FORTIFY HEALTH

Policy White Paper

Strengthening Nutrition Security: A Policy Roadmap for Wheat Flour Fortification in India

2025

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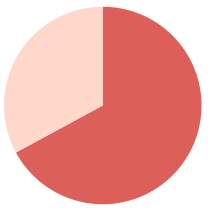
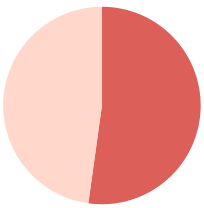
The Problem: Anaemia in India

India faces a persistent and urgent public health challenge: iron deficiency anaemia (IDA). Despite decades of national efforts—ranging from supplementation programs to dietary diversification—anaemia remains alarmingly widespread. According to NFHS-5 (2019–21), **67% of children under five and 52.2% of pregnant women are anaemic**.

With strong evidence, proven tools, and scalable solutions already available, the time to act is now.

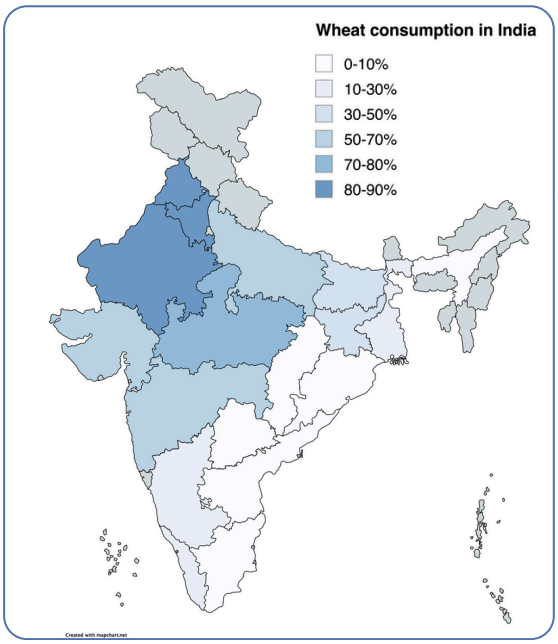


67.1% of children under 5 suffer from anaemia in India.

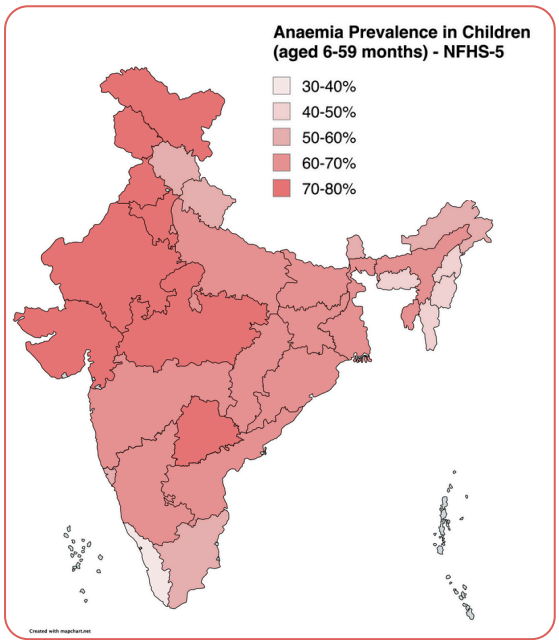


52.2% of pregnant women suffer from anaemia in India.

The Opportunity: Why Wheat Flour Fortification Matters



Wheat % share of total cereal consumption in India
(HCES 2022-23)



Anaemia Prevalence in Children
(aged 5-59 months) - NFHS 5

50 crore Indians eat wheat daily. It is time to mandate wheat flour fortification, like it was done for rice fortification.

The Evidence Base: How It Works

Global research confirms the impact of large-scale food fortification:

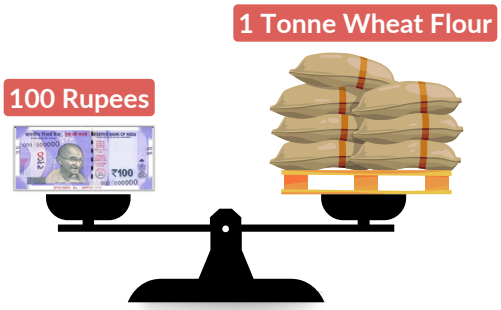
- Meta-analysis (2021): **Iron-fortified wheat flour reduced anaemia by 27%** among women and children.
- Global review (2012): **Food fortification reduced anaemia by 41% worldwide**.
- India RCT (2012): **Fortified wheat flour cut iron deficiency by 41 percentage points** in school children.

These findings are consistent across geographies and income levels, showing that fortification is effective and adaptable.

Low Cost, High Returns

Wheat flour fortification is among the most cost-effective public health interventions available. At just **₹0.10 per kg**, the additional cost is minimal—₹100 can fortify 1,000 kg (1 tonne) of wheat flour, unlocking wide-ranging health and economic benefits.

According to NITI Aayog, **IDA results in a 1.18% annual GDP loss.** Scaling up fortification can reverse this loss while supporting government schemes such as Anaemia Mukt Bharat and POSHAN 2.0.



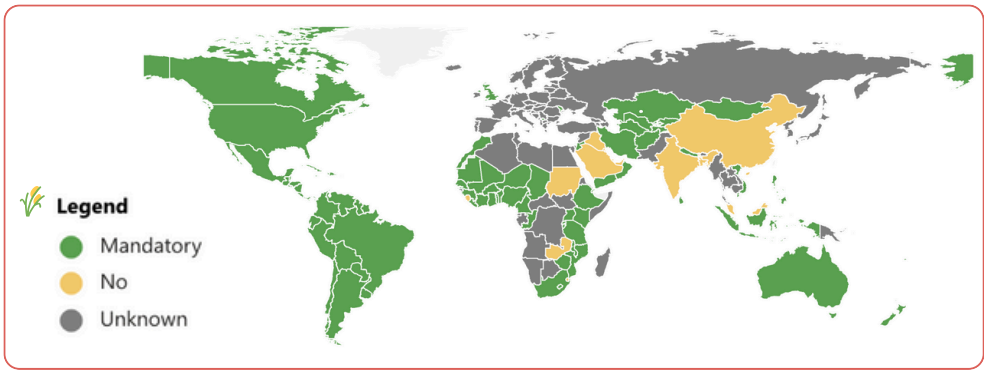
₹100 can fortify 1,000 kg (1 tonne) of wheat flour, unlocking wide-ranging health and economic benefits

Existing Systems Are Ready

- **Fortification can be integrated** into **India's Social Safety Net Programs (SSNPs)**, which collectively **serve over 90 crore people**.
  - Key schemes include the **Public Distribution System (PDS), ICDS, and PM POSHAN** scheme
  - These programs currently distribute large quantities of raw wheat grain — shifting to centrally milled, fortified flour would ensure consistent access to iron and folic acid for children, pregnant women, and adolescents.
- The **technology is simple, scalable, and already in use** across India.
- Over **170 millers across 14 states** and union territories **are currently fortifying wheat flour**. This network enables **access to fortified flour for approximately 70 lakh people each month**.
- A strong ecosystem of technical partners shows that India is ready to implement and scale fortification mandates.

Global Progress, India's Next Step

Countries with mandatory wheat flour fortification (Global Fortification Data Exchange)



INDIA:

- Salt iodisation
- Rice fortification
- Wheat flour fortification *(Opportunity)*

Policy Recommendations

1. Mandate wheat flour fortification in SSNPs
2. Phase rollout in high-burden wheat-consuming states
3. Support SMEs financially/ technically
4. Strengthen monitoring/ testing
5. Boost consumer demand via campaigns

Conclusion: A Stronger, Healthier Future

Wheat flour fortification is a practical, affordable, and evidence-based solution to one of India's long-standing public health challenges. It aligns with national nutrition goals, leverages existing systems, and delivers high returns on investment.

With strong policy leadership, cross-sector collaboration, and support from technical partners, India can close a major nutritional gap—improving lives, boosting productivity, and building a healthier future.

The evidence is clear. The tools exist. The time to act is now.

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SCAN ME

ENDORSEMENTS

The challenge of anaemia in India is not just a health crisis, it is an obstacle to our development goals and economic productivity. For any government, the priority is finding public policy solutions that are not only effective but also feasible to implement at massive scale using existing government infrastructure. Fortify Health's white paper identifies a solution ready for immediate action. The paper makes a strong case for mandating wheat flour fortification, particularly within the Social Safety Net Programs (SSNPs) - like PDS, ICDS and PM POSHAN. Fortification is a crucial health investment. It ensures the very foundation of our safety net programs delivers maximum nutritional returns to the most vulnerable, our women and children. I recommend that state governments, especially those in the major wheat consuming states, adopt and scale up wheat flour fortification This is a practical, immediate and high-impact policy that has the potential to unlock significant human capital gains for the nation.

Alok Ranjan (IAS Retired)
Former Chief Secretary, Government of Uttar Pradesh

Wheat flour fortification is a scientifically proven intervention to reduce iron deficiency and iron deficiency anaemia, supported by growing body of global and Indian evidence. Controlled trials and meta-analyses consistently show significant improvements in iron status and haemoglobin status and lower odds of anemia in the intervention group, along with reductions in neural tube defects and other micronutrient deficiencies among populations consuming fortified wheat flour. The 2012 Indian RCT using NaFeEDTA demonstrated a 41-percentage-point reduction in iron deficiency, while global analyses indicate a 27 percent decline in anaemia prevalence following fortification. With more than 90 countries now mandating wheat flour fortification, the global deployment of wheat flour fortification is extensive. This White Paper captures that evidence comprehensively and translates it into a clear, evidence-backed framework for advancing wheat flour fortification at scale through India's social safety net programmes.

Dr. Prashanth Thankachan
Professor, Division of Nutrition, St. John's Research Institute

Public health interventions such as wheat flour fortification must be approached through a multisectoral lens, supported by measurable indicators that demonstrate progress in the short and medium term. Given India's dietary diversity and varying implementation capacities across states, tailored state-level roadmaps are essential to guide action. The White Paper provides valuable evidence and policy direction to support this effort, outlining clear pathways for integrating fortified wheat flour into social safety net programmes. A focused, data-driven approach, as articulated in this paper, will be key to ensuring that fortification efforts translate into measurable improvements in nutrition and health outcomes.

Dr. Urvashi Prasad
Former Director, NITI Aayog; Senior Fellow, Pahle India Foundation; Honorary Professor, De Montfort University, Leicester

Fortifying wheat flour is a proven strategy used around the world to reduce micronutrient deficiencies. In India, it offers a practical way to improve iron intake and help prevent iron deficiency anaemia. Because wheat is a staple food for millions, fortification can reach people widely and without changing their diets. This White Paper by Fortify Health brings together important evidence and policy insights to guide the scaling up of wheat flour fortification across India.

Dr. Rajan Sankar
Former Director, Nutrition, Tata Trusts; Founding Director, TINI

About the White Paper

The white paper is intended for Central and State Governments (policymakers and implementers), Industry Leaders and Wheat Flour Millers, Development Partners, Non-Government Organisations(NGOs), and Civil Society Organisations involved in nutrition advocacy and public health. It is structured into six key sections: (1) an overview of anaemia in India and its challenges, (2) existing solutions to address anaemia, (3) the role of food fortification as a proven intervention, (4) the rationale for prioritizing wheat flour fortification, (5) an implementation roadmap with policy, regulatory, and quality control frameworks, and (6) actionable recommendations for scaling up fortification efforts. This structured approach ensures that the white paper serves as both a technical guide and a policy advocacy tool, enabling stakeholders to make informed decisions and accelerate progress in addressing anaemia across India.

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1. Anaemia in India: Current Status and Key Challenges

1.1 Background: The Triple Burden of Malnutrition

Malnutrition remains one of the most critical global health challenges, affecting millions across both developing and developed countries. The World Health Organisation (WHO) defines malnutrition as "deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients" (WHO, 2024). It can be categorised into three broad categories: undernutrition, overnutrition, and micronutrient deficiencies.

- **Undernutrition**: This includes stunting (low height-for-age), wasting (low weight-for-height), and being underweight (low weight-for-age), primarily caused by inadequate intake of calories and essential nutrients. In 2022, an estimated **149 million children under five** were stunted globally, and **45 million** were wasted.

- **Overnutrition**: Characterised by overweight, obesity, and diet-related non-communicable diseases such as heart disease, diabetes, stroke, and cancer. In 2022, **2.5 billion adults** were classified as overweight, including **890 million** living with obesity. Around **37 million children** were also affected.

Micronutrients

The WHO defines 'Micronutrients' as compounds required in very small amounts, <100 mg/d. Micronutrient deficiencies are a silent yet pervasive form of malnutrition affecting millions worldwide (Stevens et al., 2022).

- **Micronutrient deficiencies**, often referred to as **"hidden hunger"**, result from a lack of essential vitamins and minerals like iron, folic acid, vitamin A, and zinc, even when caloric intake is sufficient.

While both overweight and underweight conditions continue to pose public health risks, **micronutrient deficiencies are reaching unprecedented levels** (Green et al., 2016). India, in particular, is experiencing a **nutrition transition**, grappling with the **triple burden of malnutrition**: undernutrition, overnutrition, and micronutrient deficiencies. According to a recent meta-analysis (Venkatesh et al., 2021), the estimated prevalence of key micronutrient deficiencies in India is alarming, with an estimated deficiency of 61 percent for vitamin D, 54 percent for iron, 53 percent for vitamin B12, 37 percent for folic acid, 19 percent for vitamin A and 17 percent for iodine.

These micronutrients are essential for growth, immune function, and cognitive development. Deficiencies can lead not only to visible health issues but also to more subtle effects, such as fatigue, reduced concentration, and lowered productivity.

Among the most significant consequences of iron deficiency is anaemia, a condition that continues to affect populations across income groups and geographies. **Anaemia is not limited to low-resource settings**; it remains a **persistent global public health issue** across various socioeconomic groups (Kinyoki et al., 2021).

1.2 Understanding Anaemia: Definition, Causes, and Types

The World Health Organisation (WHO) defines anaemia as a condition in which the body lacks enough healthy red blood cells to transport oxygen effectively (WHO, 2022). This reduction in oxygen-carrying capacity can lead to symptoms such as fatigue, weakness, dizziness, and shortness of breath. The ideal haemoglobin level varies by age, sex, pregnancy status, smoking habits, and altitude of residence. Table 1 outlines the WHO's haemoglobin cut-off values (WHO, 2024).

Table 1: Haemoglobin cutoff to define anaemia in Populations and Individuals

S.no	Population	Hemoglobin concentration(g/L)
1	Children, 6 -23 months	<105
2	Children, 24-59 months	<110
3	Children 5-11 years	<115
4	Children 12-14 years (non-pregnant girls)	<120
5	Children 12-14 years, boys	<120
6	Adults, 15-65 years, non-pregnant women	<120
7	Adult, 15-65 years, men	<130
8	Pregnancy - First trimester - Second trimester - Third trimester	 <110 <105 <110

Anaemia can be caused by multiple factors, including poor nutrition or nutrient absorption issues, infections (malaria, parasitic infections, tuberculosis, HIV), inflammation, chronic diseases, gynaecological and obstetric conditions, and inherited red blood cell disorders. Among these, iron deficiency is the most common nutritional cause, though deficiencies in folate and vitamin B12 are also significant contributors.

Dietary iron deficiency may result from low intake of iron-rich foods, impaired absorption due to conditions like celiac disease or inflammatory bowel disease, or increased iron needs during pregnancy and adolescence (Kumar et al., 2022). Iron absorption can also be hindered by calcium and caffeine, which interfere with iron uptake by competing for absorption or forming insoluble compounds (Piskin et al., 2022).However, iron deficiency is not the only cause. Several other types of anaemia are also prevalent:

- **Folate or Vitamin B12 Deficiency Anaemia**: Caused by a lack of folic acid or vitamin B12, leading to the production of abnormally large and immature red blood cells.

- **Haemolytic Anaemia**: A group of conditions in which red blood cells are destroyed faster than they can be replaced. It can be inherited (e.g. sickle cell disease, thalassaemia) or acquired through infections, autoimmune disorders, or drug reactions.
- **Aplastic Anaemia**: A rare condition where the bone marrow fails to produce sufficient blood cells, often due to autoimmune disorders, viral infections, exposure to toxins, or radiation.
- **Anaemia of Chronic Disease (ACD)**: Occurs in individuals with long-term infections (e.g. tuberculosis, HIV), malaria, chronic kidney disease (CKD), or autoimmune disorders like rheumatoid arthritis. In ACD, the body's ability to process and utilise iron is disrupted due to inflammation or disease.

A recent population-based study in India (Sarna et al., 2020) found that among **children aged 1–4 years**, **iron deficiency anaemia** was the **most common** (36.5%), followed by anaemia from other causes (24.5%), vitamin B12 or folate deficiency anaemia (18.9%), mixed-type anaemia (13.5%), and inflammation-related anaemia (6.5%).

For **children aged 5–9 years**, anaemia from other causes was most prevalent (43.6%), followed by vitamin B12 or folate deficiency anaemia (24.6%), **iron deficiency anaemia** (15.6%), mixed-type anaemia (10.7%), and inflammation-related anaemia (5.4%).

Among **adolescents**, anaemia from other causes was highest (31.4%), followed by vitamin B12 or folate deficiency anaemia (25.6%), **iron deficiency anaemia** (21.3%), mixed-type anaemia (18.2%), and inflammation-related anaemia (3.4%).

1.3 Anaemia in India: A Persistent Public Health Crisis

India has the highest number of people living with anaemia globally. An alarming rise in prevalence between 2015–2016 and 2019–2021 has raised concerns among global public health researchers, donors, and policymakers. Iron deficiency, a leading cause of anaemia, was listed as one of the top ten risk factors in developing countries for 'lost years of healthy life', according to a 2002 World Health Organisation (WHO) report (Sharma et al., 2020). In 2021, the leading cause of anaemia worldwide was found to be iron deficiency, accounting for 66.2% **of all anaemia cases worldwide**, affecting **825 million women and 444 million men** (GBD 2021 Anaemia Collaborators, 2023). In India, 17.8% of maternal deaths are attributed to iron deficiency (IHME, 2021). Additionally, dietary iron deficiency accounts for around 14% of Disability-Adjusted Life Years (DALYs) lost among children aged 5–14 years.

ALARMING

In India, every second person is known to be affected by some form of anaemia.
More than half of pregnant and lactating women, as well as adolescent girls, are anaemic. While seven out of ten children in India suffer from anaemia.

Data from the fifth National Family Health Survey (NFHS-5, 2019–2021) paints a concerning picture, reversing the progress made between 2005–2006 and 2015–2016 (Ministry of Health and Family Welfare, 2021). According to the NFHS-5, anaemia prevalence is highest among children aged 6-59 months at 67.1 percent, followed by adolescent girls (15-19 years) at 59.1 percent, and women (15-49 years) at 57.0 percent. Pregnant women (15-49 years) have a prevalence of 52.2 percent, while adolescent boys (15-19 years) show a prevalence of 31.1 percent. Even though the lowest prevalence is recorded among men (15-49 years) at 25.0 percent, which is also a public health concern (Ministry of Health and Family Welfare, 2022).

Anaemia disproportionately affects women and children across all age groups (Figure 1). A life-cycle effect is evident: anaemia during adolescence increases the risk during pregnancy, and maternal anaemia is strongly correlated with childhood anaemia. Though it affects all age groups, women of reproductive age (15–49 years) are particularly vulnerable.Overall, 67 percent of children have some degree of anaemia (hemoglobin levels below 110 g/l), with 29 percent having mild anaemia (100-109 g/l), 36 percent having moderate anaemia (70-99 g/l), and 2 percent having severe anaemia (<70 g/l).

Anaemia prevalence is also linked to socioeconomic status, education, and geography. It declines with higher household income and educational attainment, and is generally lower in urban areas. However, prevalence increases notably among Scheduled Tribes, Scheduled Castes, and other backward classes (Kumar et al., 2021).

Figure 1: Anaemia Prevalence Among Various Age Groups

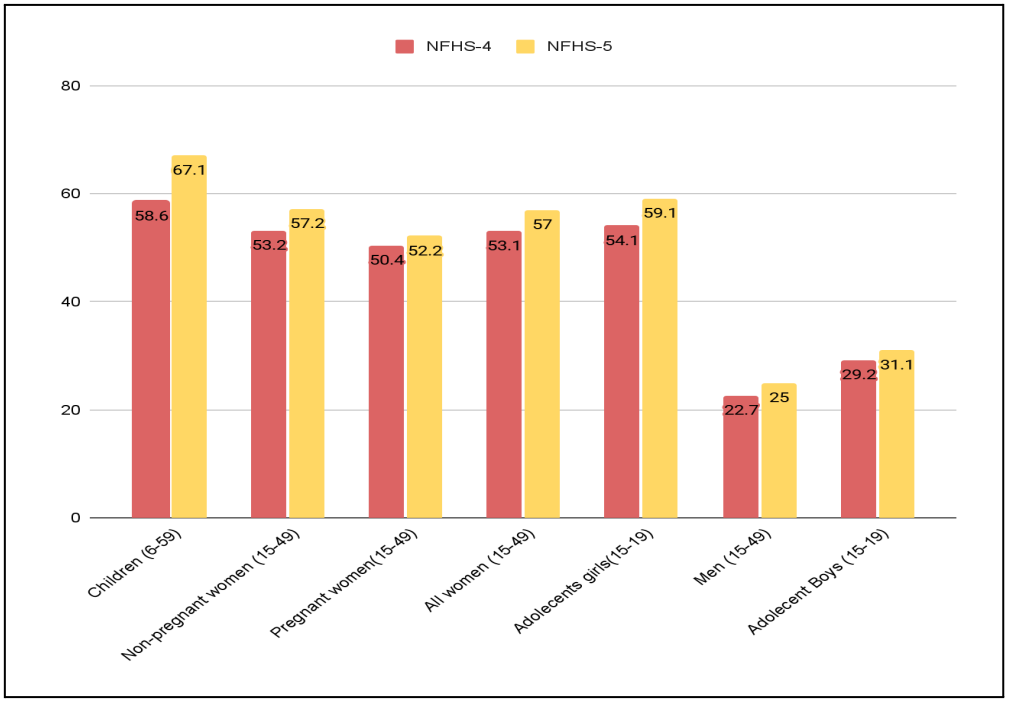


Figure 2: Anaemia among women

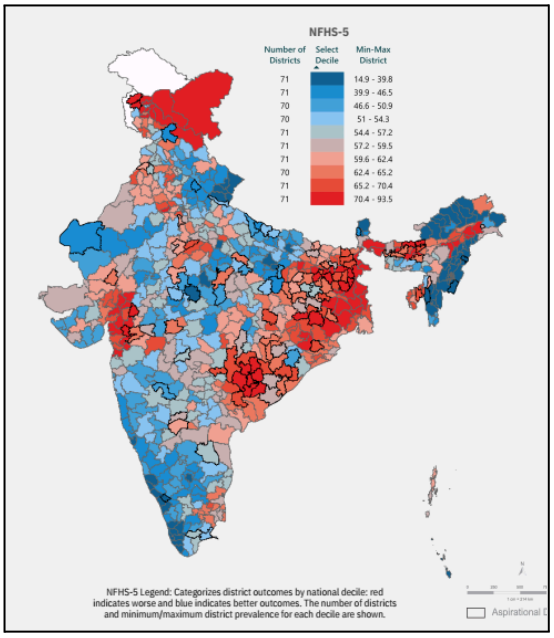
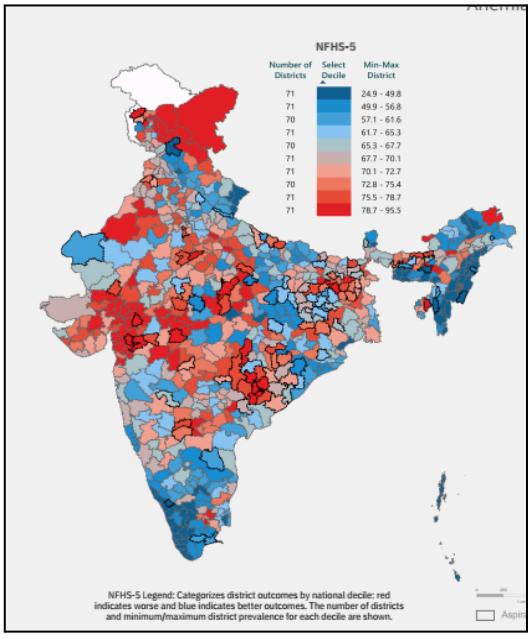


Figure 3: Anaemia among Children



There is also considerable state-level variation in anaemia prevalence (Figures 2 and 3). Ladakh reports the highest rates, with 94% of children and 78.1% of pregnant women affected.

Several other regions also show elevated anaemia levels among children, including Gujarat (80%), Daman & Diu (76%), Dadra & Nagar Haveli, Jammu & Kashmir, and Madhya Pradesh (all 73%), as well as Rajasthan (72%) and Punjab (71%). Among pregnant women, Bihar (63.1%), Gujarat (62.6%), West Bengal (62.3%), and Odisha (61.8%) follow Ladakh in terms of high prevalence.

These disparities reflect a complex interplay of socioeconomic, geographic, and healthcare access factors, including poverty, poor dietary intake, and inadequate health infrastructure. According to Singh et al. (2023), the rise in anaemia prevalence during 2019–2021 was significantly influenced by maternal anaemia status, socio-economic conditions, and levels of education.

1.4 Health and Economic Impacts

1.4.1 Maternal and Child Health

Anaemia during pregnancy is a significant public health concern, contributing to both increased maternal mortality and poor birth outcomes. The World Health Organisation (WHO, 2025) estimates that 40% of children aged 6–59 months, 37% of pregnant women, and 30% of women of reproductive age (15–49 years) are affected by anaemia globally. In 2019, iron deficiency anaemia (IDA) was estimated to cause 22% of maternal deaths worldwide (Stevens et al., 2022). In India alone, 18% of maternal deaths are attributed to anaemia (Neogi et al., 2022). Women with severe anaemia are at 3.5 times higher risk of obstetric complications such as postpartum haemorrhage and preeclampsia, increasing both maternal and neonatal mortality (World Bank, 2003).

Anaemia also raises the risk of preterm births, intrauterine growth retardation, stillbirths, and low birth weight (LBW) babies, compounding neonatal health risks (Ministry of Health and Family Welfare, 2013; WHO, 2025). Its effects extend into early childhood, influencing long-term health and development. Around 4–5% of child mortality in India is linked to anaemia (Kassebaum et al., 2014). Children with anaemia are more likely to suffer from malnutrition, stunting, and wasting (Dessie et al., 2025). This crisis is worsened by low intake of bioavailable iron, particularly after weaning, which increases vulnerability to serious infections like lower respiratory tract infections and diarrhoea, two of the leading causes of child mortality in India.

1.4.2 Cognitive Development

Iron deficiency has a profound impact on children's cognitive and motor development, causing delays in memory, attention, and problem-solving abilities (Hare, 2004). Studies suggest that anaemic children may experience impaired coordination of language and motor skills, resulting in a 6–15 point drop in IQ scores (Szajewska, 2011). The effects are especially apparent in mathematics and language skills, which directly influence academic achievement (World Health Organisation, 2001).

Longitudinal research has found that children with chronic iron deficiency in infancy score 8–9 points lower on cognitive assessments during adolescence. Observational studies estimate that for every 10 g/L reduction in haemoglobin, there is a corresponding 1.73-point drop in future IQ (Stoltzfus et al., 2004). Encouragingly, iron supplementation in anaemic children aged 5–12 years can improve general cognitive ability by 0.29 standard deviations, equivalent to an approximate 4.4-point increase in IQ (Low et al., 2013).

1.4.3 Productivity

Anaemia also compromises physical work capacity, reducing overall labour productivity (Marcus et al., 2021). Affected individuals often experience fatigue and lower endurance, with studies showing a 17% reduction in output among heavy manual labourers and a 5% decrease among those in moderate roles (Horton and Levin, 2001). The economic cost is significant. According to the World Bank, for every US$1 invested in reducing anaemia, there is a return of approximately US$12 in increased productivity and earnings (World Health Organization, n.d.).

At the global level, iron-deficiency anaemia is estimated to reduce GDP by 0.8–0.9% annually (Horton & Ross, 2003). In India, this loss is even greater, estimated at 1.18% of GDP each year (NITI Aayog, 2019).

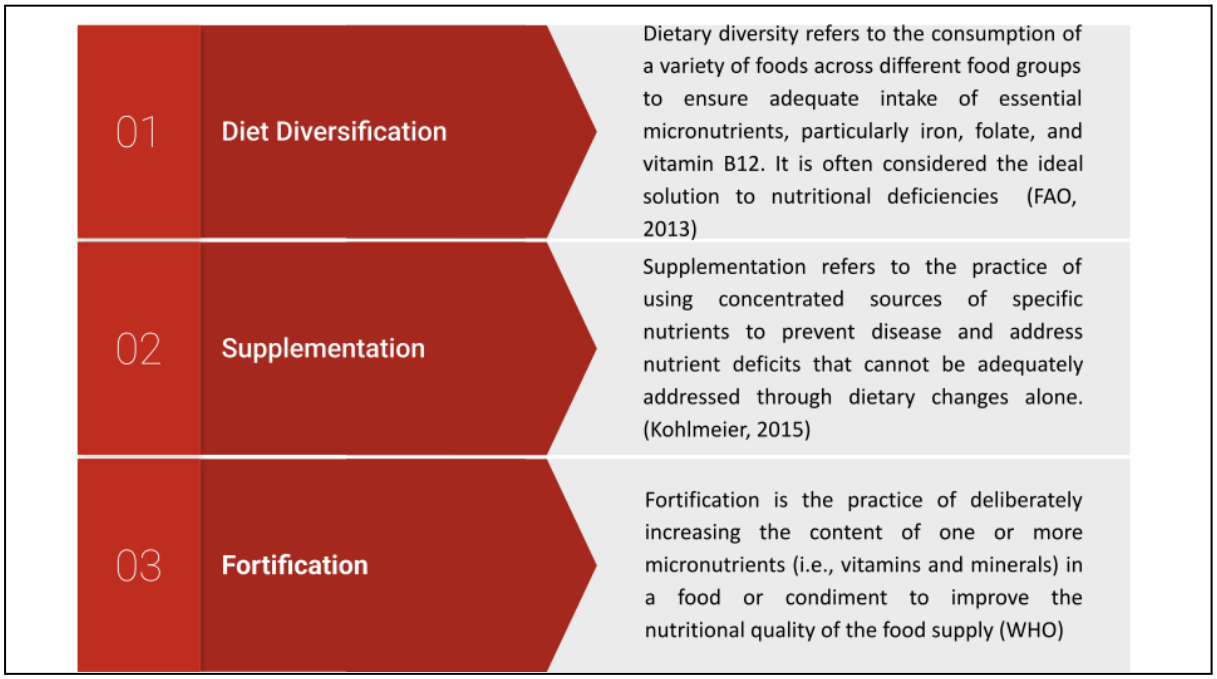
2. Addressing the Anaemia Challenge

2.1 Strategies to Tackle Anaemia

Anaemia and other micronutrient deficiencies may arise due to two main reasons: diseases that hinder the absorption or utilisation of nutrients, and inadequate dietary intake. Addressing the former requires medical and public health interventions, focused on disease prevention and treatment. The latter, however, can be tackled through preventive, food-based strategies (Bechoff et

al., 2023). The following approaches are commonly recommended to combat diet-related micronutrient deficiencies (see Figure 4).

Figure 4: Food-based strategies to address Anaemia and Malnutrition



Dietary diversity, which involves consuming a range of nutrient-rich foods, is the most natural and sustainable way to prevent deficiencies. However, this is often hard to achieve due to **s**ocioeconomic constraints, regional and seasonal food availability, low consumer awareness, and cultural taboos. According to NFHS-5, the proportion of children aged 6–59 months meeting minimum dietary diversity declined from 87.4% in 2005–06 to 77.1% in 2019–21, underlining persistent challenges in improving diet quality (Gunnal et al., 2024).

India's micronutrient supplementation initiatives—such as Anaemia Mukt Bharat (AMB), the National Iron Plus Initiative (NIPI), and Weekly Iron and Folic Acid Supplementation (WIFS)—aim to improve iron and vitamin intake among vulnerable groups. These programs distribute iron-folic acid (IFA) tablets and vitamin A doses through health systems, schools, and Anganwadis.

However, they face challenges such as weak supply chains, low community awareness, side effects, and poor adherence. NFHS-5 data show that:

- Only **44.1% of pregnant women** took IFA supplements for 100 or more days.
- Only **26% completed** the recommended 180+ days.
- About **30% of children** missed their scheduled vitamin A dose.
- Just **40% of children under five** and adolescents received weekly iron supplements through schools and Anganwadis (Ministry of Health and Family Welfare, 2021, 2025).

Given the limitations of dietary diversity and supplementation, food fortification provides a powerful complementary solution. It delivers essential nutrients to large populations through staple foods,

with minimal behaviour change required and at low cost (see Table 2). There are two main forms of fortification:

- **Biofortification**: Increasing the nutrient content of crops through plant breeding, improved farming techniques, or biotechnology. While sustainable, biofortification can be expensive, may alter the crop's appearance, and often requires significant R&D investment (Talsma and Pachón, 2017).
- **Food fortification**: Adding micronutrients (such as iron, folic acid, zinc, vitamins A and D) to commonly consumed foods like rice, wheat flour, salt, oil, and milk (Kiran et al., 2022). This method is already being implemented at scale in many countries.

> "Food Fortification is *incredibly cheap, simple intervention that saves lives*"
>
> The Copenhagen Consensus

Food fortification is a cost-effective intervention that can be seamlessly integrated into existing supply chains. It is generally well accepted by consumers, particularly when it does not alter the taste, appearance, or cooking properties of food. Unlike supplementation, it is less reliant on individual behaviour change or compliance, making it more suitable for reaching large populations. Manufacturers and millers can incorporate fortification into current production processes with minimal operational disruption, making it a practical and scalable solution to address micronutrient deficiencies.

Table 2: Comparison between strategies to address anaemia

Strategies /Challenges	Food Fortification	Supplementation (IFA, Vitamin A)	Dietary Diversity
Cost-effectiveness	✅ Low cost per capita; suitable for large-scale coverage	❌ High cost of supplements, logistics, and delivery mechanisms	❌ High cost to ensure consistent access to diverse food groups
Sustainability	✅ Sustainable once integrated into food systems	❌ Dependent on ongoing procurement and distribution	✅ Sustainable when using locally available, culturally accepted foods
Impact on Anaemia Reduction	✅ Moderate impact; requires time to show results	✅ High impact among adherent individuals	✅ Moderate impact over time with consistent adoption
Infrastructure & Policy Needs	✅ Requires collaboration with industry and clear regulatory standards	❌ Requires robust healthcare infrastructure and monitoring systems	✅ Requires agricultural diversification and strong awareness efforts
Adverse Effects	✅ No side effects	❌ Nausea and other common side effects from IFA tablets	✅ Natural and safe

Population coverage	✅ Broad reach through staple foods like wheat and salt	❌ Limited reach; only ~40% of children receive regular supplementation	❌ Limited reach in low-income areas lacking food access diversity

WHO recommends large-scale food fortification as a proven, evidence-based and cost-effective intervention to reduce vitamin and mineral deficiencies—including anaemia, iron deficiency, and iodine deficiency disorders (World Health Organisation, n.d.). It offers a viable and scalable complementary strategy for countries like India to bridge nutritional gaps and support better public health outcomes.

2.2 Policy Landscape in India

The Government of India has launched several national programs over the past five decades to address anaemia, with a primary focus on iron supplementation and pharmacological interventions. Figure 5 outlines a timeline of these key policies.

The National Nutritional Anaemia Prophylaxis Program (NNAPP), launched in 1970, was India's first structured intervention to combat iron deficiency through supplementation. It identified specific beneficiary groups and defined pharmacological doses of iron. In 1991, this initiative evolved into the National Nutritional Anaemia Control Program (NNACP), which increased the recommended dosage for adults following an Indian Council of Medical Research (ICMR) evaluation in 1989.

Two decades later, in 2012, the Weekly Iron and Folic Acid Supplementation (WIFS) program expanded the focus to include adolescents, particularly girls. This was followed by the launch of the National Iron Plus Initiative (NIPI) in 2013, which addressed previous program gaps and re-centred efforts on children, adolescents, pregnant and lactating women. NIPI introduced a multisectoral, life cycle-based approach, aiming to prevent and manage anaemia across age groups.

In 2017, the National Health Policy called for stronger screening and treatment of anaemia, leading to the launch of Anaemia Mukt Bharat (AMB) and POSHAN Abhiyan in 2018. AMB built on earlier iron supplementation programs and introduced key elements such as deworming, behaviour change communication (SBCC), delayed cord clamping, and anaemia testing at the primary care level. The program aims to reduce anaemia prevalence by three percentage points per year and make significant progress by 2022.

Despite these efforts, India's policy approach has remained heavily pharmacological, with limited emphasis on food-based solutions like dietary diversification. However, recent research underscores the potential of social safety net programs (SSNPs) in advancing nutrition strategies for anaemia prevention (Rai et al., 2023).

WHO estimates that only 42 percent of children aged 6– 59 months, 49 percent of non-pregnant women, and 50 percent of pregnant women aged 15–49 years are open to iron supplementation.

In India, five major social safety net programs have been implemented. Among them, the ICDS (1975), the Mid-Day Meal (MDM) Scheme (1995) (now known as Pradhan Mantri Poshan Shakti Nirman (PM-Poshan), the Targeted Public Distribution System (TPDS), and Social Security Pensions

are legally mandated under the National Food Security Act (NFSA) and the National Rural Employment Guarantee Act (2013).

The ICDS, PM-POSHAN, and TPDS are key government interventions aimed at improving nutrition by providing food to beneficiaries. ICDS offers supplementary nutrition through hot-cooked meals or take-home rations (THR) for children, pregnant women, and lactating mothers. PM-POSHAN provides free lunches to school-going children, while TPDS supplies subsidised food grains, such as rice and wheat, to targeted households. Nutritional standards for these programs are outlined in Schedule II of the NFSA. Section 5 provides further details on these schemes.

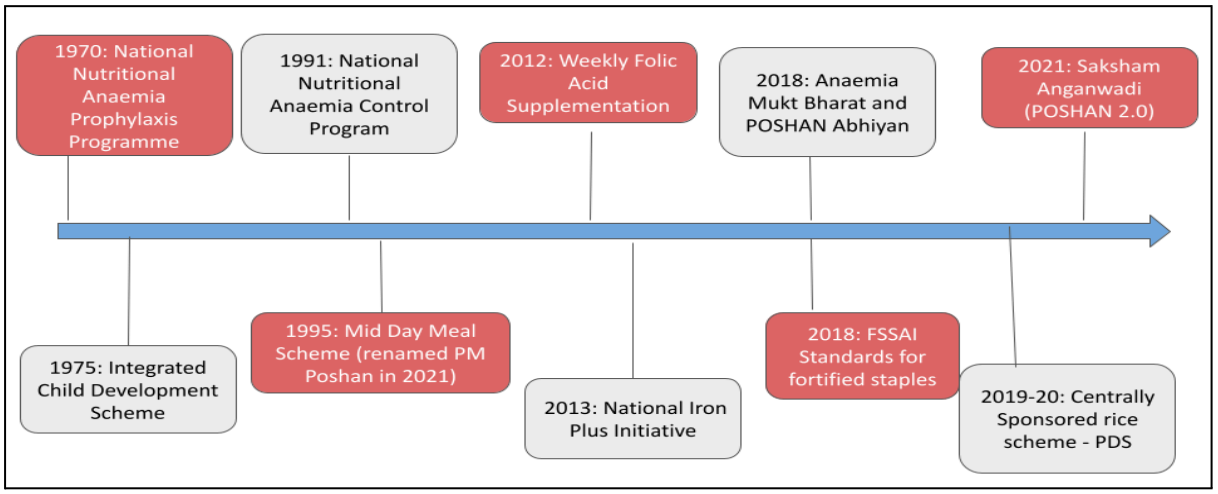
Historically, government nutrition interventions have focused on addressing protein-energy malnutrition, often overlooking micronutrient deficiencies such as iron-deficiency anaemia (IDA). To meet the targets set under the Anaemia Mukt Bharat (AMB) initiative, the government has introduced fortified rice distribution through social safety net programs.

To improve iron intake, rice fortification was mandated in all SSNPs by 2024, and fortified wheat flour pilot projects have been launched in selected states. While the efficacy of iron fortification in wheat flour is well-documented (Muthayya et al., 2012), several challenges persist—such as decentralised milling, logistical constraints, and the need to ensure the use of bioavailable iron compounds like NaFeEDTA. Strengthening monitoring systems, conducting large-scale anaemia causation studies, and integrating fortification into existing food programs are essential for achieving sustainable reductions in anaemia prevalence. Annexure 1 offers a comprehensive policy analysis using both frameworks.

2.3 Gaps in India's Anaemia Reduction Efforts

India has recently adopted a multifaceted approach to anaemia prevention, integrating interventions such as iron and folic acid (IFA) supplementation, clinical management, dietary diversification, food fortification, and water, sanitation, and hygiene (WASH) initiatives. These interventions are led by multiple ministries—including Women and Child Development, Health and Family Welfare, and Education—and often operate in parallel (Rai et al., 2023). However, certain limitations continue to undermine their effective implementation and overall impact.

Figure 5: Timeline of government interventions to address anaemia in India



2.3.1 Challenges Faced by Beneficiaries

Regardless of the widespread availability of iron and folic acid (IFA) supplements, adherence among pregnant and lactating women remains suboptimal. This is due to several factors, including limited awareness about anaemia and its health implications, misconceptions about IFA supplements, and inadequate counselling on managing side effects.

Efforts to promote dietary diversification face substantial resistance due to deeply ingrained cultural practices and food habits. Food taboos and misconceptions often prevent the consumption of nutrient-rich foods, even when they are available. Intra-household gender disparities in food distribution and the limited decision-making power of women further compromise their nutritional status. The social stigma associated with certain iron-rich foods also hampers dietary diversification efforts (Sedlander et al., 2020).

2.3.2 Systemic Barriers to Implementation

India's anaemia reduction programs face significant systemic challenges. Frequent supply chain disruptions result in stockouts of iron and folic acid (IFA) supplements at health centres and Anganwadi centres. Moreover, monitoring systems are often weak, with incomplete or outdated data on program implementation and outcomes. These challenges are further compounded by inadequate budget allocations.(Ahmad et al., 2023).

Human resource limitations also persist. Frontline workers, including Accredited Social Health Activists (ASHAs) and Anganwadi workers, often lack adequate training in nutrition counselling and supplement administration. High turnover and chronic understaffing disrupt service continuity and reduce program effectiveness (Kumar et al., 2022). At the state and district levels, poor interdepartmental coordination further limits effective resource sharing and program management.

Existing interventions largely prioritise supplementation over dietary diversity. Program coverage is inconsistent, with significant disparities between urban and rural areas. Moreover, the narrow focus on pregnant and lactating women excludes other vulnerable groups such as adolescent girls and women of reproductive age. Policy frameworks often lack flexibility to address localised needs and are slow to adopt innovative approaches. The limited emphasis on dietary diversification and gaps in food fortification strategies further constrain impact (Sedlander et al., 2020).

A detailed examination of program-specific challenges is provided in Section 5, while Section 3 offers an in-depth analysis of food fortification policies and their limitations.

3. Food Fortification as a Scalable Solution

Staple food fortification is widely recognised as a development and public health "best buy" (Global Alliance for Improved Nutrition, 2021). It offers a simple, effective way to enhance nutrition without requiring people to change their eating habits. Given the widespread consumption of staple foods, fortification enables equitable access to essential micronutrients. It helps reduce anaemia, birth

defects (Noam et al., 2016), and other micronutrient deficiencies—ultimately improving public health, productivity, and cognitive development.

3.1 Global Progress in Food Fortification: A Historical Perspective

Numerous countries have successfully implemented large-scale food fortification programs to address micronutrient deficiencies. Switzerland pioneered fortification in 1923 with iodised salt to combat goitre (International Finance Corporation, 2023), followed by the United States (US) in 1924, which drastically reduced iodine deficiency diseases. Salt fortification is now practiced in over 120 countries (TechnoServe, 2021).

During the 1930s and 1940s, vitamin A fortification in milk and margarine was adopted in Denmark, the UK, and the US. In 1943, the US mandated the addition of vitamins B1, B2, B3, and iron to white flour and bread—a move that led Canada to adopt nationwide mandatory wheat flour fortification (International Finance Corporation, 2023).

Guatemala mandated vitamin A fortification of sugar in the 1970s, reducing child blindness and mortality (TechnoServe, 2021), while China fortified soy sauce with iron in the 1990s, significantly lowering anaemia rates (Chunming, n.d.; Huo et al., 2020). South Africa introduced maize fortification in the early 2000s, targeting childhood nutrient deficiencies (Sayed et al., 2008). Kenya eliminated iodine deficiency disorders through mandatory salt iodisation (Nutrition International, 2020), and Peru addressed iron-deficiency anaemia (IDA) by mandating wheat flour fortification and exploring rice fortification (Sight and Life, 2017).

A systematic review by WHO (2018) of large-scale food fortification (LSFF) programs (Duggal et al., 2022) confirmed a 34 percent reduction in anaemia due to improved iron intake. The review also found a 74 percent reduction in goitre risk and a 41 percent decrease in the risk of birth defects (Keats et al., 2019). Another review of 24 studies on iron-fortified foods showed improved haemoglobin levels in 22 studies involving children (Athe et al., 2014).

Furthermore, universal salt iodisation has prevented 720 million cases of iodine deficiency over the past 25 years, averting iodine deficiency disorders (IDDs) in approximately 20.5 million newborns annually, and yielding an estimated $33 billion in global economic benefits. Further evidence is presented in Annexure 2.

3.2 India's Journey with Food Fortification

India has a long history of food fortification, beginning in the 1950s with the mandatory fortification of vanaspati with vitamin A—a practice that continues to this day. In 1986, India introduced a national policy of universal salt iodisation, which was later strengthened through national and state legislation in 2005 that prohibited the sale of non-iodised salt for human consumption.

India's commitment to food fortification is supported by a robust policy framework. The National Nutrition Policy (1993) identified fortification as a key short-term nutrition intervention and recommended mandatory enrichment of key food items with essential nutrients. Fortification has

also been embedded in India's 10th, 11th, and 12th Five-Year Plans, underscoring its sustained importance in national nutrition strategies (Thakur et al., 2023).

3.2.1 Overview of India's food fortification policies and guidelines

The Food Safety and Standards Authority of India (FSSAI) has regulated the fortification of wheat flour and rice with iron, folic acid, and vitamin B12 to address anaemia and neural tube defects, while edible oils and milk are fortified with vitamins A and D to combat deficiencies in these nutrients (Vakilsearch, 2024). Salt iodisation has been enforced for several decades to prevent iodine deficiency disorders (FSSAI, 2019).

In 2018, FSSAI approved the fortification of five staple foods—salt, rice, wheat flour, edible oil, and milk (Figure 6). These regulations provide clear guidelines on nutrient composition, permissible fortification levels, and labelling requirements, ensuring that fortified foods contribute meaningfully to India's national nutrition goals. Details of these standards are presented in Annexure 3.

Figure 6: Staple Foods Fortified in India

3.2.2 Alignment with National Nutrition Strategies

Wheat flour fortification is integrated into India's broader nutrition policies, including, Anaemia Mukt Bharat (AMB), and the Sustainable Development Goals (SDGs). POSHAN 2.0 (PIB, 2023), an extension of POSHAN Abhiyaan, focuses on strengthening nutritional interventions for women and children. Launched in 2018, AMB identifies food fortification as a key strategy to reduce anaemia, using a 6x6x6 framework: targeting six vulnerable groups, implementing six evidence-based interventions, and utilising six institutional mechanisms to deliver results.

Fortification of staples such as wheat flour and rice with iron, folic acid, and vitamin B12 ensures passive, sustained intake of essential nutrients, complementing interventions like IFA supplementation and deworming.

Fortified foods are also distributed through Social Safety Net Programs (SSNPs), including TPDS, PM POSHAN, and ICDS (Thakur et al., 2023). These programs are supported by advisories from the Ministries of Women and Child Development, Education, Consumer Affairs, Food, and Public

Distribution, which recommend the inclusion of all five fortified staples in SSNPs, aligned with FSSAI regulations. Copies of these government advisories are available in Annexure 4.

Additionally, wheat flour fortification supports India's commitments under SDG 2 (Zero Hunger) by tackling malnutrition, SDG 3 (Good Health and Well-being) by improving micronutrient intake, and SDG 12 (Responsible Consumption and Production) by encouraging sustainable fortification practices (UNDP, 2015). By aligning fortification with both national and global policy frameworks, India can advance its public health goals and accelerate the reduction of micronutrient deficiencies at scale.

3.2.3 Addressing Gaps in Fortification Policy: Challenges and Opportunities

A Complex but Fragmented Policy Landscape

Despite notable progress, significant gaps persist in India's fortification policies. Although the Food Safety and Standards Authority of India (FSSAI) has established comprehensive standards, some key staple foods remain outside the mandate, limiting the reach of fortification initiatives. Enforcement is inconsistent across states, leading to disparities in access, particularly in regions with high malnutrition burdens (Dalberg Advisors, 2020).

Small and Medium Enterprises (SMEs) face financial and technical constraints that hinder their participation in fortification, underscoring the need for incentives, training, and capacity-building support (Monroy-Gomez et al., 2022). Consumer awareness remains low, which reduces demand and acceptance for fortified foods, highlighting the importance of stronger social behaviour change campaigns (National Academy of Agricultural Sciences, 2022).

Monitoring and evaluation mechanisms also require strengthening to ensure compliance with fortification standards and to measure program impact (OECD, 2024). In addition, more context-specific research is needed to optimise nutrient bioavailability and assess fortificant efficacy across diverse food matrices (Thakur et al., 2023).

Opportunities for Policy Harmonization and Scale-Up

Addressing these gaps presents a clear opportunity to strengthen and expand food fortification efforts in India. Policy harmonisation between central and state governments can ensure uniform enforcement and implementation of fortification standards nationwide. Providing financial incentives and technical assistance to SMEs will enable them to adopt fortification technologies more easily.

Public-private partnerships can be leveraged to combine expertise, resources, and innovation for scale-up. Community engagement and behaviour change communication (BCC) campaigns will be crucial to improving consumer awareness and acceptance. Strengthened monitoring systems, supported by real-time data collection and analytics, can help track compliance, identify bottlenecks, and measure reductions in anaemia prevalence more accurately.

3.3 Leveraging India's Fortification Experience

3.3.1 Salt Iodisation: A Pioneering Public Health Model

India's iodised salt program is a landmark public health initiative that has substantially reduced iodine deficiency disorders (IDDs). Launched in 1962 as the National Goitre Control Program (NGCP), it was South Asia's first large-scale salt iodisation initiative (IGN, 2023). In collaboration with WHO and UNICEF, India established iodisation plants in Sambhar Lake (Rajasthan), Kharagoda (Gujarat), and Howrah (West Bengal) to expand production (Salt Commissioner Office, n.d.).

In 1992, the initiative evolved into the National Iodine Deficiency Disorders Control Program (NIDDCP) to tackle a broader range of IDDs (IGN, 2023). Over two decades, iodised salt production increased more than eightfold—from 0.7 million metric tonnes in 1985–86 to 6.2 million metric tonnes—driven by policy continuity, industry collaboration, and public demand (Rah et al., 2015).

Key success factors included adaptive policymaking, industry engagement, and global partnerships. However, inconsistent quality control during transportation and limited distribution subsidies posed operational challenges. This experience offers valuable lessons for wheat flour fortification, particularly the need for standardised quality assurance, long-term government support, and multi-stakeholder collaboration.

3.3.2 Rice Fortification: Scaling with Systems and Stakeholders

India's rice fortification program has played a vital role in combating iron-deficiency anaemia, particularly among vulnerable groups. Using a pilot-to-scale approach (Gie, 2022), initial successes informed the nationwide integration of fortified rice into safety net program such as PM POSHAN and ICDS (Institute for Competitiveness, 2023).

FSSAI developed robust regulatory standards, ensuring uniform quality and safety. Cross-sector partnerships—between government agencies, the private sector, and civil society—strengthened supply chains and supported awareness campaigns (Institute for Competitiveness, 2023).

Despite these gains, implementation challenges remain. Ensuring a consistent supply of fortified kernels, maintaining quality assurance, and logistics management have proved difficult (Gie, 2022). Cultural perceptions and misinformation have also affected consumer acceptance (Milani et al., 2016).

Effective monitoring and evaluation systems are crucial for tracking compliance and impact (Darwar et al., 2023). Lessons for wheat flour fortification include the importance of evidence-based policy advocacy, inclusive stakeholder engagement, and strong regulatory infrastructure. Additionally, consumer education initiatives and streamlined logistics will be critical for scaling wheat flour fortification across India (Milani et al., 2016; Gie, 2022).

3.3.3 Edible Oil and Milk Fortification: Strengthening Through Partnerships

The fortification of edible oil and milk with vitamins A and D has been a significant advancement in addressing widespread micronutrient deficiencies. The success of these programs is largely

attributed to robust public-private partnerships, where FSSAI facilitated collaboration between government agencies, private companies, and non-governmental organisations (NGOs) to expand production and ensure accessibility.

Major dairy and edible oil manufacturers voluntarily adopted fortification practices, leading to notable improvements in population-level nutrition outcomes (Food Safety and Standards Authority of India, 2017). To ensure quality and safety, FSSAI introduced regulatory standards through the Food Safety and Standards (Fortification of Foods) Regulations, 2016 (PIB, 2018). These guidelines specified nutrient thresholds and introduced the 'F+' logo to help consumers identify fortified products.

By 2020, FSSAI was moving toward mandatory fortification of edible oil and milk to standardise nutrient content across brands (FoodNavigator-Asia, 2020). However, low consumer awareness remains a key barrier. Targeted public awareness campaigns promoting the health benefits of fortified foods have been instrumental in improving consumer adoption and trust (Food Safety and Standards Authority of India, 2017).

The experience of edible oil and milk fortification highlights the importance of policy consistency, private sector participation, and effective consumer engagement—lessons that are highly applicable to scaling wheat flour fortification.

3.3.4 Cross-Sector Learning: Adapting Successful Strategies for Wheat Flour Fortification

India's wide-ranging experience with food fortification offers critical insights for expanding wheat flour fortification. A key lesson from rice fortification is the success of a pilot-to-scale approach, which allowed for the identification and resolution of implementation challenges before national rollout (Gie, 2022).

Integrating fortified wheat flour into existing social safety net programs—such as TPDS, PM POSHAN, and ICDS—will be essential to reach nutritionally vulnerable populations efficiently and affordably. This integration is expected to maximise impact while leveraging existing distribution infrastructure.

Another critical requirement is the establishment of strong monitoring and evaluation systems to ensure regulatory compliance and track improvements in nutritional outcomes—a strategy that has proven successful in both rice and salt fortification efforts.

In addition, consumer engagement will be pivotal. Social and Behaviour Change Communication (SBCC) strategies used in rice fortification—such as community taste-testing events, school-based nutrition drives, and training sessions for frontline workers—can be adapted to improve the acceptance and uptake of fortified wheat flour.

Finally, the sustainability and long-term success of wheat flour fortification will depend on continued policy backing, consistent funding, and active industry participation. The rice fortification program demonstrated that persistent advocacy and institutional support are critical to making fortification efforts systemic and impactful. By applying cross-sector lessons and building on India's fortification legacy, wheat flour fortification can be scaled effectively and embedded into the country's broader national nutrition strategy.

4. Making the Case for Wheat Flour Fortification in India

4.1 Global Evidence of Impact

The World Health Organization (WHO) recognises fortification as one of the most cost-effective public health strategies to reduce health disparities. In a resolution adopted in May 2023, delegates at the World Health Assembly described large-scale food fortification as 'a powerful evidence-informed and cost-effective intervention to fight the consequences of vitamin and mineral deficiencies' (WHO, 2023).

Wheat flour fortification has proven to be an effective public health strategy across diverse global settings, significantly reducing micronutrient deficiencies and improving population health outcomes. In Asia, countries such as Pakistan, Tajikistan and Indonesia have implemented successful fortification programs through government–private sector collaboration. Indonesia, which mandated wheat flour fortification in 2002, strengthened its approach in 2021 by reformulating its iron compound to improve bioavailability. Bangladesh has also integrated fortified flour into its social safety net programs, increasing access for vulnerable groups (Herrington et al., 2019; Mildon et al., 2023).

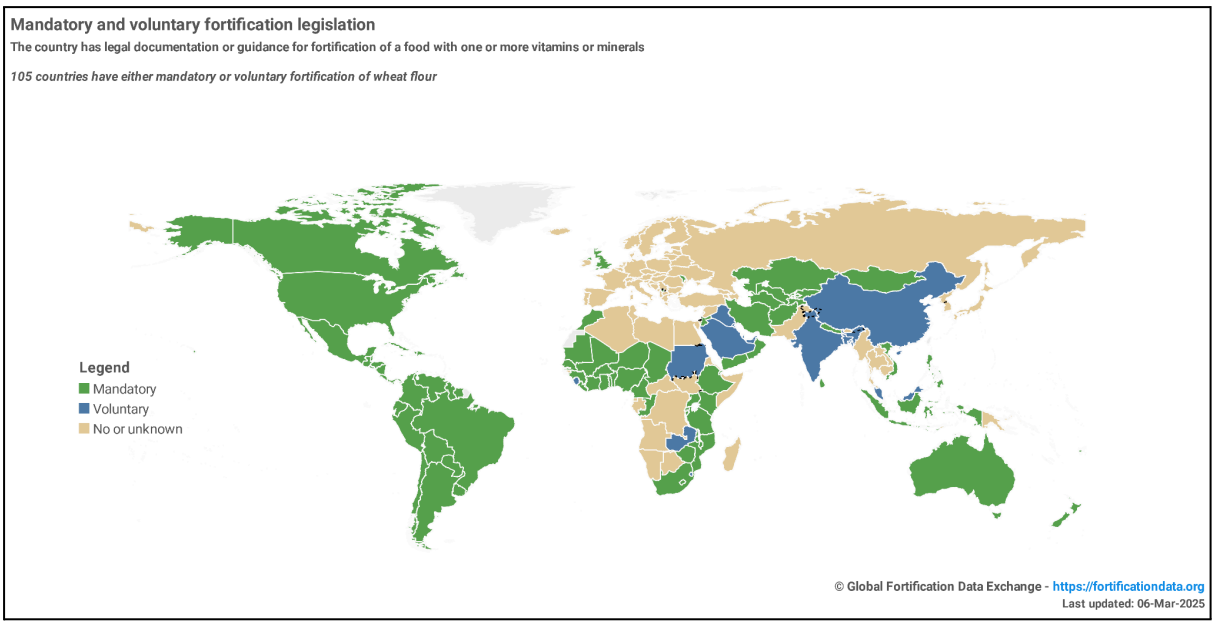
In the Americas and Oceania, fortification has played a key role in reducing neural tube defects (NTDs). Chile's mandatory folic acid fortification program led to regional adoption across South America, contributing to a 15–25 percent reduction in congenital malformations (Martorell et al., 2015). Similarly, Australia introduced mandatory fortification in 2009, followed by New Zealand in 2021—underscoring the role of scientific evidence and public engagement in shaping nutrition policy. These global experiences offer compelling evidence for India to scale up wheat flour fortification through coordinated, multi-stakeholder action and evidence-based policy interventions (Starck et al., 2024).

Food fortification has proven particularly effective in reducing iron deficiency anaemia (IDA) among at-risk populations. Further details are available in Annexure 5. Notable findings include:

- A 2021 meta-analysis of six trials found that consumption of iron-fortified wheat flour reduced anaemia prevalence by 27 percent (Field et al., 2021). In each study, both intervention and control groups received flour fortified with other micronutrients; the only difference was the presence of iron.
- A global meta-analysis from 2012 found that fortified foods reduced anaemia rates by 41 percent. The analysis covered 60 trials across various geographies and included fortification or biofortification of staple foods with iron (Gera et al., 2012).
- In India, a 2012 randomised controlled trial demonstrated that iron deficiency among schoolchildren dropped from 62 percent to 21 percent (a 41 percentage point reduction) after seven months of consuming wheat flour fortified with NaFeEDTA, the same iron compound used by Fortify Health (Muthayya et al., 2012).

Wheat flour fortification is currently mandatory in 92 countries and voluntary in 13, bringing the total to 105 countries. In comparison, rice fortification is mandatory in 8 countries and voluntary in 9, across 17 countries globally (Figure 7).

Figure 7: Mandatory and voluntary fortification legislation for wheat flour across countries
(Source: Global Fortification Data Exchange, accessed on 06 March 2025)



Wheat Flour Fortification: The Preferred Choice Worldwide

1. **Global Adoption and Mandatory Policies**
   Wheat flour fortification is far more widespread than rice fortification. Over 105 countries have adopted mandatory or voluntary wheat flour fortification, while only 17 countries have similar policies for rice.
2. **Established Fortification Infrastructure**
   Many countries have well-developed wheat milling industries, where large-scale roller mills dominate production, making it easier to integrate iron, folic acid, and vitamin B12 into the flour during processing. In contrast, rice fortification requires specialised fortificant kernels and blending techniques, which are less common and harder to regulate in many regions.
3. **Cost and Efficiency Advantages**
   Wheat flour fortification is cheaper and more efficient than rice fortification. The cost of fortifying wheat flour is as low as ₹0.10 per kg, whereas fortified rice production involves higher costs (₹0.73/kg as reported DoFPD pilot scheme) due to the need for extrusion technology and blending processes.
4. **Consumer Acceptance and Dietary Patterns**
   In many wheat-consuming countries, flour-based products like bread, chapatis, and noodles are staple foods, making it easier to deliver fortified nutrients to the population. Rice, however, requires fortified kernels to be mixed with regular rice, which can lead to uneven nutrient distribution and lower consumer acceptance due to changes in texture and appearance.
5. **Proven Health Impact and Scalability**
   Studies have consistently shown that wheat flour fortification significantly reduces anaemia rates, particularly in women and children. Countries like Canada, the USA, and South Africa have successfully implemented mandatory wheat flour fortification, resulting in improved

public health outcomes. While rice fortification has potential, its adoption and effectiveness are still evolving, making wheat flour the more widely used fortification vehicle globally.

4.2 Reaching the Missed: Who Is Left Out of Fortification

Around 41 percent of the rural population and 45 percent of the urban population in India consume wheat as a staple food (National Statistical Office, 2024). Details on state-wise wheat and rice preferences are provided in Figure 8. Rajasthan has the strongest preference for wheat, while Manipur leads in rice consumption.

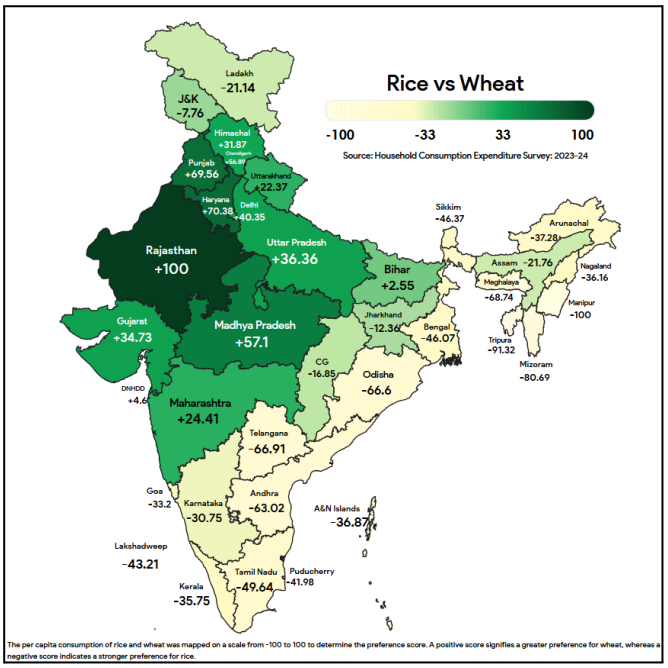
Although India exhibits significant dietary diversity, wheat is the primary staple in 11 states, where it accounts for more than 50 percent of total cereal consumption. As of 2023, these states are home to 38 percent of the Indian population, according to population projections from the National Commission on Population (HECS 2022–23). Rajasthan, Haryana, Madhya Pradesh, Punjab, Uttar Pradesh, Himachal Pradesh, Chandigarh, Bihar, Uttarakhand and Gujarat have the highest levels of wheat consumption, exceeding 145 grams per capita per day. Detailed figures on state-wise daily wheat intake are available in Annexure 6.

A recent study (Mottaleb et al., 2023) projects that, compared to 2019 levels, aggregate wheat demand in India will rise by 32–38 percent by 2030 and by 70–104 percent by 2050. These trends reflect India's evolving dietary landscape, which is shaped by regional differences in staple food preferences (Green et al., 2016). In northern and central states such as Punjab, Haryana and Uttar Pradesh, wheat-based foods like chapati and roti dominate, while southern and eastern states including Tamil Nadu, Kerala and West Bengal rely primarily on rice. Some states also consume multiple staples; for example, Rajasthan traditionally includes both bajra and wheat in its diet (IndiaEveryday.com, 2024).

This regional variation highlights the need for tailored nutritional interventions. While the government has advanced fortification policies for staples such as rice (Ministry of Consumer Affairs, Food & Public Distribution, 2024) and salt (Nutrition International, 2019), wheat flour fortification remains largely voluntary and lacks a national mandate. As a result, populations in high wheat-consuming regions may not receive fortified food through government schemes, potentially leaving them vulnerable to micronutrient deficiencies.

Advocating for mandatory wheat flour fortification—especially in wheat-dominant states—can help close this gap and ensure equitable access to essential micronutrients across India, regardless of regional dietary patterns.

Figure 8: Rice vs Wheat consumption in different Indian states (2022-23)

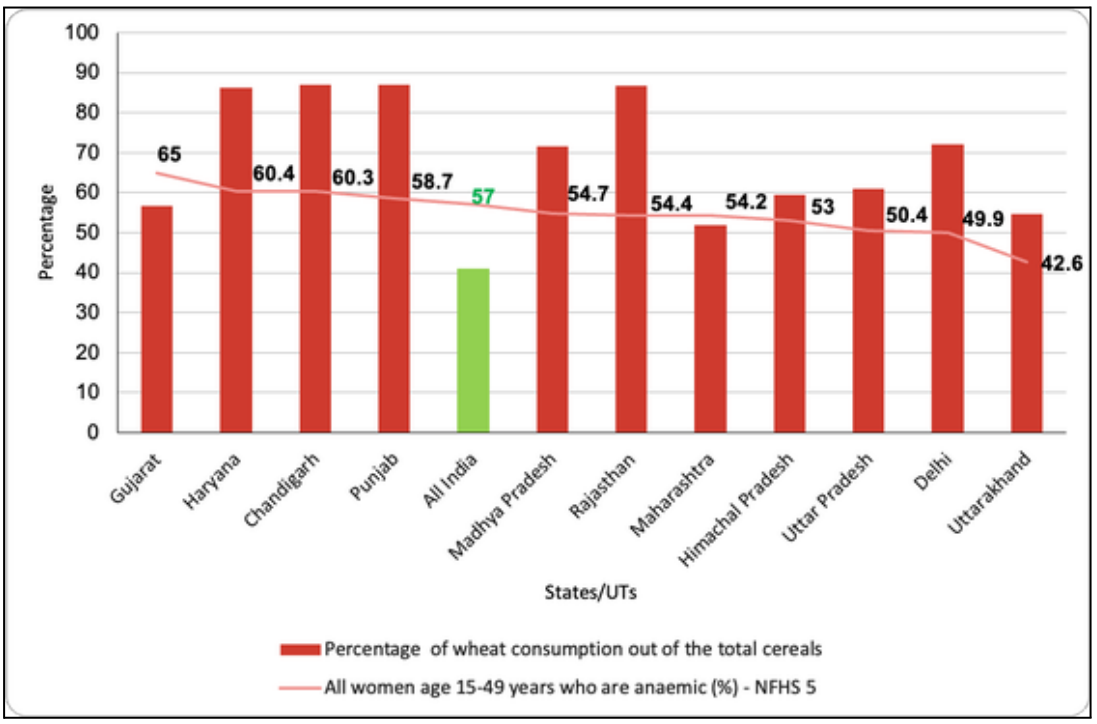


Anaemia in Wheat-Consuming States

According to NFHS-5 (2019–21), the top wheat-consuming states also report high rates of anaemia among women aged 15–49.

Gujarat records the highest prevalence of anaemia, while Haryana, Chandigarh, and Punjab have anaemia rates that exceed the national average. In all of these states, wheat constitutes more than 55 percent of total cereal consumption. Several other wheat-consuming states also report anaemia prevalence rates of 50 percent or higher, with the exception of Uttarakhand (see Figure 9)

Figure 9: Anaemia Prevalence in Wheat Consuming States



4.3 A Smart Investment: The Cost-Effectiveness of Wheat Flour Fortification

Wheat flour fortification is a s**c**ientifically validated and cost-effective (Noshirvan et al., 2021) intervention to address micronutrient deficiencies, particularly iron-deficiency anaemia (IDA), which continues to be a major public health challenge in India.

Large-scale food fortification is endorsed by the World Bank and the Copenhagen Consensus as one of the most cost-effective development strategies. It requires only a minimal annual investment per person while delivering significant returns in the form of improved cognitive development, enhanced productivity, and national economic growth. According to the Gates Foundation's report *Doubling Down on Food Fortification*, every US$1 invested in food fortification yields a return of US$27, driven by disease prevention, increased lifetime earnings, and improved work output. This benefit–cost ratio of 27:1 outperforms many other public health interventions, including vaccination, which has an estimated benefit–cost ratio of 16:1 (Gates Foundation, 2019).

In the Indian context, the cost of one disability-adjusted life year (DALY) lost due to IDA is approximately ₹30,000, while the cost to prevent one DALY loss is only ₹1,545. This translates into a cost–benefit ratio of 1:18, demonstrating high return on investment. Notably, this expenditure amounted to just 1 percent of the total food subsidy bill in 2018–19 (NITI Aayog, 2021).

Folic acid fortification, in particular, has shown strong economic value. A comprehensive meta-analysis of 13 global studies found that for every unit of investment, governments could expect a return of 17.5 units in health-related economic benefits (Rodrigues et al., 2021), reinforcing its importance as a public health strategy.

4.4 Built for Scale: Feasibility in India

During 2023–24, wheat production in India reached a record 1132.92 lakh metric tonnes (LMT) (Ministry of Agriculture & Farmers Welfare, 2024). For 2024–25, the food-seed-industrial (FSI) wheat consumption is forecast at 107.5 million metric tonnes (MMT)—a 1.2 percent increase from the previous year. With the government expanding subsidised wheat allocations under open market sales, FSI wheat consumption has increased by 4 percent over 2023–24 (USDA, 2024).

Approximately 70 to 80 percent of domestically produced wheat is consumed as flour in households and restaurants. India's wheat milling industry is diverse, comprising large-scale roller flour mills and a vast number of small, local stone mills (chakki mills) (Food Fortification Initiative, 2023). The organised sector includes around 1,300 to 1,400 medium- and large-scale flour mills with an annual milling capacity of 28–30 MMT, though they currently operate at 55–60 percent capacity, milling roughly 16–18 MMT annually.

In addition to these, India has 1,472 commercial flour mills and 376,803 small local mills, highlighting the fragmented nature of wheat processing (FSSAI, 2017). The unorganised sector, comprising neighbourhood chakkis, processes a large share of wheat for home consumption.

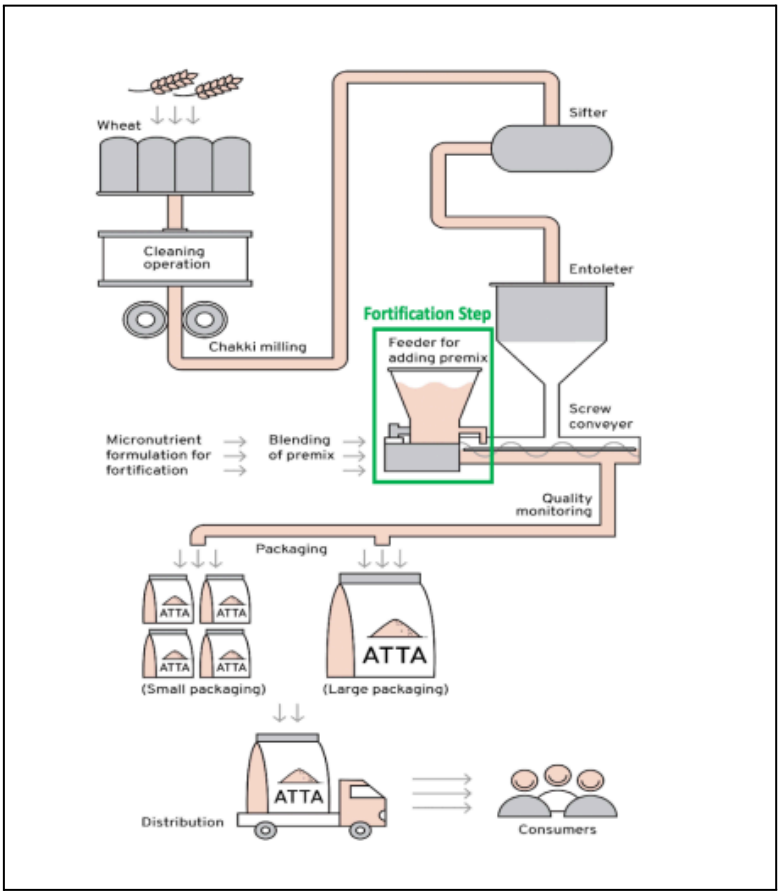
Fortification is technically feasible and straightforward. As illustrated in Figure 10, micronutrients are added to flour during milling or packaging. Once the wheat is ground and sieved, a fortificant premix

is blended into the flour using a screw microdoser, which is calibrated to ensure compliance with FSSAI standards.

Roller flour mills are particularly well-suited to fortification, given their mechanised operations and capacity to produce a significant portion of the country's wheat flour. These mills can easily integrate premix dispensers into existing infrastructure, enabling precise and consistent nutrient addition.

As of March 2025, there are 197 Food Business Operators with a + F endorsement from FSSAI for wheat flour (FoSCoS, March 2025).

Figure 10: Outlining the process of producing wheat flour-fortified Roti



4.5 State Experiences in Wheat Flour Fortification

Wheat flour fortification was first piloted in 2000 in Darjeeling, West Bengal. The program was later scaled up through the Targeted Public Distribution System (TPDS) in several districts across the state. Following this, multiple states introduced fortified wheat flour into their Social Safety Net Programs (SSNPs), each adopting a distinct operational model. Drawing on the impact of wheat flour fortification in reducing anaemia rates (Food Safety and Standards Authority of India, 2019; Food Fortification Initiative, 2023) and the high levels of consumer acceptability (Duggal et al., 2022), states such as Kerala (2017), Haryana (2018), Himachal Pradesh (2020), Ladakh (2023), and Andhra Pradesh (2023) have introduced fortified wheat flour delivery through TPDS (GAIN, 2022). Other states, including Maharashtra, Rajasthan, Gujarat, Punjab, Tamil Nadu, and Madhya Pradesh, have also adopted wheat flour fortification within SSNPs. Further details are provided in Annexure 7.

Implementation Experience of Wheat Flour Fortification in States

- **To Combat Micronutrient Deficiencies:** In 2018, a wheat flour fortification program was introduced in the Ambala district of Haryana within the government-run Public Distribution System (TPDS). The program aimed to combat micronutrient deficiencies by fortifying wheat flour with iron, folic acid, and vitamin B12 (Duggal et al., 2022).
- **State-specific Consumption Pattern:** Himachal Pradesh began distributing fortified wheat flour because the state's population primarily consumes wheat. Additionally, rice fortification is costlier for the state due to its limited rice milling capacity (Food Safety and Standards Authority of India, 2019).
- **To Address the High Prevalence of Anaemia:** Gujarat initiated wheat flour fortification in the open market in 2006 and later extended it to the TPDS until 2010 due to the state's high anaemia rates, which exceeded the national average (The Indian Express, 2014). Similarly, Tamil Nadu implemented a four-year fortified wheat flour distribution program (2008–2012) targeting pregnant women to improve haemoglobin levels and reduce anaemia (Chakrabarti et al., 2019).
- **To Improve Nutritional Intake:** Andhra Pradesh was already distributing fortified rice. To further improve the nutritional intake of TPDS beneficiaries, fortified wheat flour was introduced (Milling & Millers, 2023).

Challenges and Discontinuation in Some States

Despite progress, **some states discontinued wheat flour fortification** due to a range of operational and systemic challenges:

- **Political and Administrative Instability:** Changes in government, political opposition to fortification, and lobbying by millers led to disruption in Andhra Pradesh, Rajasthan, and Haryana. Inadequate tendering processes and a lack of transparency also deterred bidders (The Hindu, 2024)
- **Financial Viability:** Rising costs of fortification, higher bidding rates from millers, and concerns over long-term financial sustainability caused discontinuation in states like West Bengal and Maharashtra.
- **Supply Chain and Logistics Issues:** Maintaining a robust delivery chain, ensuring the timely supply of fortified flour to Fair Price Shops, and dealing with the shorter shelf life of flour compared to whole grains posed logistical hurdles, especially in Maharashtra and Punjab (FFI, 2018; 2023).
- **Quality Control and Testing:** Variability in premix quality, challenges in ensuring consistent iron levels, and lack of standardised quality testing were significant issues in Andhra Pradesh.
- **Consumer Acceptability and Awareness:** Changes in taste or colour, or the inclusion of other ingredients (e.g., **soybean in Gujarat**), affected acceptance. Low consumer awareness was also a barrier in Himachal Pradesh, Ladakh, and Kerala (KHPT, 2024).
- **Program Implementation and Monitoring:** Scaling up to reach all beneficiaries and maintaining effective program monitoring systems proved difficult in several states.

These challenges, though significant, are operational—not structural—and therefore solvable. Improving inter-ministerial coordination, strengthening procurement processes, building logistics and cold-chain capacity, standardising quality control, and running coordinated public awareness campaigns will be key to ensuring sustainability.

With a shared vision to provide nutritious food to vulnerable populations, a unified and collaborative national approach can enable the success of wheat flour fortification at scale. The next section (Section 5) outlines concrete strategies for scaling and sustaining these efforts within government schemes.

5. Implementation of Wheat Flour Fortification

5.1 Leveraging Government Programs for Nutritional Impact

Government-aided food distribution initiatives, including social safety net programs (SSNPs), present a critical opportunity to improve nutritional outcomes at scale. India's social protection network has expanded significantly, with coverage nearly doubling over the past decade. According to the International Labour Organization's *World Social Protection Report 2024–26*, approximately 920 million people—around 65 percent of the population—now receive at least one form of social protection benefit, either in cash or in kind, through central government schemes. This highlights the potential for leveraging these programs to enhance public health and nutrition (Ministry of Labour & Employment, 2025; International Labour Office, 2024).

Government-supported schemes such as the TPDS, ICDS, and PM Poshan provide subsidised or free food to millions of beneficiaries, including vulnerable sections of children and pregnant women. The inclusion of fortified wheat flour in these programs can ensure the consistent delivery of essential micronutrients, including iron, folic acid, and vitamin B12, which are critical for cognitive development, maternal health, and overall physiological well-being (Table 3).

Table 3: Description of Safety Net Programs under the Government of India

Wheat Allocation (as per Ministry of Consumer Affairs, Food & Public Distribution, 2024)

S. No.	Scheme	Details	Beneficiaries	No. of Beneficiaries	Wheat Allocation	Rice allocation
1.	TPDS	A government-run food security program that provides subsidised food grains through a nationwide network of fair price shops.	Economically vulnerable populations.	80.67 crore (Ministry of Consumer Affairs, Food & Public Distribution, 2024)	**184.45 LMT***	**364.19 LMT***
2.	PM Poshan	A centrally sponsored program that provides nutritious, cooked meals to school	Children from Class one to eight.	11.80 crore (Ministry of Education, Government of India, 2025)	**3.76 LMT****.	**19.21 LMT**

		children in government and government-aided schools.				
3.	ICDS	A flagship program that aims to improve health, nutrition, and development. It operates through Anganwadi Centres and includes services like supplementary nutrition.	Children under six years, pregnant women, and lactating mothers.	10.11 crore (Ministry of Women and Child Development, 2023)	**11.74 LMT**	**13.89 LMT**
*wheat /rice allocated under TPDS, including Antodaya Anna Yojna, Priority Household, and Tide Over. ** Lakh Metric Ton						

In 2024, Ministry of Consumer Affairs, Food and Public Distribution (2024), allocated 201.83 lakh tonnes of wheat to states for various SSNPs. The Food Corporation of India (FCI) also reported an increase in wheat and paddy allocations to states, from 600 to 1,100 lakh metric tonnes (LMT), with an average annual procurement of 1,200 LMT of food grains. This rise reflects growing state demand for wheat allocations (Ministry of Consumer Affairs, Food & Public Distribution, 2024).

5.2 Integrating Fortified Wheat Flour into Social Safety Net Programs

India's SSNPs were originally designed to ensure food security for vulnerable populations. These programs now offer a powerful opportunity to integrate nutritional goals, particularly wheat flour fortification, to address widespread micronutrient deficiencies.

As discussed in Section 4, fortified wheat flour can play a pivotal role in reducing micronutrient deficiencies, especially iron-deficiency anaemia, which affects a large segment of the population. Integrating fortified wheat flour into government schemes such as TPDS, PM POSHAN, and ICDS can help reach at-risk groups more effectively.

Targeted Public Distribution System (TPDS):
TPDS provides subsidised food grains to over 80 crore beneficiaries under the National Food Security Act (NFSA). Most states currently distribute raw wheat, which beneficiaries mill locally. To introduce wheat flour fortification within TPDS, the government can:

- Transition from distributing raw wheat to centrally milled fortified wheat flour via state-empanelled mills.
- Roll out implementation in phases, piloting in select states or districts before national scale-up.
- Incorporate fortification guidelines into state TPDS policies to ensure compliance.
- Use automated systems to track the production and distribution of fortified wheat flour in real time.

Pradhan Mantri Poshan Shakti Nirman (PM POSHAN):
This program delivers hot-cooked meals to schoolchildren in government and government-aided schools. Many states already use wheat flour for items like chapatis, puris, and parathas. To integrate wheat flour fortification into PM POSHAN:

- Procure fortified wheat flour through state food corporations or empanelled mills.
- Mandate the use of fortified flour in PM POSHAN meal guidelines at the state level.
- Train school cooks on handling and preparing meals using fortified flour.
- Establish monitoring systems to ensure quality control and efficient distribution.

Integrated Child Development Services (ICDS):
ICDS offers take-home rations (THR) and cooked meals through Anganwadi centres to children under six, pregnant and lactating women, and adolescent girls. Common wheat-based items include panjiri, dalia, and puris. To integrate fortification into ICDS:

- Replace regular flour with fortified wheat flour in both cooked meals and THR products.
- Train Anganwadi workers and cooks on safe handling and correct usage of fortified flour.
- Conduct sensory trials and community outreach to build acceptance among beneficiaries.

5.3 Aligning Stakeholders for Impact

Effective wheat flour fortification in SSNPs requires a multi-stakeholder approach. Stakeholders range from government ministries responsible for policymaking to development partners, civil society organisations, and implementation agencies that support outreach to vulnerable groups. Table 4 below outlines the categories of stakeholders and their roles in the fortification process. Detailed descriptions are provided in Annexure 8.

Table 4: Stakeholder Mapping for Wheat Fortification in SSNPs

Stakeholder Group	Key Players	Roles & Responsibilities
Government Policymakers & Implementers	• Ministry of Health & Family Welfare • Food Safety and Standards Authority of India (FSSAI) • Ministry of Consumer Affairs - State Governments • Ministry of Education • Ministry of Women and Child Development	• Develop fortification policies and regulations (e.g., FSSAI standards) • Ensure implementation & monitoring of wheat flour fortification • Integrate fortified wheat flour into public food programs (TPDS, PM Poshan, ICDS) • Conduct consumer awareness campaigns

Food Industry & Millers	● Large wheat millers - Flour producers ● Food processors ● Industry associations (e.g., Roller Flour Millers Federation of India)	● Implement fortification process (iron, folic acid, B12 premix blending) ● Ensure quality control & compliance with standards ● Distributes fortified wheat through government & retail markets ● Collaborate with research institutions for innovation
Development Organisations (UN, Bilateral & Multilateral Agencies)	● Fortify Health ● WHO ● UNICEF ● FAO ● Global Alliance for Improved Nutrition (GAIN) ● World Food Program (WFP) ● USAID	● Provide technical guidelines on nutrient levels & fortification methods ● Assist in policy development & capacity building ● Advocate for mandatory fortification policies ● Fund research & pilot projects for scale-up
Non-Government Organisations (NGOs) & Civil Society	● Nutrition International ● Tata Trusts ● PATH	● Conduct public awareness & advocacy campaigns ● Ensure community engagement & demand creation ● Monitor quality control & policy implementation ● Support small-scale millers with resources & training
Funders & Philanthropic Organisations	● Tata Trusts ● Gates Foundation ● Give Well ● World Bank ● Global Fund	● Provide financial support for implementation & research ● Facilitate Public-Private Partnerships (PPP) ● Fund subsidies for small-scale millers to adopt fortification
Academia & Research Institutions	● Indian Council of Medical Research (ICMR) ● National Institute of Nutrition (NIN) - ● IITs & Universities	● Conduct scientific research on effectiveness & safety ● Develop new fortification technologies ● Assess the impact of fortified wheat on anaemia & public health

5.4 Addressing the Challenges

India faces multiple challenges in implementing large-scale wheat flour fortification. The fragmented milling industry—comprising numerous small-scale local mills and industrial mills—makes consistent fortification and monitoring difficult. Financial constraints are significant: even small cost increases affect affordability for low-income consumers, and many small millers lack the resources to purchase specialised equipment.

Operational and Industry Constraints

Cultural preferences for freshly ground wheat and resistance to perceived changes in taste or texture also present barriers. Regulatory enforcement is challenging due to the sheer number of mills and the need for coordination across multiple government departments. These infrastructure, economic, social, and policy challenges complicate the nationwide rollout of wheat flour fortification.

Successful implementation will require strong intersectoral collaboration, robust regulatory frameworks, and reliable quality assurance systems. Addressing decentralised production, supply chain limitations, and logistical hurdles is essential. The shorter shelf life of fortified flour demands improved storage infrastructure, while regular quality monitoring remains difficult for small mills. One-time equipment installation costs are a further deterrent.

Government policies around the Goods and Services Tax (GST) for branded and unbranded flour also disincentivise millers from branding and adopting fortified wheat flour. Table 5 outlines the key challenges in implementing wheat flour fortification in government programs, along with potential solutions.

Challenges in the Public Distribution System (PDS)

At present, wheat distribution under the Public Distribution System (PDS) faces additional critical issues that hinder its effectiveness in ensuring food security. One major concern is the leakage and diversion of food grains—an estimated 46% is siphoned into the black market, according to the Shanta Kumar Committee (Government of India, 2015). Beneficiary identification errors, often due to outdated data, exclude nearly 20% of eligible households (Ministry of Finance, 2021). Storage and transportation inefficiencies contribute to significant losses—up to 14% as per the CAG (2019). Moreover, poor-quality distribution and corruption at Fair Price Shops reduce public trust and participation (Khera, 2011).

Digital Reforms and Infrastructure Improvements

In response, the government has introduced several digital reforms. Aadhaar authentication now covers 93% of PDS transactions, improving accountability (Department of Food & Public Distribution, 2023). The One Nation One Ration Card (ONORC) initiative enables benefit portability across states, particularly helping migrant workers (NITI Aayog, 2022). Infrastructure is being enhanced through schemes like the Pradhan Mantri Kisan SAMPADA Yojana, which supports investment in storage and processing (Ministry of Food Processing Industries, 2021). Data analytics and regular audits are also improving targeting accuracy and system efficiency (NITI Aayog, 2020).

Enabling Fortified Wheat Flour Delivery

Despite ongoing challenges, these reforms are steadily transforming the PDS into a more transparent and effective delivery system. Leveraging these improvements, the distribution of fortified wheat flour in place of raw wheat is now more feasible. This shift ensures that beneficiaries receive a ready-to-use product, easing the burden—particularly on women—of having to access milling services externally. It also reduces post-distribution losses, strengthens quality control, and helps ensure that the nutritional intent of government subsidies reaches the intended recipients.

Table 5: Key Challenges and Solutions in Wheat Flour Fortification for Government Programs

S. No.	Category	Challenge	Solution
1.	Logistical and Supply Chain	Complex distribution networks and difficulty in transitioning from wheat grain to wheat flour.	Pilot projects in selected states before full-scale implementation. Implement blended models where beneficiaries receive both wheat grain and fortified flour, ensuring a smooth transition.
2.	Shorter Shelf Life	Compared to wheat grain, wheat flour requires proper storage and faster distribution to prevent spoilage.	Set up storage facilities with proper climate control to prevent fortified flour degradation.
3.	Decentralised Milling Structure	Many beneficiaries currently mill wheat at local mills, making centralised fortification challenging.	Equip state-approved mills with microdosing technology for fortification.
4.	Lack of Nationwide Mandate	Wheat flour fortification remains voluntary under FSSAI guidelines, leading to inconsistent adoption across states.	Incorporate wheat flour fortification into the National Food Security Act (NFSA) guidelines to ensure state-level adoption. This can initially be taken for high wheat consumption states. Develop state-specific implementation strategies for a phased rollout.
5.	Absence of Standardised Fortification Practices	There is a need for state-specific implementation guidelines to ensure uniformity.	FSSAI should issue uniform fortification standards for wheat flour in TPDS and ICDS, PM POSHAN, and other schemes.
6.	Quality Assurance Gaps	Ensuring that fortified flour meets FSSAI standards across all mills is crucial but requires regular testing and compliance monitoring.	Establish state-level monitoring units to ensure compliance.

7.	Behavior and Acceptance	Beneficiaries may hesitate to adapt to the fortified wheat flour due to low awareness of the benefits of fortified flour.	Conduct education sessions for beneficiaries on the benefits of fortified wheat flour. Engage frontline workers like ASHA, Anganwadi workers, self-help groups, and community leaders in awareness drives.
8.	Resistance from Local Millers	Small mills may oppose fortification efforts, fearing loss of business if beneficiaries shift to government-provided fortified flour.	Provide incentives to millers for adopting fortification processes. Supporting subsidies for equipment for initial installations.
9	Leakages in the existing system is also causing resistance in the market	Leakages may be of three types: (i) pilferage or damage during transportation of food grains, (ii) diversion to non-beneficiaries at fair price shops through issue of ghost cards, and (iii) exclusion of people entitled to food grains but who are not on the beneficiary list	Scaling digital monitoring of supply chain(Global Positioning Systems(GPS) based, e-procurement supported), Aadhar-based beneficiary recognitions, whistleblower policies, and social audits could be a few of the solutions to improve leakages
10	Tax implications	The current GST rates create an imbalance that discourages wheat flour millers from producing packaged atta. While unpackaged atta is exempt from GST, branded and packaged atta incurs a 5 percent GST rate. As per the current GST slabs, fortificants and premixes also come under the 18 percent GST slab.	GST rates may be made favourable for packaged and brand foods vis-à-vis unbranded products. Premixes and fortificants need to be brought to the zero GST slab to further accelerate large-scale fortification efforts.

5.5 Cost Implications

Wheat flour fortification entails two primary cost components, depending on whether whole wheat grains or wheat flour is distributed under social safety net programs (Table 6). The marginal cost of fortifying wheat flour consists of two main components:

- **Marginal cost of converting wheat grain into flour**: This includes costs associated with cleaning, milling, electricity, equipment, staff, and administration.
- **Marginal cost of converting flour into fortified wheat flour**: This covers the cost of premix, microdoser equipment, quality monitoring and testing, and packaging.

Table 6: Marginal Costs of converting wheat grain to fortified wheat flour

Transition	Major cost components	Estimated marginal cost
Wheat grains to unfortified wheat flour	Cleaning and Grinding of wheat into flour at a commercial wheat mill	1.88 rupees per kg
Unfortified wheat flour to fortified wheat flour	a) Premix b) Quality testing of fortified flour	0.10 rupees per kg of wheat flour
Packaging	Packaging flour for distribution	0.35 rupees per kg

The total estimated cost of converting wheat grain into flour is approximately **₹1.88 per kilogram**, while fortifying wheat flour adds only **₹0.10 per kilogram**, with an additional ₹0.35 per kilogram for packaging. A detailed cost breakdown is available in Annexure 9, which also discusses financial considerations when transitioning from decentralised to centralised supply chains.

Financial Incentives for Millers:

Millers participating in government fortification schemes can benefit financially in the following ways:

- **Bran by-product**: If 5% bran is extracted, yielding 95% wheat flour, millers can earn approximately ₹18 per kilogram from selling the bran in the open market.
- **Gunny bags**: Empty wheat gunny bags can be sold at ₹15 per bag, providing an additional revenue stream.

5.6 Strengthening the Fortified Wheat Flour Ecosystem

5.6.1 Expanding Access Through Open Market Channels

Ensuring the widespread availability of fortified wheat flour in India requires a comprehensive strategy that involves private millers, retailers, and consumers. The private sector plays a crucial role in supporting fortification efforts by ensuring product quality and stimulating consumer demand. Capacity-building initiatives, such as training millers to meet national fortification standards and establishing effective monitoring systems, are

Fortify Health recently conducted a qualitative study with millers and key stakeholders across multiple states using in-depth interviews and a KAP framework. Insights from 42 stakeholder interactions revealed key enablers and barriers influencing millers' adoption of wheat flour fortification and highlighted FH's critical role in ensuring long-term sustainability. Key enablers included:

1. ***Public Health Impact:*** Millers recognized fortification's role in addressing micronutrient deficiencies, particularly iron-deficiency anemia, cited by 12 out of 42 respondents.
2. ***Financial and Technical Support:*** Fortify Health's provision of free premix, financial assistance, and technical guidance reduced financial risks and operational burdens.
3. ***Market Differentiation:*** Fortification was seen by some millers as a way to distinguish their products and potentially boost sales, especially in premium and export markets.
4. ***Trust and Peer Influence:*** Success stories and peer influence encouraged hesitant millers to adopt fortification.
5. ***Potential Government Incentives:*** Millers suggested that government-backed procurement and subsidies could further motivate adoption.

essential to ensure product consistency and compliance (Food Fortification Initiative, 2022).

Public-private partnerships can significantly enhance the reach and impact of fortification programs. For example, the collaboration between the Gujarat government and the Gujarat Roller Flour Millers Association has led to a notable increase in micronutrient intake among beneficiaries (Fiedler et al., 2012). Retailers play an essential role in the supply chain; ensuring the presence of fortified wheat flour in retail outlets improves consumer access. Providing incentives to retailers—whether through promotional support, financial benefits, or inclusion in public distribution systems—can motivate them to stock and promote fortified products.

Equally important is promoting consumer demand. Targeted marketing campaigns led by private sector actors can shape purchasing decisions, particularly among parents of young children, by emphasising the nutritional benefits of fortified wheat flour. Ensuring affordability for low-income populations is critical. Subsidised initiatives—such as the program in Tamil Nadu—have proven effective by increasing uptake through reduced prices. These efforts contribute to bridging nutritional gaps and improving public health outcomes.

5.6.2 Strengthening Quality Assurance and Monitoring Systems

Ensuring the consistent quality and safety of fortified wheat flour in India requires a robust quality assurance (QA) and monitoring framework (Food Fortification Initiative, n.d.). These systems are essential to uphold fortification standards, sustain program credibility, and evaluate the impact on public health outcomes.

Key Pillars of Effective QA and Monitoring

- **Defined Standards and Regulatory Clarity:** A strong program starts with **clear,** evidence-based guidelines outlining the required levels of iron, folic acid, and vitamin B12 in fortified wheat flour, as per FSSAI regulations.
- **Training and Capacity Building:** Comprehensive training for millers, food inspectors, and supply chain actors is vital to ensure proper implementation, quality control, and compliance at each stage of production and distribution.
- **Internal and External Monitoring:** Implement internal QA protocols within mills and independent external audits by regulatory agencies or accredited third parties to ensure transparency, detect deviations, and maintain consumer trust.
- **Impact Evaluation:** Periodic impact assessments and biomarker surveys should be conducted to measure the program's effectiveness in reducing anaemia and other micronutrient deficiencies, and to guide course corrections.
- **Data Management Systems:** Develop and integrate digital data collection and dashboard systems to enable real-time tracking, performance monitoring, and evidence-based decision-making.
- **Overcoming Operational Barriers:** Address common implementation challenges—including resource limitations, inconsistent oversight, and limited technical expertise—through coordinated planning, stakeholder engagement, and investment in QA infrastructure.

The WHO manual (World Health Organization, 2021) provides monitoring flour fortification guides to ensure that fortified wheat and maize flour meet quality standards and achieve public health goals. It outlines a monitoring framework, including internal, external, import, commercial, and consumption monitoring. The manual emphasizes data collection, stakeholder collaboration, and regulatory enforcement to maximize health benefits.

5.6.3 Driving Public Awareness and Behaviour Change

Public awareness and behaviour change are critical for the success and sustainability of wheat flour fortification efforts in India. Educating communities about the health benefits of fortified wheat flour can drive demand, encourage adoption, and ultimately improve nutritional outcomes (Food Fortification Initiative, 2017). Clear and consistent messaging about the safety, benefits, and availability of fortified foods helps build trust, dispel myths, and normalise consumption across socio-economic groups.

Key Strategies to Foster Behaviour Change and Demand

- **Information, Education, and Communication (IEC):** Develop tailored IEC materials that explain the role of iron, folic acid, and vitamin B12 in health, and highlight how fortified wheat flour helps prevent deficiencies like anaemia.
- **Community Engagement:** Conduct **workshops, health talks, and local interactive events** to engage directly with households and community leaders, addressing misconceptions and encouraging behavioural shifts.
- **Mass Media Campaigns:** Use **television, radio, print media, and social media** to run multilingual, culturally relevant campaigns that raise awareness and promote fortified wheat flour consumption
- **School-Based Nutrition Education:** Integrate fortification awareness into school curricula and midday meal discussions, equipping children as nutrition ambassadors within their families and communities.
- **Public-Private Partnerships:** Leverage corporate social responsibility (CSR) partnerships to co-create and fund outreach campaigns, and engage brands and retailers to promote fortified wheat flour through in-store promotions, packaging messages, and loyalty schemes.

Rajasthan's Fortification Initiative: In Rajasthan, a study was conducted to develop appropriate positioning strategies for fortified foods. The research assessed consumer buying behavior and perceptions, leading to tailored communication strategies that effectively promoted fortified products (Purohit et al., 2015).

PATH's Rice Fortification Campaign: PATH has implemented information, education, and communication activities around fortified rice in India. These campaigns aim to spread awareness about the benefits of fortified rice to various stakeholders, including government officials,

community health workers, teachers, and consumers. Similar strategies can be adapted for wheat flour fortification (Maknikar, 2022).

Consumer acceptability of fortified wheat flour in India appears generally positive across diverse settings. In Delhi, while only 56–65% of urban women recognized food fortification symbols, around 70% valued fortified products and were willing to pay more for them (Kumari & Dubey, 2020). Programmatic data from Haryana's Public Distribution System revealed a 98% consumption rate among eligible households, with 63% finding fortified wheat flour equal to or better than conventional options (Bhan et al., 2023). Similarly, a case study from Gujarat, which evaluated an open market test for fortified flour, demonstrated that when fortified flour meets consumer expectations regarding quality, taste, and pricing, it is well accepted in the market (Nambiar et al., 2012).

6. Recommendations: A Multi-Stakeholder Roadmap to Scale Wheat Flour Fortification Nationwide

This section outlines a strategic set of recommendations to accelerate the adoption of fortified wheat flour across India. It emphasises the need for coordinated action across government, private sector, civil society, and global development partners. Through strong policy mandates, technical capacity building, financial incentives, and community engagement, wheat flour fortification can become a sustainable and impactful public health intervention.

6.1 Mandate, Incentivise, and Mainstream Fortification

1. **Mandate Fortification in Government Schemes**: Expand existing FSSAI regulations to make wheat flour fortification mandatory across all Social Safety Net Programmes (SSNPs). Begin with pilot implementation in high wheat-consuming states to identify operational challenges and evaluate health and economic impact.
2. **State-level Prioritisation**: Encourage states with high wheat consumption to transition from raw wheat to fortified wheat flour in TPDS, ICDS, and PM POSHAN.
3. **Subsidies for Millers**: Offer financial incentives to small and medium-sized flour mills to cover fortification equipment, premix, and labeling and packaging upgrades.
4. **Strengthen Infrastructure and Supply Chains**: Equip mills with microdosing and quality control technology, and invest in logistics and monitoring systems to ensure FSSAI compliance and timely distribution.
5. **Bharat Atta and Open Market Access:** Make fortification mandatory under the Bharat Atta initiative (2023) and expand distribution through Jan Poshan Kendras (JPKs), Fair Price Shops, and retail outlets to increase consumer access.

6.2 Leverage Market Forces to Accelerate Impact

1. **Utilise CSR Funding**: Mobilise Corporate Social Responsibility (CSR) contributions to support fortification infrastructure and public awareness, particularly in underserved communities.
2. **Brand-driven Fortification**: Encourage flour producers to use fortification as a differentiator in premium, retail, and export markets, boosting consumer demand and private sector buy-in.

6.3 Civil Society Leadership and Community Engagement

1. **Consumer Awareness Campaigns**: Launch targeted communication initiatives to educate communities about the benefits of fortified wheat flour and how to identify fortified products (e.g., the F+ logo).
2. **Independent Monitoring and Transparency**: Create community-based monitoring systems to track fortification compliance and ensure accountability in distribution.
3. **Capacity Building for Millers**: Provide technical training and capacity building for local millers on premix handling, equipment use, and quality assurance.
4. **Evidence Generation and Advocacy**: Support impact studies and longitudinal research to assess improvements in anaemia and other micronutrient deficiencies, and use the evidence to sustain political commitment and investment.

6.4 Global Collaboration and Technical Assistance

1. **Technical Expertise Exchange**: Partner with international organisations to provide expertise in fortification science, logistics, and program design, drawing from proven global models.
2. **Innovative Financing**: Develop results-based financing mechanisms, such as impact bonds or public-private co-financing, to support early-stage program rollout.
3. **Cross-country Learning**: Facilitate knowledge exchange with countries that have scaled successful wheat flour fortification programs.
4. **Global Standards Alignment**: Align India's fortification norms with global food safety and nutrition standards, while maintaining local relevance.
5. **Explore Fortification of Wheat-Based Products in SSNPs:** Assess the feasibility of fortifying other wheat-based foods distributed through SSNPs (e.g., atta-based rotis, puris, and snacks) to increase micronutrient coverage.

7. Conclusion

Towards Nutritional Equity: Why Wheat Flour Fortification Must Scale

This white paper underscores the urgent need to expand wheat flour fortification through India's government food programs to address micronutrient deficiencies, particularly iron deficiency anaemia (IDA). While rice fortification has achieved measurable success in predominantly rice-consuming states, wheat-consuming states—especially in the northern and western regions such

as Punjab, Rajasthan, Gujarat, Haryana, Madhya Pradesh, Uttar Pradesh, and Bihar—remain highly vulnerable to anaemia due to limited access to fortified staples.

Close the Nutritional Gap: Mandate Wheat Flour Fortification in Government Schemes

Currently, approximately 33.67 percent of the food grains supplied through TPDS, ICDS, and PM Poshan consist of wheat (to be verified). However, wheat fortification remains largely absent, leaving a significant proportion of beneficiaries without essential micronutrients. While government efforts in rice fortification have yielded positive outcomes, the lack of fortified wheat flour continues to create a nutritional gap.

To bridge this gap, a **phased transition to fortified wheat flour over the next three years** should be mandated. This initiative should ensure that all wheat-based foods in cooked meals and take-home rations (THR) under ICDS and PM Poshan are fortified.

Strengthen Reach: Expand Fortified Wheat Flour in Open Markets

Wheat flour fortification is not only effective—it is affordable. At an estimated marginal cost of ₹0.10 per kg, it offers a significantly more economical intervention compared to fortified rice.

Integrating fortified wheat flour into open market initiatives such as the Bharat Atta scheme—launched in November 2023 under the Open Market Sale Scheme (OMSS-D)—can enhance access for the general population. This approach will ensure that fortified wheat flour reaches low-income households beyond the government schemes, promoting nutritional equity through subsidised retail channels.

A Collective Push for Nationwide Scale-Up

Scaling wheat flour fortification across India will require a coordinated, multi-stakeholder effort. Government bodies at central and state levels must prioritise its inclusion in TPDS, ICDS, and PM POSHAN. At the same time, the capacity of millers—especially small and medium enterprises—must be built through financial incentives, equipment support, and training to ensure FSSAI compliance.

Community awareness and social behaviour change communication (SBCC) campaigns are critical to build public trust and acceptance of fortified wheat flour. Moreover, robust, independent monitoring systems are needed to track coverage, compliance, and impact.

With strategic leadership and sustained investment, wheat flour fortification can become a cost-effective, scalable solution to reduce anaemia and improve the health and productivity of millions of Indians.

Annexures

Annexure 1: Policies and programmes to address anaemia and micronutrient deficiencies, comprehensive analysis

Annexure 2: Case studies of successful wheat flour fortification programmes globally

Annexure 3: Detailed regulatory specification for wheat flour fortification and technical details of the process of wheat flour fortification

Annexure 4: Government recommendations and directions on Fortification in SSNPs

Annexure 5: Detailed evidence of wheat flour fortification

Annexure 6: Average per capita monthly quantity consumption of Wheat and Rice in India

Annexure 7: Details of state experiences of wheat flour fortification in SSNPs

Annexure 8: List of key stakeholders and their roles in scaling wheat flour fortification

Annexure 9: Estimated Cost of Fortifying Wheat Flour

Annexure 10: FAQs

References

The detailed references are **kept here.** (alphabetical order)

Abbreviations

The detailed abbreviations are **kept here.**