analysis of cost-effectiveness for different RUTFs requires considering several contextual factors. Table 1 outlines important elements frequently employed in cost-effectiveness analysis of RUTFs.

The RUTF supply chain is complex. According to the UNICEF supply chain system, the smooth operation of the RUTF product flow process depends on the coordinated efforts of multiple entities (Figure 1). Consideration of the costs associated with each stage of the RUTF supply chain is important for cost saving.

	Key Variables
Costs	This involves identifying and quantifying all relevant costs associated with implementing an intervention. It includes both direct and indirect costs spent in the manufacturing process as well as the service provision (the cost breakdown of ingredients, equipment, program expenses, human resource, packaging, quality control and assurance in accordance with UNICEF Awarded LTAs, overhead, administrative costs etc) (READY-TO-USE, T.F, 2009, pg70)
Effectiveness	The effectiveness variable represents the outcomes or benefits achieved by the intervention. This could be measured in various ways with other specific health indicators. Such as the recovery rate, average duration it takes to recover, mortality rate.
Market size and characteristics	Understanding the market size and characteristics (the need, forecast and actual demand) help determine the scale and scope of the intervention, the cost and effectiveness estimates. Factors such as demographics, disease prevalence, and risk factors can influence the cost-effectiveness analysis. Including the number and type current buyers, competitions, also national and international market regulation, are all important market characteristics.

Table 1: Typical elements involved in cost effective analysis of RUTFs.

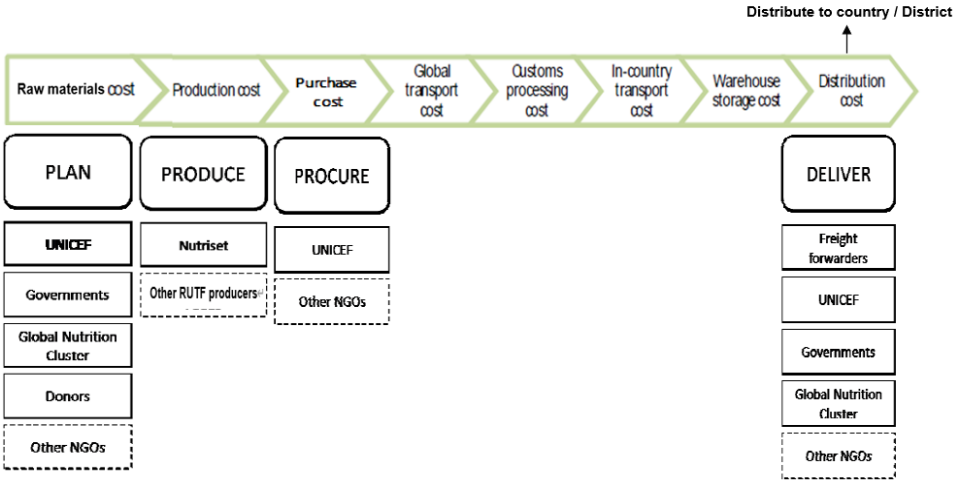

Figure 1: Supply chain components and key actors at different stages for RUTF delivery. Adapted from ref[11].

[10] Valid Nutrition. Annual Review of 2021. Amino-acid enhanced, plant-based formula. Lower cost and adaptable to alternate product formulations. Bantry, Ireland: Valid Nutrition; 2022. Available from: https://www.validnutrition.org/wp-content/uploads/2022/02/220208_Annual-Report-2021_F.pdf

When Valid Nutrition attempted to set up a supply chain for their plant-based RUTF formulation in Malawi, several challenges were encountered (Table 2), many of which particularly affect local producers. A comprehensive assessment of the cost effectiveness of different RUTF component options requires access to data on costs of materials, production and supply outlined in Figure 1[11]. As RUTFs are provided as a commercial business, much of this information may not be available from all the companies engaged in RUTF manufacture or delivery.

	Local production challenges
Product quality	· Quality assurance challenges to meet specific UNICEF long-term supply agreement (LTA)
Necessary facility	· Slow access to external laboratories
Logistic	· For some countries, importation complexities due to logistics. For example, Malawi is a land locked country which increases the cost of production of the milk-peanut recipe.
Importation/ Shipping	· According to the company Valid Nutrition, in Malawi it could take up to 9 months from the order of milk (and requisite immediate payment) to shipment, receipt in country, manufacture of RUTF, sale and invoice completion and eventual payment.
Service	· The lack of scale and influence on secure priority service provision to UNICEF
Production technology	· A lack of up-to-date operating systems, which do not facilitate confidence in production (for instance, converted warehouse in Malawi), unlike the other suppliers who have modern, purpose-built plants designed to optimize efficiency (WHO Review Cost Analysis, Valid Nutrition, 2022, pg12)

Table 2: Local production challenges for RUTFs.

Policy considerations for more effective RUTF delivery

For RUTFs to be more accessible and affordable for treatment of SAM, more openly accessible data on the costs of RUTF components, details on quality standards, and openness by the actors in the RUTF "system" to pilot RUTF alternative formulations will be required. Stronger cooperation between government, NGOs, and RUTF manufacturing and distribution companies could improve coordination during emergencies, reduce costs of RUTF delivery, simplify supply chains, expand markets, and guarantee a more robust supply of RUTF to children in need, while supporting reputational and financial interests for commercial RUTF providers. Planning, funding, and implementation of monitoring processes are necessary to continually assess RUTF efficacy, while ensuring consistent quality standards for RUTF production, distribution, and marketing.

[11] Gilland W, Mourchero-Vickery C, So A and Swaminathan JM. A Supply Chain Analysis of Ready-to-Use Therapeutic Foods for the Horn of Africa: The Nutrition Articulation Project. New York, UNICEF; 2009.