

Abstract of the Problem

India continues to face a serious and multi-dimensional nutritional challenge characterized by iron deficiency anemia, protein-energy malnutrition, micronutrient gaps, and the rapid rise of lifestyle-related diseases. Despite being one of the world's largest food producers, access to balanced, affordable, and clean-label nutrition remains limited for a significant portion of the population. Women, children, working professionals, and elderly individuals are particularly vulnerable to inadequate dietary diversity and insufficient intake of quality plant-based protein.

Iron deficiency remains one of the most widespread nutritional disorders in India, affecting productivity, cognitive development, maternal health, and overall immunity. At the same time, protein intake among low- and middle-income households is often heavily dependent on carbohydrate-rich staples such as polished rice and refined wheat flour. These staples provide calories but lack balanced amino acid profiles and sufficient micronutrients. Urban populations face a parallel challenge: increased consumption of ultra-processed foods that are calorie-dense but nutritionally poor, contributing to obesity, diabetes, and cardiovascular diseases. This dual burden of undernutrition and unhealthy overnutrition highlights systemic gaps in the current food ecosystem.

Existing market solutions do not fully address this challenge. Many commercially available fortified flours and malt-based health drinks depend on synthetic nutrient fortification after high-temperature industrial processing. Excessive heat during conventional drying and manufacturing destroys natural amino acids and sensitive micronutrients. Manufacturers then compensate by adding artificial vitamins and minerals. While this approach improves nutritional labels, it does not always ensure optimal bioavailability and often increases product cost. Furthermore, several health products are limited to beverage formats and lack versatility in daily cooking applications, reducing household adoption and long-term consumption consistency.

Another limitation in the market is the narrow focus on single-grain formulations. Although millet-based products have gained popularity, consuming a single grain does not guarantee a complete amino acid profile. Balanced plant-based protein requires thoughtful blending of multiple ingredients, including millets, pulses, vegetables, fruits, and traditional crops. Affordable, naturally processed, multi-ingredient solutions remain scarce in mainstream markets.

In parallel with nutritional challenges, small and marginal farmers struggle with low income realization and price volatility. Millets, vegetables, and traditional

crops often fetch minimal farm-gate prices due to lack of local value-addition infrastructure. Post-harvest losses remain significant, and farmers have limited integration into high-value functional food supply chains. Without decentralized and sustainable processing models, both farmer income growth and rural economic development remain constrained.

Environmental sustainability presents another critical dimension of the problem. Conventional food processing systems frequently rely on fossil-fuel-based drying and energy-intensive manufacturing processes, leading to high carbon emissions and increased operational costs. As climate change concerns intensify, there is growing demand for eco-friendly food production systems that reduce carbon footprint while maintaining nutrient integrity. However, scalable and affordable green-processing alternatives are still limited in the MSME food sector.

Consumer preferences are also evolving rapidly. There is increasing awareness regarding clean-label foods, chemical-free ingredients, preservative-free products, and sustainable packaging. However, premium health-focused products are often priced beyond the reach of middle-income families. This creates a significant gap between inexpensive staple foods with low nutritional density and high-cost specialty health products targeted at niche urban markets.

Government initiatives such as millet promotion, nutrition missions, and sustainable MSME programs aim to address these issues, but effective on-ground integration of nutrition, farmer income enhancement, clean-label production, and environmental sustainability remains inadequate. There is a clear need for an integrated and scalable solution that simultaneously:

- Provides affordable, balanced plant-based protein and micronutrients
- Preserves nutrients naturally without chemical fortification
- Supports farmer income through value-added sourcing
- Reduces carbon emissions through sustainable processing
- Aligns with Indian culinary habits and multi-purpose usage