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Comparative analysis of nutritional interventions and cultural food practices: lessons from India and Ethiopia for sustainable solutions to malnutrition and food security

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ABSTRACT

The study falls into **SDG focus goal** 2: Zero Hunger — Target 2.2: End all forms of malnutrition, including achieving targets on stunting and wasting in children under five years, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons; Target 2.4: Ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters.

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This study examines the comparative approaches to nutritional interventions and cultural food practices between India and Ethiopia, focusing on the integration of traditional foods (millets in India, home-garden production in Ethiopia), the effectiveness of large-scale programs (ICDS in India, nutrition-sensitive agriculture in Ethiopia), and the role of cultural acceptability in intervention design and outcomes. A comparative policy and program analysis was conducted examining primary and secondary sources including peer-reviewed research on fortified millet interventions in India, home-garden micro-interventions in Ethiopia, systematic reviews of school feeding programs, demographic and health survey data on nutritional inequalities, and policy frameworks covering the period 2010-2026. India's nutritional landscape is characterized by the "South Asian Enigma": despite economic progress, child undernourishment rates exceed those of Ethiopia, a nation with significantly lower per capita income. The ICDS program reaches millions through Anganwadi Centers, yet gaps persist in nutrient adequacy and dietary diversity. Fortified ragi malt interventions demonstrate strong acceptability (sensory scores ≥8.0 on 9-point scale), with milk-based preparations outperforming water-based alternatives. Millets show promise: a millet-based mid-day meal intervention achieved significant improvements in mean HAZ (0.07) and BMI (0.166). However, barriers include preparation quality, menu rigidity, and supply chain weaknesses. Ethiopia presents a contrasting model where nutrition-sensitive agriculture interventions focus on home-garden diversification. A micro-intervention with 40 women increased Women's Dietary Diversity Score (WDDS) from 3.68±1.16 to 6.13±0.76, and production diversity from 2.63±1.00 to 5.63±0.90. Cost-optimized food basket research demonstrates that culturally acceptable, nutritionally adequate diets for low-income families cost ETB 71.2 (≈$2.45) for 64 foods, compared to minimal-cost baskets (ETB 31-38) with poor diversity. Both countries face persistent socioeconomic inequalities in nutritional status: anemia, low BMI, and poor healthcare access are concentrated among the less well-off, while iron supplementation, ANC visits, and institutional deliveries favor the better-off. India's strength lies in large-scale program infrastructure and innovative millet-based interventions, yet faces challenges of implementation quality and dietary diversity. Ethiopia's home-garden approach demonstrates remarkable success in diversifying diets through community-level intervention, but requires scaling. Both countries demonstrate that culturally appropriate interventions—respecting traditional food practices while addressing nutritional gaps—achieve superior outcomes. Effective nutritional interventions must: (1) leverage traditional foods (millets, home gardens) as culturally

acceptable platforms; (2) address implementation quality alongside program coverage; (3) target socioeconomic inequalities through geographically targeted services; (4) integrate nutrition-sensitive agriculture with direct interventions; (5) ensure preparation quality and sensory acceptability; (6) combine fortification with dietary diversity strategies; and (7) engage communities through participatory approaches.

KEYWORDS: Nutritional interventions, cultural food practices, India, Ethiopia, millets, home gardens, ICDS, dietary diversity, child malnutrition, women's nutrition, food security, SDG 2.

RÉSUMÉ

Cette étude examine les approches comparatives des interventions nutritionnelles et des pratiques alimentaires culturelles entre l'Inde et l'Éthiopie, en se concentrant sur l'intégration des aliments traditionnels (millets en Inde, production potagère en Éthiopie), l'efficacité des programmes à grande échelle (ICDS en Inde, agriculture sensible à la nutrition en Éthiopie), et le rôle de l'acceptabilité culturelle dans la conception et les résultats des interventions. Une analyse comparative des politiques et des programmes a été menée en examinant des sources primaires et secondaires, y compris la recherche évaluée par les pairs sur les interventions de millets enrichis en Inde, les micro-interventions de jardins potagers en Éthiopie, les revues systématiques des programmes d'alimentation scolaire, les données d'enquêtes démographiques et de santé sur les inégalités nutritionnelles, et les cadres politiques couvrant la période 2010-2026. Le paysage nutritionnel de l'Inde est caractérisé par « l'Énigme sud-asiatique » : malgré les progrès économiques, les taux de sous-alimentation infantile dépassent ceux de l'Éthiopie, une nation avec un revenu par habitant significativement plus faible. Le programme ICDS atteint des millions de personnes via les centres Anganwadi, mais des lacunes persistent dans l'adéquation nutritionnelle et la diversité alimentaire. Les interventions de malt de ragi enrichi démontrent une forte acceptabilité (scores sensoriels ≥8,0 sur une échelle de 9 points), les préparations à base de lait surpassant les alternatives à base d'eau. Les millets montrent des promesses : une intervention de repas de midi à base de millets a obtenu des améliorations significatives du HAZ moyen (0,07) et de l'IMC (0,166). Cependant, les obstacles incluent la qualité de préparation, la rigidité des menus et les faiblesses de la chaîne d'approvisionnement. L'Éthiopie présente un modèle contrasté où les interventions d'agriculture sensible à la nutrition se concentrent sur la diversification des jardins

potagers. Une micro-intervention auprès de 40 femmes a augmenté le score de diversité alimentaire des femmes (WDDS) de 3,68±1,16 à 6,13±0,76, et la diversité de production de 2,63±1,00 à 5,63±0,90. La recherche sur les paniers alimentaires optimisés en coût démontre que des régimes culturellement acceptables et nutritionnellement adéquats pour les familles à faible revenu coûtent 71,2 ETB (≈2,45 $) pour 64 aliments, comparés aux paniers à coût minimal (31-38 ETB) avec une faible diversité. Les deux pays font face à des inégalités socioéconomiques persistantes dans le statut nutritionnel : l'anémie, le faible IMC et le mauvais accès aux soins de santé sont concentrés parmi les moins favorisés, tandis que la supplémentation en fer, les visites de soins prénatals et les accouchements institutionnalisés favorisent les mieux lotis. La force de l'Inde réside dans son infrastructure de programmes à grande échelle et ses interventions innovantes à base de millets, mais elle fait face à des défis de qualité de mise en œuvre et de diversité alimentaire. L'approche des jardins potagers en Éthiopie démontre un succès remarquable dans la diversification des régimes alimentaires par une intervention au niveau communautaire, mais nécessite une mise à l'échelle. Les deux pays démontrent que les interventions culturellement appropriées—respectant les pratiques alimentaires traditionnelles tout en comblant les lacunes nutritionnelles—obtiennent de meilleurs résultats. Les interventions nutritionnelles efficaces doivent : (1) tirer parti des aliments traditionnels (millets, jardins potagers) comme plateformes culturellement acceptables ; (2) traiter la qualité de mise en œuvre parallèlement à la couverture des programmes ; (3) cibler les inégalités socioéconomiques par des services géographiquement ciblés ; (4) intégrer l'agriculture sensible à la nutrition avec des interventions directes ; (5) assurer la qualité de préparation et l'acceptabilité sensorielle ; (6) combiner l'enrichissement avec des stratégies de diversité alimentaire ; et (7) engager les communautés par des approches participatives.

MOTS-CLÉS : Interventions nutritionnelles, pratiques alimentaires culturelles, Inde, Éthiopie, millets, jardins potagers, ICDS, diversité alimentaire, malnutrition infantile, nutrition des femmes, sécurité alimentaire, ODD 2.

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1. INTRODUCTION

Malnutrition remains one of the most persistent and devastating challenges to human development, affecting hundreds of millions of people across the globe and undermining progress toward virtually every Sustainable Development Goal. Despite decades of interventions and substantial investments, the world is not on track to achieve SDG Target 2.2—ending all forms of malnutrition by 2030. The burden falls disproportionately on low- and middle-income countries, where poverty, inadequate diets, and weak health systems combine to perpetuate cycles of undernutrition that span generations .

India and Ethiopia, two of the world's most populous nations and both significant contributors to global malnutrition burdens, present a compelling comparative case. India, despite its remarkable economic growth and status as a global technology powerhouse, continues to struggle with persistently high rates of child undernutrition. The "South Asian Enigma" captures the perplexing reality that child undernourishment rates in India exceed those of Ethiopia, a nation with significantly lower per capita income . This paradox suggests that economic growth alone is insufficient to address malnutrition—cultural factors, dietary practices, and the design and implementation of nutritional interventions matter profoundly.

Ethiopia, by contrast, has made significant strides in reducing malnutrition through innovative approaches that leverage agriculture as a platform for nutrition improvement. The country's focus on nutrition-sensitive agriculture, home-garden diversification, and community-level interventions has yielded measurable gains in dietary diversity and nutritional outcomes, even in the face of significant poverty and recurrent climate shocks .

Both countries share important commonalities. They are characterized by rich agricultural traditions, diverse food cultures, and deep-rooted dietary practices that shape what people eat and why. They both face the "triple burden of malnutrition"—undernutrition, micronutrient deficiencies (hidden hunger), and rising overweight/obesity—often coexisting within the same communities and even households . And both have developed large-scale nutrition programs that reach millions: India's Integrated Child Development Services (ICDS) and Mid-Day Meal Scheme, and Ethiopia's Productive Safety Net Programme and health extension system.

Yet their approaches to integrating cultural food practices with nutritional interventions differ markedly. India has increasingly focused on leveraging traditional grains—particularly millets—as nutrient-dense, culturally acceptable platforms for intervention. Research on fortified ragi (finger millet) malt demonstrates strong acceptability and potential for scale-up through existing ICDS and school platforms . Millets, championed by Prime Minister Modi and declared the International Year of Millets by the United Nations in 2023, offer a pathway to address micronutrient deficiencies while respecting cultural food preferences .

Ethiopia's approach emphasizes home-garden production and dietary diversity at the household level. A micro-intervention with 40 women in Boru Meda Kebele demonstrated that training and support for diversified home gardening could increase Women's Dietary Diversity Score (WDDS) from 3.68 to 6.13—a dramatic improvement . This approach recognizes that women's nutritional status is inextricably linked to their role in food production and household food decisions, and that interventions must address both knowledge and practical capacity.

This study examines the comparative approaches to nutritional interventions and cultural food practices in India and Ethiopia, analyzing how each country has sought to integrate traditional foods and practices into programmatic responses to malnutrition. Through systematic comparison of intervention designs, implementation challenges, cultural considerations, and outcomes, the study aims to identify best practices and inform evidence-based policy development for sustainable solutions to malnutrition.

The research is particularly timely given renewed global attention to food systems transformation, the recognition that dietary diversity is as important as calorie adequacy, and the growing evidence

that culturally appropriate interventions achieve better outcomes than those imposed without attention to local context. The findings speak directly to Sustainable Development Goal 2, particularly Target 2.2 on ending all forms of malnutrition and Target 2.4 on sustainable food production systems.

2. LITERATURE REVIEW

2.1 Defining Nutritional Interventions and Cultural Food Practices

Nutritional interventions encompass a wide range of strategies aimed at improving dietary intake and nutritional status, including supplementation, fortification, dietary diversification, behavior change communication, and food-based approaches such as school feeding and maternal and child health programs . The effectiveness of these interventions depends not only on their technical design but on their alignment with cultural food practices—the deeply embedded patterns of food production, preparation, and consumption shaped by history, ecology, religion, and social norms.

Cultural food practices influence what foods are considered acceptable, how they are prepared, who eats what within households, and what meanings attach to different foods. Interventions that ignore these practices risk low uptake, poor adherence, and unintended consequences. Conversely, interventions that leverage culturally valued foods and practices can achieve high acceptability and sustainability .

2.2 The South Asian Enigma and India's Nutritional Challenges

India's nutritional landscape presents a paradox that has puzzled researchers and policymakers for decades. Despite sustained economic growth, substantial investments in nutrition programs, and improvements in food production, rates of child undernutrition remain stubbornly high. The "South Asian Enigma" refers to the observation that child undernourishment rates in India exceed those of sub-Saharan African countries with much lower per capita incomes, including Ethiopia .

This paradox has multiple explanations. One hypothesis points to the importance of dietary diversity and nutrient quality over mere calorie adequacy. While India's food security policies have focused on providing enough food—particularly through the Public Distribution System (PDS) and ICDS—they have often overlooked the diversity of diets needed to prevent micronutrient deficiencies . Even within higher socioeconomic groups, "hidden hunger" persists, creating a "double burden of malnutrition" where undernutrition and overnutrition coexist.

A second explanation relates to women's status and agency. Research on socioeconomic disparities across four countries (Bangladesh, Ethiopia, India, and Nigeria) found that nutritional status and health care inequalities among women followed patterns of socioeconomic disparities. Anemia, low BMI, perceived distance to health services, and needing permission to visit health facilities were concentrated among the less well-off, while iron supplementation, antenatal care visits, and institutional deliveries favored the better-off . These findings underscore that women's nutrition cannot be separated from broader issues of gender equality and access to services.

A third factor is the quality of intervention implementation. A mixed-method study examining ICDS and school-based interventions in Telangana and Karnataka found that despite program reach, "gaps in nutrient adequacy and dietary diversity continue, particularly in low-resource settings" . Operational bottlenecks—supply chain weaknesses, kitchen infrastructure deficits, human resource shortages, and digital reporting burdens—undermine program effectiveness even where policies are sound.

2.3 India's ICDS and School Feeding Programs

The Integrated Child Development Services (ICDS) represents one of the world's largest nutrition programs, reaching millions of pregnant women, lactating mothers, and young children through a network of Anganwadi Centers. The program provides supplementary nutrition, immunization, health check-ups, and nutrition education. School feeding through the Mid-Day Meal (MDM) scheme similarly reaches millions of school-age children.

A 2026 study examining interventions through ICDS and schools in Telangana and Karnataka provides detailed insights into program implementation and the potential for millet-based

interventions. The study tested fortified ragi malt powder (SaiSure) enriched with essential vitamins and minerals, developed "to support the nutritional needs of both undernourished and healthy children" .

Key findings from household interviews (272 households in Telangana, 240 in Karnataka) revealed:

- **Millet consumption:** Any millet use was 90.8% in Telangana and 100% in Karnataka; daily consumption was 83.5% in Telangana and 100% in Karnataka .
- **Species mix:** Jowar dominated in Telangana (86.8% vs 56.2% in Karnataka); ragi consumption was high in both states (82.7% and 68.3%); bajra was moderate (28.7% and 43.3%); other millets showed minimal use.
- **Sources:** Telangana households predominantly purchased millets (76.5%), while Karnataka households relied on own-produce (59.6%).
- **Barriers:** In Telangana, barriers included cost (5.5%), lack of awareness (55.9%), and availability (18.4%). In Karnataka, availability (19.2%) was the main concern, with negligible cost barriers.
- **Awareness:** 94.9% of Telangana respondents were aware of nutritional benefits, compared to 62.5% in Karnataka .

The study's sensory evaluation of fortified ragi malt demonstrated "overall high acceptability," with scores for both variants (ragi malt mixed in milk or water) reaching ≥8.0 on a 9-point hedonic scale. Milk-based preparations consistently outperformed water-based alternatives, suggesting that preparation medium significantly affects acceptability .

Qualitative interviews revealed several implementation challenges:

- **Preparation quality:** Critical for acceptance; improper mixing or incorrect viscosity reduced intake.
- **Menu rigidity and waste:** Fixed menus created predictable dislikes (e.g., brinjal curry), causing avoidable waste.
- **THR/Balamrutham:** Monotony and large pack sizes encouraged diversion to other family members.

- **Supply chain:** Egg supply irregularities, storage challenges, and infrastructure deficits.
- **Human resources:** Helper shortages increased workload; need for refresher training.
- **Digital reporting burden:** Multiple platforms and paper forms strained frontline workers' time .

A systematic review of school feeding interventions globally provides additional context. A meta-analysis including studies from 20 LMICs found that school feeding vs control increased mean WAZ by 0.100, with no significant effects on HAZ or hemoglobin. In South Asia specifically, one of four studies found significant reduction in stunting. In India, RCTs using double-fortified salt in school lunch programs demonstrated significant improvements: one study found increased hemoglobin by 0.267 g/dL and reduced anemia likelihood by 13.4 percentage points; another found hemoglobin increased by 0.19 g/dL and 9.9 percentage point reduction in any anemia .

A millet-based mid-day meal RCT in India found significant improvements: mean HAZ increased by 0.07, and mean BMI increased by 0.166 .

2.4 Ethiopia's Nutrition-Sensitive Agriculture and Home-Garden Interventions

Ethiopia has pursued a distinct approach emphasizing nutrition-sensitive agriculture and household-level food production. The rationale is compelling: in a country where the majority of the population depends on agriculture for livelihoods, improving what farmers grow and consume can directly enhance dietary diversity and nutritional outcomes.

A 2024 study in Boru Meda Kebele, Ethiopia, tested a home-garden micro-intervention with 40 women aged 15-49 . The intervention aimed "to increase home-gardening system's contribution to raising women's dietary diversity score (WDDS) by diversifying family farming practices." The research team conducted initial and end-line dietary diversity surveys using FAO's standardized questionnaire, with careful attention to cultural and religious elements. Qualitative data were gathered through case studies, key informant interviews, and focus group discussions.

Results were striking:

- **Pre-intervention:** The average number of food groups produced was 2.63±1.00; consumed was 3.68±1.16.
- **Post-intervention:** WDDS increased to 6.13±0.76; production diversity increased to 5.63±0.90 .

The study concluded that "home-garden agriculture helps to increase WDDS" and recommended that "development partners must concentrate on farming system diversification by increasing the accessibility of vegetable seeds and educating local farmers about the contribution of diversified vegetable production and consumption" .

The study highlighted that before intervention, "the local population's diet was dominated by staple cereal crops, and women were less knowledgeable about home gardening and diverse diets" . The intervention succeeded not only in providing seeds and training but in shifting knowledge and attitudes.

Research on cost-optimized nutritionally adequate food baskets for Ethiopians provides additional context for understanding dietary constraints. Using linear programming, researchers identified that nutritionally adequate rural and urban food baskets with highest affordability cost as little as ETB 31 and 38 (≈USD 1.07 and 1.31) respectively, but had poor dietary diversity (16 and 19 foods). Baskets costing ETB 71.2 (≈USD 2.45) contained 64 and 48 foods and were much more similar to the food supply pattern reported by FAO. The composed baskets suggest dietary guidelines recommending approximately: up to 60% cereals, up to 20% roots and tubers, 10% legumes, and 10% fruits and vegetables by weight, plus only a small share from animal foods .

2.5 Comparative Nutritional Inequalities

A 2025 study analyzing Demographic and Health Survey data from Bangladesh, Ethiopia, India, and Nigeria provides important comparative insights into nutritional inequalities among women .

Key findings for Ethiopia and India:

- **Anemia:** Concentrated among the less well-off in both countries (negative Erreygers index values).
- **Low BMI:** Similarly concentrated among disadvantaged women.

- **Health care access:** Perceived distance to health services and needing permission to visit health facilities were significant barriers for disadvantaged women in both countries.
- **Service coverage:** Iron and folic acid supplementation, four or more antenatal care visits, and institutional deliveries all favored the better-off (positive index values).
- **Urban-rural differences:** Varied by indicator and country, but generally favored urban areas.

The study concluded that "nutritional status and health care inequalities among women followed patterns of socioeconomic disparities" and that "inequalities favoring the better-off were even greater for health care across countries" . These findings underscore that nutrition interventions must address not only technical design but also the structural barriers that prevent disadvantaged populations from accessing services.

2.6 Cultural Food Practices: Millets in India, Home Gardens in Ethiopia

India's Millet Tradition: Millets—including finger millet (ragi), sorghum (jowar), pearl millet (bajra), and minor millets—have been cultivated in India for millennia and remain deeply embedded in food cultures, particularly in drier regions. Traditional Indian thalis (plates) combine diverse foods: fortified wheat chapatis, cooked lentils, seasonal greens, rice or millets, curd, salad, and jaggery—a "cultural blueprint for sustainable and complete nutrition" .

Nutrition experts emphasize that returning to traditional thalis can overcome micronutrient deficiencies. As one nutritionist noted, "We should create thalis that combine variety, balance and biofortified ingredients for nourishment and taste" . Millets offer particular advantages: they are hypoallergenic, nutrient-dense, and enhance nutrient absorption, addressing a root cause of deficiencies .

The potential of millets is illustrated by a striking comparison: while teff (finger millet) in Ethiopia has lower iron content than wheat in India, Ethiopians exhibit lower prevalence of anaemia, suggesting that overall nutritional profile and bioavailability matter more than single-nutrient content .

Ethiopia's Home-Garden Tradition: Home gardens are traditional in Ethiopian farming systems, but their potential for nutrition improvement has been underutilized. The Boru Meda intervention demonstrated that with training and support, home gardens can dramatically increase dietary diversity. This approach recognizes women's central role in both food production and household nutrition, and leverages existing practices rather than introducing entirely new systems.

2.7 The Role of Fortification and Biofortification

Both countries have explored fortification and biofortification as strategies to address micronutrient deficiencies. India's experience with double-fortified salt in school meals demonstrated significant reductions in anemia . The fortified ragi malt tested in Telangana and Karnataka combined the cultural acceptability of a traditional food with enhanced nutrient content .

Ethiopia's approach has focused more on dietary diversity through home gardens, though fortification of staple foods is also pursued. The cost-optimized food basket research provides a basis for developing food-based dietary guidelines that can guide fortification priorities .

A workshop in India emphasized "integrating fortified staples like wheat, rice and edible oils into traditional recipes" as a strategy to help families "meet their daily vitamin and mineral needs more effectively" . This approach respects cultural food practices while addressing nutrient gaps.

2.8 Implementation Challenges and Quality Gaps

Across both countries, the gap between policy and implementation emerges as a critical theme. The ICDS study documented multiple operational bottlenecks: "supply chain irregularities, storage challenges, and infrastructure deficits in kitchens and water supply"; "helper shortages"; "multiple platforms and paper forms strained frontline workers' time" . These findings echo the broader literature on health systems strengthening: programs require not just design but sustained attention to implementation quality.

Menu rigidity emerged as a particular challenge: "Fixed menus created predictable dislikes (e.g., brinjal curry), causing avoidable waste" . This finding underscores the importance of flexibility and community engagement in program design.

The Ethiopian home-garden intervention succeeded in part because it worked at small scale with intensive support. Scaling such approaches while maintaining quality remains a challenge.

3. RESEARCH QUESTIONS

This study addresses the following research questions:

1. How do the design, implementation, and outcomes of nutritional interventions differ between India and Ethiopia, and what role do cultural food practices play in shaping these differences?
2. What evidence exists on the effectiveness of interventions leveraging traditional foods—millets in India, home gardens in Ethiopia—in improving nutritional outcomes, and what factors facilitate or constrain success?
3. What implementation challenges and socioeconomic inequalities affect nutrition program effectiveness in both countries, and what strategies can address these barriers to achieve more equitable outcomes?

4. METHODOLOGY

This study employs a comparative policy and program analysis methodology to examine nutritional interventions and cultural food practices in India and Ethiopia. The research design integrates document analysis of primary sources with synthesis of secondary literature to develop a comprehensive understanding of intervention designs, implementation contexts, cultural considerations, and outcomes in both countries.

Primary sources analyzed include: peer-reviewed research on fortified millet interventions in India ; home-garden micro-interventions in Ethiopia ; systematic reviews of school feeding

programs ; demographic and health survey data on nutritional inequalities ; cost-optimized food basket research ; and policy frameworks and program documentation.

The comparative framework examines four dimensions of nutritional interventions: (1) intervention design and cultural appropriateness; (2) implementation quality and operational challenges; (3) nutritional outcomes and impact evidence; and (4) equity and socioeconomic disparities.

The analysis covers the period from 2010 to 2026, capturing key developments including India's ICDS implementation studies, Ethiopia's nutrition-sensitive agriculture research, and recent evidence on millet-based interventions.

5. RESULTS

5.1 Comparative Intervention Approaches

India: India's nutritional intervention landscape is characterized by large-scale, government-implemented programs with national reach. The ICDS and Mid-Day Meal schemes provide supplementary nutrition to millions through institutional platforms. Recent innovations include fortified traditional foods (ragi malt) and millet-based meals, leveraging cultural food practices within program structures .

The fortified ragi malt intervention tested in Telangana and Karnataka represents a model of "culturally acceptable and nutritionally rich" intervention. Developed to address nutritional gaps in low-resource settings, the product was designed for integration into existing ICDS and school platforms .

Ethiopia: Ethiopia's approach emphasizes nutrition-sensitive agriculture and household-level interventions. The home-garden micro-intervention tested in Boru Meda Kebele worked directly with women to diversify household food production, building on traditional farming practices while introducing new knowledge and inputs .

Cost-optimized food basket research provides evidence for developing culturally adapted dietary guidelines that are affordable for low-income populations. The research demonstrates that nutritionally adequate diets are possible within budget constraints, but require attention to diversity and food combinations .

Table 1: Comparative Intervention Approaches

Dimension	**India**	**Ethiopia**
Primary intervention platforms	ICDS (Anganwadi Centers); School Mid-Day Meals	Home gardens; Health extension system
Target populations	Children 3-6 years (ICDS); School children; Pregnant/lactating women	Women of reproductive age; Households
Traditional foods leveraged	Millets (ragi, jowar, bajra); Fortified traditional preparations	Home garden vegetables; Staple cereals
Key strategies	Fortification; Supplementary nutrition; Behavior change communication	Dietary diversification; Production diversity; Nutrition education
Scale	National programs reaching millions	Pilot interventions; Scaling in progress
Evidence base	RCTs on fortified salt; Fortified ragi malt studies; Systematic reviews	Micro-intervention studies; Cost-optimization research

5.2 Acceptability and Cultural Appropriateness

India's Fortified Ragi Malt: Sensory evaluation results demonstrate strong acceptability of fortified ragi malt. Scores for both variants (milk-based and water-based) reached ≥8.0 on a 9-

point hedonic scale. Karnataka's milk-based preparation consistently outperformed Telangana's water-based version, with better taste, aroma, and texture scores .

Key sensory findings:

- Taste and aroma: Milk-based preparations rated higher, linked to milk fat aroma.
- Texture: Smooth, lump-free preparations rated highest; thick or watery variations lowered scores.
- Children generally consumed the full serving when preparation quality was optimal.
- Caregivers reported willingness to continue product use, citing perceived energy boost and health benefits .

Traditional Indian thalis were highlighted by nutrition experts as a "cultural blueprint for sustainable and complete nutrition." A vegetarian UP-style thali includes: fortified wheat chapatis, cooked lentils, seasonal greens, rice or millet, curd, salad, and jaggery—providing diverse nutrients through familiar combinations .

Ethiopia's Home Gardens: The Boru Meda intervention demonstrated that home-garden production is culturally acceptable and can be rapidly scaled. Pre-intervention, women's diets were dominated by staple cereals; post-intervention, production diversity increased from 2.63 to 5.63 food groups, and consumption diversity from 3.68 to 6.13 . This dramatic shift occurred within a single intervention cycle, suggesting strong cultural alignment.

The cost-optimized food basket research provides quantitative evidence for cultural acceptability: baskets costing ETB 71.2 contained 64 foods and closely matched FAO-reported consumption patterns, while minimal-cost baskets with only 16-19 foods deviated substantially .

5.3 Nutritional Outcomes and Effectiveness

India: Systematic review evidence on school feeding in South Asia shows mixed but generally positive outcomes. One of four studies found significant reduction in stunting. RCT evidence from India is stronger: double-fortified salt interventions demonstrated significant reductions in anemia (9.9-13.4 percentage points) and increases in hemoglobin (0.19-0.267 g/dL) .

A millet-based mid-day meal RCT found significant improvements in mean HAZ (0.07) and mean BMI (0.166) . These effect sizes, while modest, are meaningful at population level.

The fortified ragi malt study did not report nutritional outcome data but established high acceptability and identified key implementation factors for scale-up .

Ethiopia: The home-garden intervention achieved remarkable improvements in dietary diversity: WDDS increased by 2.45 points (from 3.68 to 6.13). This exceeds the minimum threshold for adequate diversity (WDDS ≥5), suggesting meaningful improvement in micronutrient adequacy .

The cost-optimized food basket research demonstrates that nutritionally adequate diets are achievable at modest cost (ETB 71.2 per day for a family of five, ≈$2.45), providing a benchmark for food-based interventions .

Table 2: Comparative Nutritional Outcomes

Outcome	**India**	**Ethiopia**
Stunting reduction	Mixed evidence; 1/4 studies significant	Not measured in home-garden study
Anemia reduction	9.9-13.4 percentage points (fortified salt)	Not measured
HAZ improvement	0.07 (millet meals)	Not measured
BMI improvement	0.166 (millet meals)	Not measured
Dietary diversity	Not reported in reviewed studies	WDDS increase: 3.68 → 6.13
Production diversity	Not applicable	Increase: 2.63 → 5.63

5.4 Implementation Challenges and Barriers

India: The ICDS study identified multiple implementation barriers :

- **Preparation quality:** Critical for acceptance; variations in viscosity, lumps, and serving temperature affected intake.

- **Menu rigidity:** Fixed menus created predictable dislikes and avoidable waste.
- **THR format:** Large pack sizes and monotony encouraged diversion to other family members.
- **Supply chain:** Egg supply irregularities, storage challenges, infrastructure deficits.
- **Human resources:** Helper shortages; need for refresher training.
- **Digital reporting:** Multiple platforms and paper forms strained frontline workers.
- **Market barriers:** In Telangana, cost (5.5%), lack of awareness (55.9%), and availability (18.4%) limited millet consumption. In Karnataka, availability (19.2%) was the main concern .

Ethiopia: The home-garden study identified pre-intervention barriers: "women were less knowledgeable about home gardening and diverse diets" . Post-intervention, sustainability and scaling remain challenges not addressed in the pilot.

The cost-optimized food basket research highlights affordability as a persistent barrier: even minimal-cost nutritionally adequate baskets cost ETB 31-38 daily (≈$1.07-1.31), a significant burden for low-income families. More diverse baskets cost double .

5.5 Socioeconomic Inequalities

The DHS analysis across four countries reveals persistent socioeconomic inequalities in both countries :

India:

- Anemia and low BMI concentrated among less well-off women.
- Iron supplementation, ANC visits, and institutional deliveries favor better-off women.
- Perceived distance to health services and needing permission to visit facilities are significant barriers for disadvantaged women.

Ethiopia:

- Similar patterns: negative Erreygers indices for anemia, low BMI, and access barriers.
- Positive indices for service coverage favoring better-off.
- Urban-rural disparities vary by indicator but generally favor urban areas.

The study concludes that "inequalities favoring the better-off were even greater for health care across countries" than for nutritional status itself, suggesting that health systems amplify rather than reduce socioeconomic disparities .

6. DISCUSSION OF RESULTS

6.1 Leveraging Cultural Food Practices: A Shared Principle, Different Expressions

Both India and Ethiopia demonstrate the power of interventions that respect and leverage cultural food practices, yet they express this principle differently. India's approach works through large-scale programs, introducing fortified versions of traditional foods (ragi malt) and promoting millets within existing meal structures. Ethiopia's approach works at household level, diversifying production of traditional garden crops to enhance dietary diversity.

The contrast reflects different structural conditions. India's institutional infrastructure—ICDS centers reaching millions, school meal programs—provides platforms for intervention at scale. Ethiopia's weaker institutional reach necessitates household-level approaches, but these may offer advantages in sustainability and empowerment.

The common lesson is that cultural appropriateness is not about preserving traditional diets unchanged, but about working within cultural frameworks to introduce improvements. Fortified ragi malt is not traditional, but it is made from a traditional grain and prepared in familiar ways. Home gardens are traditional, but diversifying them with new vegetable varieties and nutrition knowledge transforms their contribution to diets.

6.2 The Promise and Challenge of Millets

India's experience with millets illustrates both the potential and the challenges of leveraging traditional foods. The evidence is promising: millet-based meals improved HAZ and BMI ; fortified ragi malt achieved high acceptability ; and millets address multiple nutrient gaps

simultaneously . The comparison with Ethiopia's teff is instructive: despite lower iron content than wheat, teff-based diets in Ethiopia are associated with lower anemia prevalence than wheat-based diets in India, suggesting that overall dietary patterns and nutrient bioavailability matter more than single-nutrient comparisons .

Yet barriers persist. Awareness of nutritional benefits varies dramatically (94.9% in Telangana vs 62.5% in Karnataka) . Market access differs: Telangana households predominantly purchase millets, while Karnataka households rely on own-produce. Cost remains a barrier for some households. And other millets (little, foxtail, barnyard) show minimal use, suggesting untapped potential.

The policy implications are clear: promoting millets requires attention to awareness, market development, and supply chains alongside production support. ICDS and school meal programs offer platforms to create demand and demonstrate benefits.

6.3 Home Gardens as a Platform for Women's Nutrition

Ethiopia's home-garden intervention demonstrates that working directly with women on household food production can rapidly improve dietary diversity. The increase from 3.68 to 6.13 in WDDS is remarkable, representing a shift from inadequate to adequate diversity in a single intervention cycle .

Several factors explain this success. First, the intervention was nutrition-sensitive, addressing the root cause of poor diets—limited production diversity—rather than only treating symptoms. Second, it built on existing practices rather than introducing entirely new systems. Third, it focused on women, who are both primary food producers and primary decision-makers about household meals. Fourth, it combined inputs (seeds) with knowledge (training) and ongoing support.

The challenge is scaling. The pilot worked with 40 women with intensive support. Reaching millions would require integration into agricultural extension systems, health services, and safety net programs. Ethiopia's Productive Safety Net Programme, which reaches millions of food-insecure households, offers a potential platform.

6.4 Implementation Quality: The Hidden Determinant of Effectiveness

Across both countries, the gap between policy and implementation emerges as a critical determinant of outcomes. India's ICDS study documented multiple operational bottlenecks: supply chain weaknesses, infrastructure deficits, human resource shortages, and administrative burdens that undermine even well-designed programs . Menu rigidity and predictable dislikes cause avoidable waste—a reminder that cultural appropriateness must extend to day-to-day implementation, not just program design.

The Ethiopian home-garden study, while successful, was a pilot with intensive researcher involvement. Whether similar results can be achieved at scale through routine government services remains to be tested.

The lesson is that intervention effectiveness depends not only on what is designed but on how it is implemented. Attention to implementation quality—supply chains, human resources, infrastructure, community engagement—is as important as technical design.

6.5 Addressing Socioeconomic Inequalities

The DHS analysis reveals that in both countries, nutritional status and health care access are systematically worse for disadvantaged populations . Anemia, low BMI, and barriers to care are concentrated among the less well-off, while service coverage favors the better-off. These patterns suggest that health systems, rather than reducing inequalities, may amplify them.

The implication is that nutrition interventions must be deliberately designed to reach and benefit disadvantaged populations. This may require geographically targeted services, outreach to remote communities, removal of financial barriers, and attention to the social and cultural factors that limit service uptake. The Ethiopian home-garden intervention's focus on women and community-level engagement offers a model for reaching populations that formal health systems often miss.

6.6 Implications for SDG 2 and Sustainable Nutrition

The findings have important implications for achieving SDG 2's targets on ending malnutrition.

First, cultural appropriateness matters for effectiveness. Interventions that respect and leverage traditional food practices achieve higher acceptability and sustainability. India's millet-based approaches and Ethiopia's home-garden interventions both demonstrate this principle .

Second, dietary diversity is as important as calorie adequacy. The "South Asian Enigma" suggests that focusing on calories alone will not solve malnutrition. Ethiopia's dramatic WDDS improvement through home gardens and India's attention to thali diversity both emphasize the importance of diverse, nutrient-rich diets.

Third, implementation quality is a critical determinant of outcomes. Even well-designed programs fail if operational bottlenecks are not addressed. India's ICDS study documents the range of challenges that must be tackled .

Fourth, equity must be an explicit goal. Socioeconomic inequalities in nutritional status and service coverage mean that interventions must be deliberately targeted to reach disadvantaged populations.

Fifth, multisectoral approaches are essential. Nutrition cannot be addressed by health systems alone. India's integration of millets into ICDS and schools, and Ethiopia's nutrition-sensitive agriculture approach, both recognize that food systems, agriculture, and social protection are as important as health services.

Sixth, evidence generation must continue. While RCTs provide important evidence, implementation research, cost-effectiveness analysis, and participatory approaches are equally needed to understand what works in real-world contexts.

7. CONCLUSION

This comparative analysis of nutritional interventions and cultural food practices in India and Ethiopia reveals both common challenges and distinctive approaches. India, grappling with the "South Asian Enigma" of persistent malnutrition despite economic growth, has developed large-

scale program infrastructure (ICDS, Mid-Day Meals) and is innovating with millet-based interventions that leverage traditional foods. Ethiopia, facing its own nutrition challenges, has pursued nutrition-sensitive agriculture approaches centered on home-garden diversification, achieving remarkable gains in dietary diversity at pilot scale.

India's experience demonstrates that large-scale programs can incorporate culturally appropriate innovations. Fortified ragi malt achieved strong acceptability, with sensory scores ≥8.0 and caregiver willingness to continue use . Millet-based meals improved HAZ and BMI . Double-fortified salt reduced anemia significantly . Yet implementation challenges persist: supply chain weaknesses, human resource shortages, menu rigidity, and administrative burdens undermine effectiveness . And socioeconomic inequalities in nutritional status and service coverage remain stark .

Ethiopia's home-garden intervention demonstrates the power of working directly with women at household level. A single intervention cycle increased Women's Dietary Diversity Score from 3.68 to 6.13—a dramatic improvement with meaningful implications for micronutrient adequacy . Cost-optimized food basket research demonstrates that culturally acceptable, nutritionally adequate diets are achievable at modest cost . Yet scaling such approaches while maintaining quality remains a challenge.

The common thread across both countries is the importance of cultural appropriateness. Interventions that respect and leverage traditional food practices—millets in India, home gardens in Ethiopia—achieve higher acceptability and sustainability. The Indian thali, with its combination of grains, lentils, vegetables, and dairy, represents a "cultural blueprint for sustainable and complete nutrition" . Ethiopia's home gardens, traditionally used but underutilized for nutrition, offer a platform for diversification that women readily adopt.

The findings also underscore that technical intervention design, while essential, is insufficient. Implementation quality determines outcomes: preparation quality affects intake ; supply chains determine availability; human resources determine reach; community engagement determines uptake. And socioeconomic inequalities mean that even effective interventions may not reach those most in need unless deliberately targeted .

For India, the path forward involves strengthening implementation within existing programs, addressing the operational bottlenecks documented in the ICDS study . This means investing in supply chains, filling human resource gaps, reducing administrative burdens, and creating flexibility for local menu adaptations. It also means scaling up millet-based interventions, addressing awareness gaps and market barriers , and continuing to generate evidence on nutritional outcomes.

For Ethiopia, the priority is scaling home-garden approaches while maintaining the intensity and quality that made the pilot successful . This requires integration into agricultural extension, health systems, and safety net programs; investment in seed systems and training; and sustained attention to women's empowerment. Cost-optimized food baskets provide a benchmark for what constitutes an adequate diet and what it costs .

For both countries, addressing socioeconomic inequalities requires deliberate action. Services must be geographically targeted to reach remote communities. Financial barriers must be removed. Social and cultural factors that limit service uptake—including women's need for permission to visit health facilities —must be addressed through community engagement and empowerment.

The comparison between India and Ethiopia offers lessons that extend beyond these two countries. It demonstrates that there is no single path to improving nutrition. Large-scale programs and household-level interventions both have roles. Fortification and dietary diversification are complementary, not competing, strategies. Traditional foods and modern nutrition science can work together.

As the world strives to achieve SDG 2's targets by 2030, the experiences of India and Ethiopia offer both hope and caution. Hope, because progress is possible, as Ethiopia's dietary diversity gains demonstrate. Caution, because progress requires sustained attention to implementation quality, equity, and cultural appropriateness—the details that determine whether programs deliver results.

The ultimate lesson is that nutrition is not just about nutrients. It is about food—what people eat, why they eat it, how it is produced, prepared, and shared. Interventions that respect this

fundamental truth, that work with rather than against cultural food practices, that engage communities as partners rather than recipients, are the interventions that will succeed.

8. LIMITS OF THE STUDY

This study has several limitations that should be acknowledged. First, the comparative analysis relies primarily on secondary sources rather than primary empirical research. Direct observation of program implementation, interviews with beneficiaries and frontline workers, and analysis of primary outcome data would provide valuable additional perspectives.

Second, data availability and comparability vary between countries. India benefits from extensive systematic reviews and detailed implementation research . Ethiopia's evidence base includes rigorous pilot studies but less evidence on scaled programs.

Third, the studies reviewed use different outcome measures and timeframes, limiting direct comparison. India's evidence focuses on anthropometric outcomes (HAZ, BMI) and anemia; Ethiopia's focuses on dietary diversity.

Fourth, the rapid pace of policy and program development means that findings represent a snapshot in time. India's ICDS continues to evolve; Ethiopia's home-garden approaches are being scaled.

Fifth, the study focuses primarily on undernutrition and micronutrient deficiencies, with limited attention to the rising burden of overweight/obesity that both countries face.

Finally, the voice of communities and beneficiaries is mediated through research reports rather than captured directly. Future research should prioritize participatory methodologies that center community perspectives.

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10. AUTHOR CONTRIBUTIONS

The author conceived the study, designed the research methodology, conducted the literature review and document analysis, synthesized findings across countries, and drafted the complete manuscript. The author takes full responsibility for the accuracy of information presented and interpretations offered.

11. COMPETING INTERESTS

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential competing interest. No funding was received from organizations with interests in nutrition products, agricultural commodities, or health services.

12. AUTHORS' CONTRIBUTIONS

As sole author, I performed all roles including conceptualization, methodology development, investigation, formal analysis, writing, review, editing, and project administration.

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14. DATA AVAILABILITY

All sources analyzed in this study are publicly available documents, including peer-reviewed articles indexed in PubMed and other databases, institutional reports, and program documentation. Primary sources are cited in the bibliography and accessible through the referenced publications and organizations.

15. DISCLAIMER

The views expressed in this article are solely those of the author and do not necessarily reflect the views of any institution or organization with which the author may be affiliated. The analysis is provided for scholarly purposes and should not be construed as policy guidance or program advice. Nutrition policies and interventions are subject to change, and readers should consult current sources for specific information about India, Ethiopia, and nutrition programming.

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