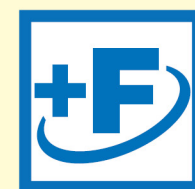




FOOD SAFETY AND STANDARDS  
AUTHORITY OF INDIA

# JOURNEY OF FOOD FORTIFICATION

Fighting Malnutrition  
Improving Lives



**FORTIFIED**  
SAMPOORNA POSHAN  
SWASTH JEEVAN



*Inspiring Trust, Assuring Safe & Nutritious Food*





“However much a mother may love her children, but it is impossible for her to provide quality child care if she herself is poor, illiterate, anemic and unhealthy” -

Dr. V. Ramalingaswami



“State shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties...” –

Article 47, Constitution of India

“Costs of core micronutrient interventions are as low as \$0.05–3.60 per person annually. Returns on investment are as high as 8–30 times the cost” – Horton et al. 2009

“Micronutrient interventions – fortification and supplements designed to increase nutrient intake – are the most effective investment that could be made, with massive benefits for a tiny price-tag” –

Copenhagen Consensus, 2012

“Annually, India loses over US\$12 billion in GDP to vitamin and mineral deficiencies. Scaling up core micronutrient interventions would cost less than US\$574 million per year” – UNICEF and Micronutrient Initiative, 2004 and

World Bank, 2009

“Vitamin mineral deficiencies are widely prevalent in the Indian population. When technology for ensuring community benefit is available, affordable and scalable, it is a crime to let a single child be born with physical or mental disability arising due to vitamin or mineral deficiency. Food fortification is the need of the hour and is the opportunity that should not be missed rather fully harnessed.” – Dr. B. Sesikaran

“The doctor of the future will no longer treat the human frame with drugs, but rather will cure and prevent disease with nutrition.” – Thomas Edison

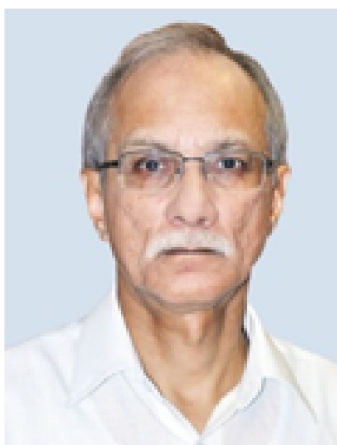








# Foreword



## **Ashish Bahuguna, Chairperson, FSSAI**

A large part of the population of our country suffers from acute malnutrition. The deficiencies in vitamins, minerals and other micronutrients, in particular, have long ranging effects on health, cognition and productivity which are critical to our all round socio-economic development. These deficiencies need to be addressed on a war footing so as to place our country on a path of sustained growth, prosperity and well being.

Over the years, food fortification has established itself as an effective tool to tackle the deficiencies of vitamins and minerals in our diets. The time is now ripe to wholeheartedly adopt fortification as a strategy to help fight these deficiencies which have long lasting devastating effects on health and productivity. FSSAI, has, on its part, brought out a comprehensive regulation on fortification of foods namely 'Food Safety and Standards (Fortification of Foods) Regulations, 2016' covering the production, manufacture, distribution, sale and consumption of fortified food. These regulations need to be backed with technical assistance programmes, strengthening of laboratories and research institutions, and incentivisation of measures to encourage fortification.

We, at FSSAI, have stepped up to protect, promote and improve established legislations for food fortification in India and assist all stakeholders to adopt scientific standards, processes and protocols to ensure safe, nutritious and wholesome food to all sections of society.

I would like to solicit the cooperation of all stakeholders in this endeavour so that we could, together, bring about the vision of a 'Swasthya Bharat'.









# Preface



## **Pawan Agarwal, CEO, FSSAI**

A comprehensive regulation on fortification of food by FSSAI is an important milestone in the country's journey to address malnutrition. Fortification is seen as an important intervention to tackle micronutrient malnutrition.

The country has four decades of experience in fortifying salt with iodine that helped address one of the most significant micronutrient deficiency disorders. The FSSAI Regulation covers five food categories i.e. wheat flour, rice, milk, edible oil and salt that addresses the gap for multiple micronutrients and is significantly more comprehensive than iodized salt and is likely to be far more challenging.

There is, however, rich experience in the country in taking up fortification projects successfully across food categories. It is now time that this should be scaled up and overtime get universally adopted.

In doing so, support of many stakeholders would be needed. This would include manufacturers and suppliers, scientists and researchers, governments at all levels and many development partners. Public education on large scale would be key.

This publication - "Journey of Food Fortification: Fighting Malnutrition, Improving Lives" which brings together key facts around malnutrition, global and national evidence, experience around fortification and some basic information on fortification in various food categories will be extremely useful in bringing alignment of all stakeholders so that gigantic task of ensuring universal adoption of fortification across these food categories is achieved in a short time.









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# The Malnutrition Burden



“End all forms of malnutrition by 2030”–

Sustainable Development Goals

“Out of 129 countries (with data), 57 countries have severe levels of under-nutrition and adult overweight”–

Global Nutrition Report 2016

“Out of world population of 7 billion, 2 billion suffer from micronutrient deficiencies” –

Global Nutrition Report 2016

Malnutrition manifests itself in many forms – deficiencies or excesses of macronutrient and micronutrients. Micronutrient or vitamin and mineral deficiencies affect more than 2 billion people worldwide and are especially prevalent in developing countries including India. Conditions due to vitamin mineral deficiencies account for 7.3 percent of the global disease burden<sup>1</sup>.

## **Indian diets are rich in staples; provide calories but not “nourishment”.**

Consumption of fruits, vegetables, meat and eggs which are considered to be the richest sources of vitamin and minerals is very low among the Indian population<sup>2</sup>.

Unlike the gnawing hunger that results from going without food, the deficiencies of vitamins and minerals often goes unnoticed. Hence, it is also referred to as ‘hidden hunger’. Although hidden hunger rarely shows visible signs, its consequences are long lasting and devastating as it leads to poor physical and mental health, reduced IQ, increased susceptibility to infection, increased child and maternal mortality, reduced cognitive development and physical work capacity. For example, the absence of sufficient folic acid in the first weeks of pregnancy increases the risk of neural tube defects that result in serious birth defects. Iodine deficiency was the world’s most prevalent cause of preventable brain damage, till recently. Universal salt iodisation programmes in countries have helped avert this to a large extent. Deficiency of vitamin A – affecting millions of children and women – is associated with night blindness and is also known to compromise immunity. In anaemic women, iron deficiency leads to higher risk of death during child birth. It also impairs physical and cognitive development of their babies.

<sup>1</sup>Ezzati et al., 2004

<sup>2</sup>NSSO, 2011







# Vitamin & mineral deficiencies continue to be silent emergencies in India

Though we have national supplementation programmes in place, the results in reducing some critical nutrient deficiencies e.g., iron, folic acid and vitamin A have not been encouraging. Iron deficiency (anaemia), vitamin A and iodine deficiency disorders continue to be a grim public health problem. Iron deficiency is wide spread, exists across income quintiles and age groups. Apart from women and children, even 24 percent of men are found to be anaemic<sup>3</sup>. In India, more than a quarter of the world's vitamin A deficient preschool children reside who suffer from subclinical vitamin A deficiency and one-third of the preschool children show clinical

signs and symptoms of vitamin A deficiency<sup>4</sup>. More than 13 million infants are susceptible to iodine deficiency disorders<sup>5</sup>. Most importantly, these deficiencies do not occur in isolation. Other micronutrient deficiencies, such as vitamin B group, zinc and vitamin D are also prevalent and have overwhelming impact on the health and productivity of the population. Thus, elimination of vitamin and mineral deficiencies is essential to improve the overall health of the masses as well as to sustain economic growth and national development.

More than half the population across any age group consumes less than 50 percent of their daily needs of iron, zinc, vitamin A, folate, and other B vitamins.

Source: National Nutrition Monitoring Bureau, 2012



<sup>3</sup>National Family Health Survey-3, 2004-2005

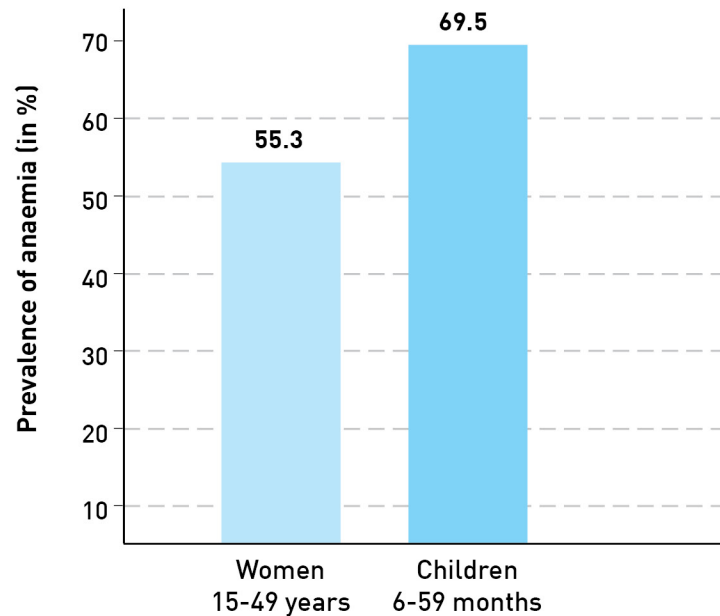
<sup>4</sup>WHO, 2009

<sup>5</sup>UNICEF, 2009



## Prevalence of anaemia in India

Anaemia in India among women and children



Anaemia affect the rich and the poor

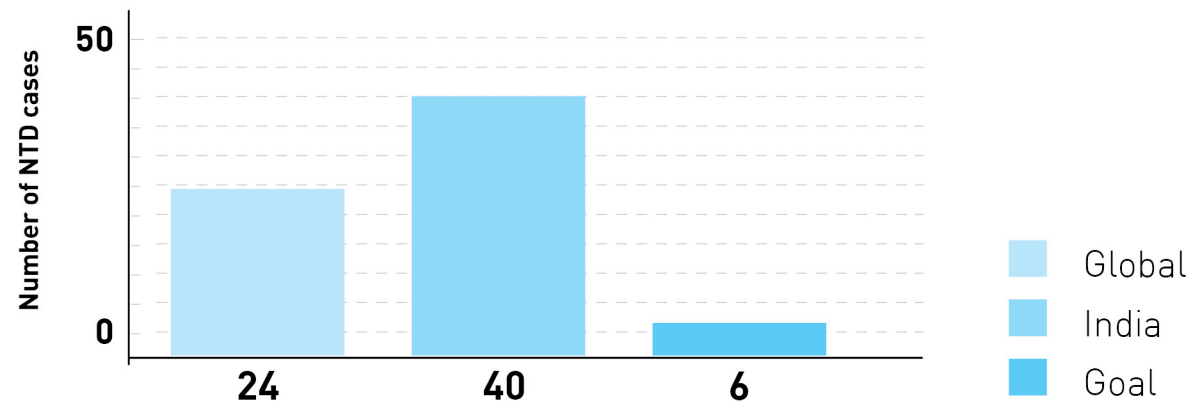
Income quintiles	% Children anaemic (HB<11 g/dl)
Lowest	78.8
Second	79
Middle	75.1
Fourth	72.3
Highest	63.9

Source: India Health Report, Nutrition 2015

## Prevalence of neural tube defects in India

NTD prevalence in India per 10,000 births

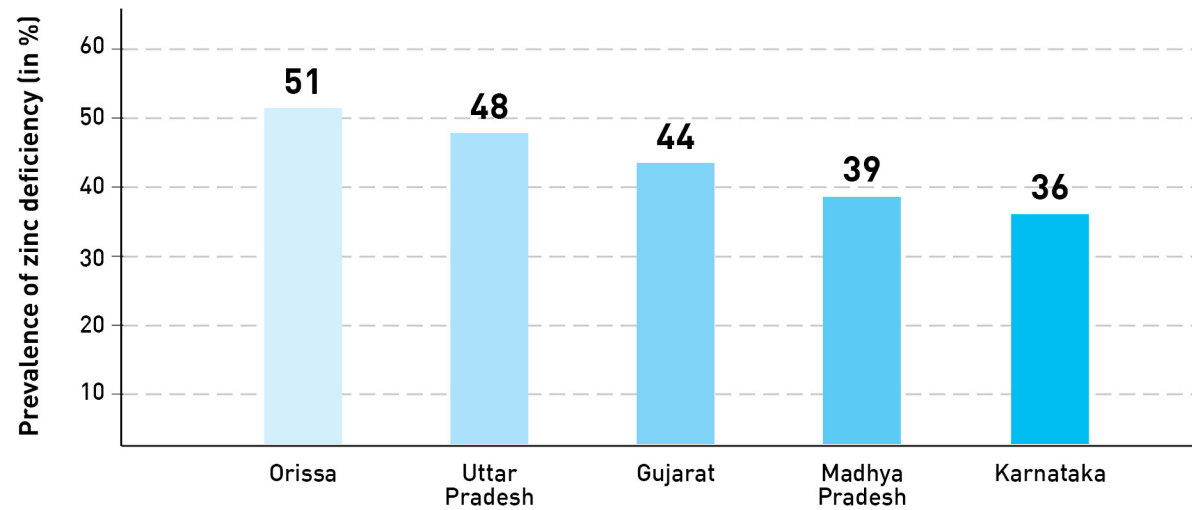
Neural tube defects (NTDs) is the most common birth defect in India. The risk for NTD can be reduced by consumption of adequate amount of folic acid in the diet prior to conception and in early pregnancy.



Source: Food Fortification Initiative, Bhide et al. (2013) and Allagh et al. (2015) \*Lowest level achievable with current folic acid fortification practices (Center for Disease Control, 2010 and Berry et al. 2010).

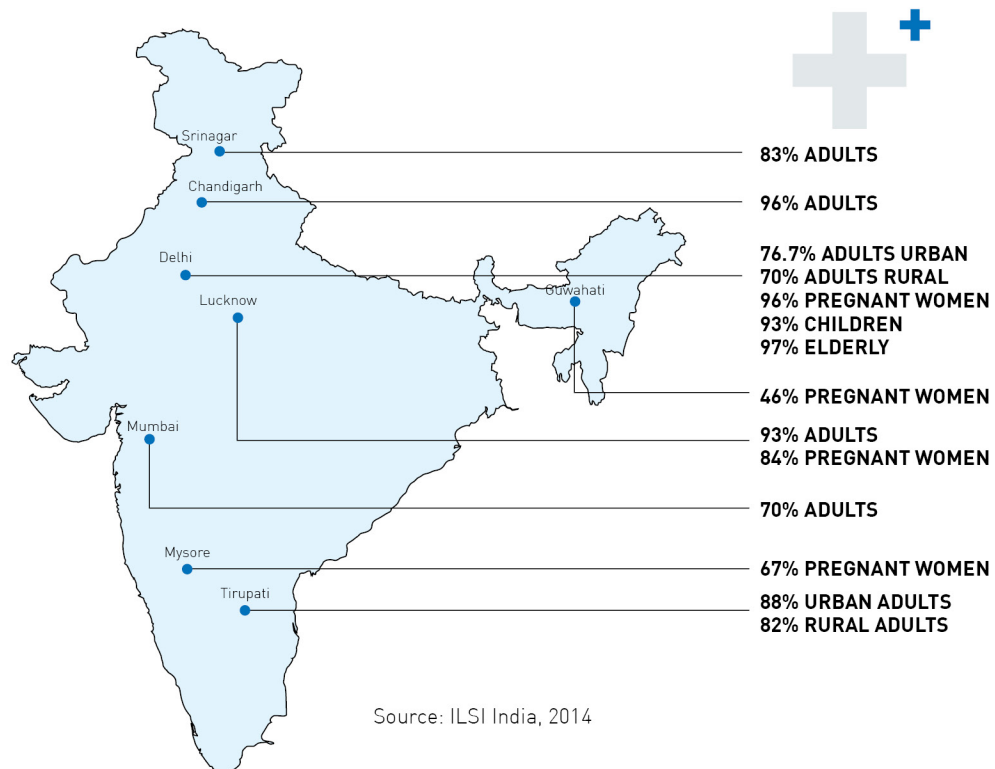


## Prevalence of zinc deficiency among children in India



Source: Kapil and Jain, 2011

## Vitamin D deficiency in India



Source: ILSI India, 2014









# Combating vitamin and mineral deficiencies

Solutions to control and prevent micronutrient deficiencies are available and affordable. Interventions such as dietary diversification (consumption of variety of foods including green vegetables, fruits, and animal protein), supplementation in the form of vitamin A and iron tablets, fortification of widely consumed foods with vitamins and minerals such as iron, folic acid, iodine, zinc, vitamin A, D are known and implemented across the globe. For effective impact, appropriate infant and young child feeding practices, adequate public health measures like provision of safe drinking water, deworming etc. are critical.

These interventions have shown a positive impact on the micronutrient status of the vulnerable population particularly when implemented in conjunction with other public health measures.

## Food fortification - A promising intervention to deliver vitamin and mineral rich foods to masses

- Food fortification is an effective intervention to deliver vitamin and mineral rich foods to large populations. Through this process, minute quantities of missing nutrients in the daily diet such as vitamin A, iron, and iodine are added to commonly consumed food like milk, wheat flour, rice, oil to enhance the nutrient quality of the food, thereby increasing consumption among the population. These have minimal effects on taste and cooking properties. Fortification is known to have helped eliminate vitamin and mineral malnutrition in industrialized nations and many developing countries.
- In addition to the prevention of vitamin and mineral deficiencies, food fortification is an effective measure to raise vitamin and mineral levels by moving the population towards consuming recommended dietary allowances for most micronutrients – making it a long-term and a sustainable strategy.
- Even in under-developed countries, food fortification has proved to be a type of nutritional insurance that protects the population from changes in the availability, affordability and consumption of essential nutrients through diet.
- Technology to fortify food is simple to use and easy to implement. A vitamin and mineral mixture (also known as 'premix') is added to the widely consumed food that is to be fortified.
- The cost of fortification is minimal compared to the sale price of the commodity making it cost effective for consumers of all strata.
- For the large and expanding population that regularly purchases and consumes staple foods, fortification can provide a cost-effective and sustainable solution with no requirement of change in consumption patterns.

Fortification refers to adding vitamins and minerals to commonly consumed foods in order to prevent nutritional deficiencies. The nutrients regularly used in staple food fortification prevent diseases, strengthen the immune system and improve productivity and cognitive development.





In food fortification, benefits outweigh cost



"Providing micronutrients" has been recognized as having the best cost/benefit ratio to achieve a major impact in the developing world as stated by more than fifty economists at the Copenhagen Consensus, 2012

Copenhagen Consensus  
US \$347 million investment in vitamins and minerals

US \$5 billion in savings from avoided deaths, improved earnings and reduced healthcare spending

Probably no other technology available today offers as large an opportunity to improve lives & accelerate development at such low cost & in such a short time. (Source: Enriching Lives, The World Bank)





# The importance of vitamins & minerals

Vitamin/ Mineral	Functions	Deficiency
Iron	<ul style="list-style-type: none"> <li>Carries oxygen to tissues.</li> <li>Regulation of immune function.</li> <li>Part of various enzyme systems.</li> </ul>	Iron deficiency anaemia (IDA) can: <ul style="list-style-type: none"> <li>Reduce physical working capacity.</li> <li>Cause extreme fatigue and depression.</li> <li>Negatively impact cognitive development and concentration.</li> <li>Increase susceptibility to infections.</li> <li>Lead to maternal haemorrhage (associated with 20% of all maternal deaths).</li> <li>Reduce IQ by 8 points in children.</li> </ul>
Zinc	<ul style="list-style-type: none"> <li>Growth nutrient - synthesis of carbohydrates, protein and fat.</li> <li>Helps in metabolism of various vitamins and minerals.</li> <li>Strengthens immunity.</li> </ul>	Zinc deficiency can cause: <ul style="list-style-type: none"> <li>Growth retardation</li> <li>Diarrhoea</li> <li>Increased susceptibility to infections.</li> <li>Impaired appetite</li> </ul>
Iodine	<ul style="list-style-type: none"> <li>Needed for the formation of thyroid hormone.</li> <li>Helps in metabolism of macronutrients, vitamins and minerals.</li> </ul>	Iodine deficiency disorders (IDD) cause: <ul style="list-style-type: none"> <li>Goitre (enlargement of thyroid gland in the neck).</li> <li>Growth retardation</li> <li>Mental retardation or cretinism.</li> <li>Children to have IQs that are 10 to 15 points lower than those not deficient.</li> </ul>
Vitamin A	<ul style="list-style-type: none"> <li>Needed for healthy vision.</li> <li>Normal growth and development.</li> <li>Strengthening immune system.</li> <li>Reproduction</li> </ul>	Vitamin A deficiency can cause: <ul style="list-style-type: none"> <li>Night blindness</li> <li>Increased susceptibility to infections.</li> <li>Impaired immune responses.</li> </ul>
Folic Acid	<ul style="list-style-type: none"> <li>Appropriate development of the brain and spinal cord of babies.</li> </ul>	<ul style="list-style-type: none"> <li>Pregnant women with low folic acid status are at increased risk of having a baby with neural tube defect.</li> <li>Low folic acid intake is also associated with increased cardiovascular diseases and colorectal cancer.</li> </ul>
Vitamin D	<ul style="list-style-type: none"> <li>Required for adequate bone health.</li> <li>Modulates the immune system and its response.</li> </ul>	Vitamin D deficiency can cause: <ul style="list-style-type: none"> <li>Rickets in children</li> <li>Osteoporosis in adults</li> </ul> Vitamin D deficiency can increase the risk of: <ul style="list-style-type: none"> <li>Cardiovascular diseases</li> <li>Hypertension</li> <li>Cancer</li> <li>Depression</li> </ul>









# Global Evidence

The world has witnessed the power of food fortification

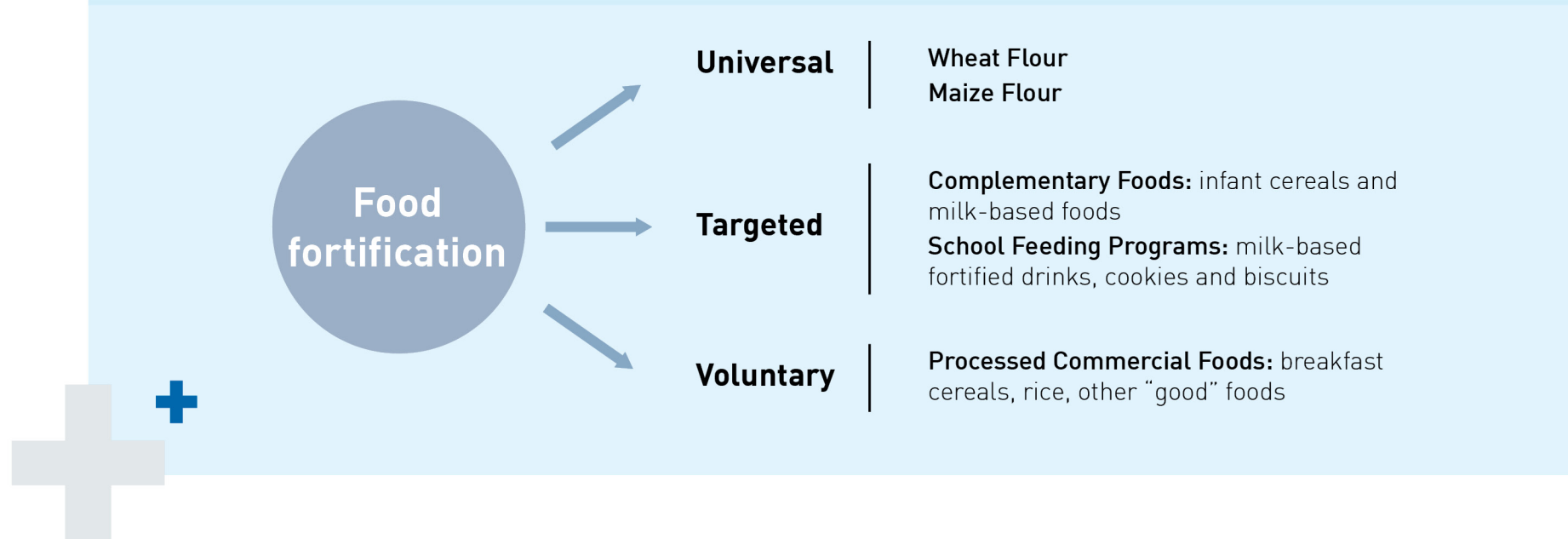
Across the globe, food fortification has been used safely and effectively to prevent vitamin and mineral deficiencies for more than a century.

Fortification is not new – it's a century old technology to address vitamin and mineral deficiencies		
Iodine	Switzerland 1923 USA 1930 India 1964	Salt
Vitamin D	Denmark 1918, India 1953 Indonesia 1996, New Zealand 2007 Mexico 2002	Margarine Vanaspati Milk
Vitamin A	USA, UK 1923, Malaysia 1985, Thailand 1993, Mexico 2002 India 1953, Chile 1997, Mexico 1974  Central America 1974, Philippines 2000	Milk  Margarine Vanaspati Sugar
Iron, B1, B2, Niacin, Folic Acid	Canada 1933, USA 1941 Chile 1954 Australia 2009 Costa Rica 1991, Philippines 2001	Wheat flour Flour for making bread Rice
Zinc	Indonesia, 1998 Costa Rica, 1991	Wheat flour Rice



In United States of America, fortifying salt with iodine and fortifying margarine with vitamin A began in 1920s, fortification of milk with vitamin A and D in 1930s, and enrichment of flour and bread with iron and B complex in 1940s - all of which has contributed to virtual elimination of vitamin and mineral deficiency diseases like goitre, rickets, beriberi, and pellagra<sup>6</sup>. In 1938, adding iron and B complex vitamins to corn, wheat and rice products was made mandatory in the United States. Today, the fortified flour provides the population of the United States and Canada with about a quarter of its daily iron intake. Rickets was eliminated in many European countries and in North America by double-fortifying milk and margarine with vitamins A and D. Almost 99% of milk supply in the USA is fortified with 10 microgram of vitamin D per litre.

## How America tackled its vitamin and mineral deficiency through food fortification.



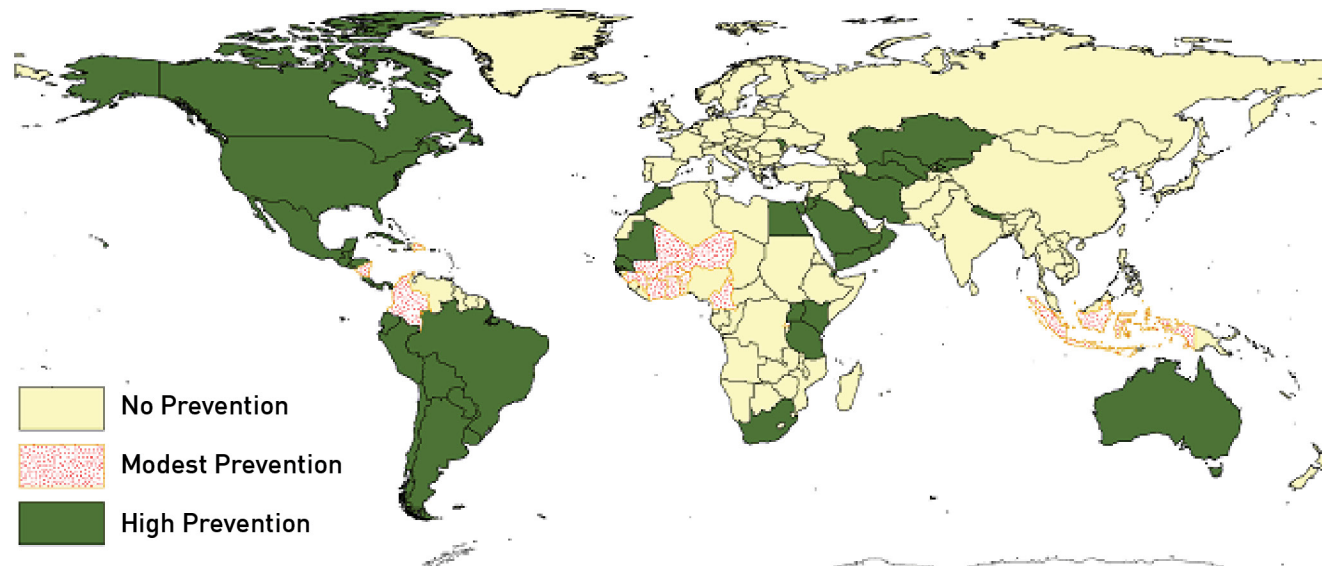
Developing countries in Central America and in Africa have decades of experience in fortifying which has led to elimination of vitamin A deficiency. Similarly, tremendous progress has been made in these countries specifically in salt iodization which has led to an increase in consumption of iodized salt from 20 to 70 percent within 2 decades.

<sup>6</sup>Bishai and Nalubola, 2002



## 13.2 percent of neural tube defects were prevented in 2015 in 58 countries practicing mandatory fortification of flour with folic acid

2015 recorded an estimated 35,500 babies – an average of 97 a day who were born without neural tube defects (NTDs) in 58 countries which implement mandatory programs to fortify flour with folic acid. Australia, Fiji, most countries in North, Central, South America and the Caribbean have a high degree of prevention due to mandatory flour fortification. Several countries in Africa have achieved modest prevention. But Europe and most countries in Asia and Africa had no NTD prevention from flour fortification (Arth et al. 2016).



“Mandatory flour fortification is a proven intervention that reaches majority of the population in the country equitably. It is safe, effective and extremely cost-saving. We urgently need political will to improve the nutrition of women of reproductive age in all countries so that we can prevent serious birth defects that occur due to lack of enough folic acid in the mother.” - Vijaya Kancherla, Emory University, Georgia, United States of America.

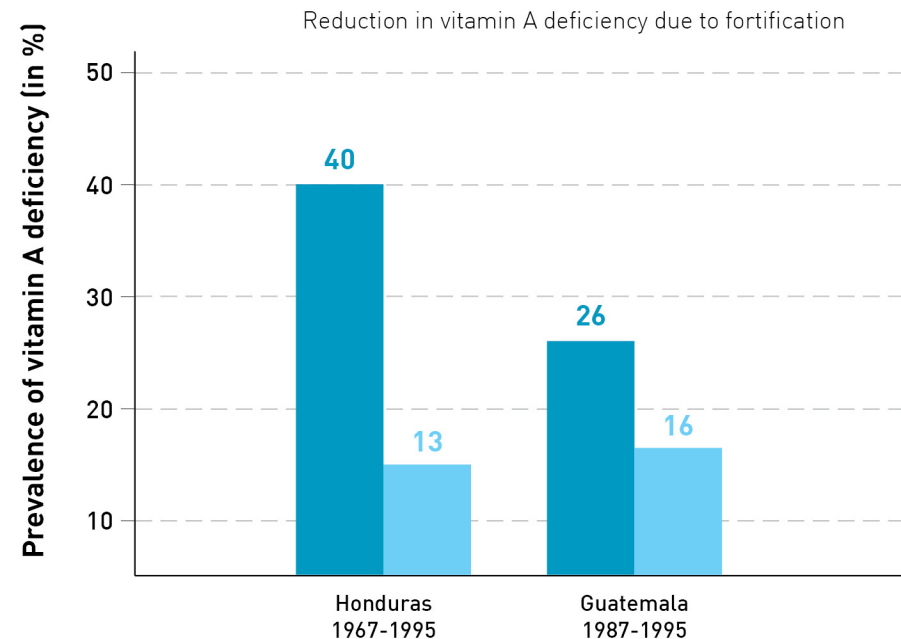
Source: Food Fortification Initiative, 2016





## In Central America, sugar fortification paved way for reduction in vitamin A deficiency among pre-schoolers

Some countries in Central America decided to fortify sugar in the 1970s. Appropriate technology was developed, legislation promoted, and national programs in three countries (Guatemala, Honduras and Costa Rica) were established. An evaluation in the mid-1970s in Guatemala demonstrated the effectiveness of sugar fortification in reducing vitamin A deficiency. The cost of fortification was \$9.18 (INR 596.7) per MT (to industry), which translated to about US\$0.20/y (INR 13) per person (Dary and Mora, 2002).



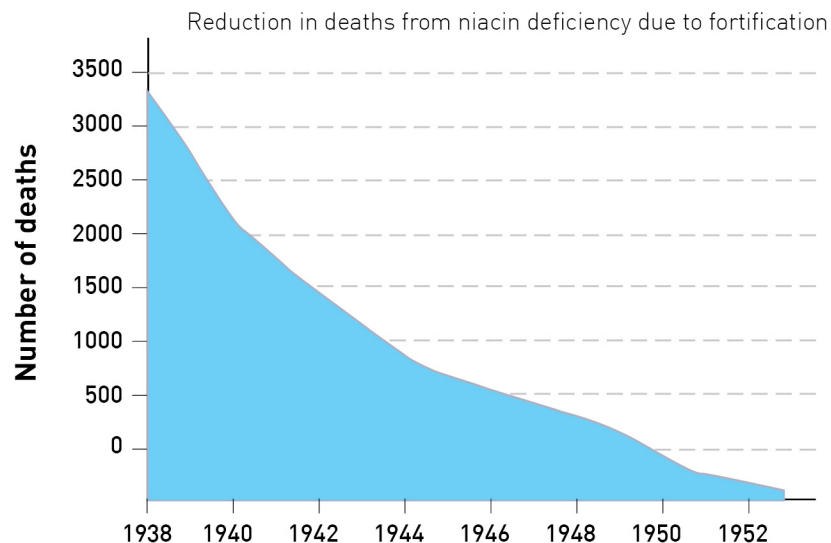
Fortification programme in Costa Rica improved iron status and reduced incidence of anaemia. Costa Rica has a long history of food fortification, starting in 1958 with adding iron to wheat flour, iodine to salt since 1972, and later, expanding to include milk, maize, flour, rice and sugar. This resulted in significant decrease in the prevalence of anaemia in children and women. Anaemia was reduced from 19 to 4 percent in children, from 18 to 10 percent in women. In children, iron deficiency reduced from 27 to 7 percent (Martorell et al. 2015).



# Successful Flour Fortification Programmes

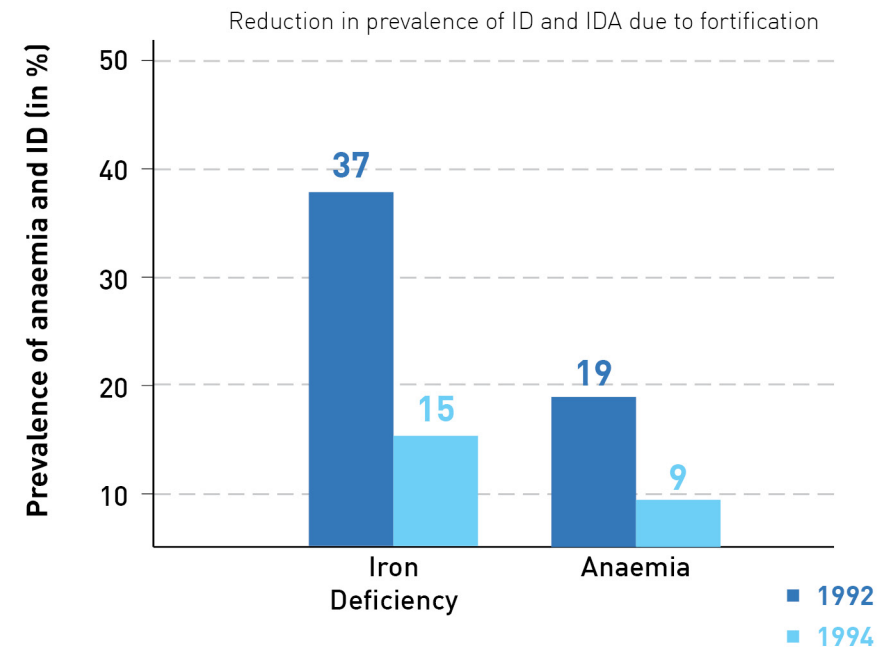


## Fortification of flour helped the United States of America to fight niacin deficiency



The period between 1928 and 1932 and other beginning in 1939 witnessed a large, consistent decline in pellagra mortality. In the second phase (1939 onwards), fortification of grain products along with other factors and voluntary enrichment of bread with high-vitamin yeast by bakers contributed significantly towards a decline in pellagra deaths. Enrichment of bread alone increased per capita niacin intake by 2.9 to 5.7 mg/d which is about 4 to 8 times more than what would be attributable to the increase in the availability of animal-derived foods.

## Flour fortification in Venezuela reduced iron deficiency and anaemia by 50%



In 1992, Venezuelan health authorities began a programme to fortify precooked maize and wheat flour with iron and other vitamins. The authorities achieved success by selecting an effective and well-absorbed iron compound, choosing food vehicles that are consumed daily and maintaining quality control over the process. The prevalence of anaemia in children aged 7, 11 and 15 years fell by 50 percent within 12 months of introduction of this programme, and average ferritin concentrations had almost doubled in the first 6 years since implementation (Gracia, 2002).



# Fortification regulations around the world



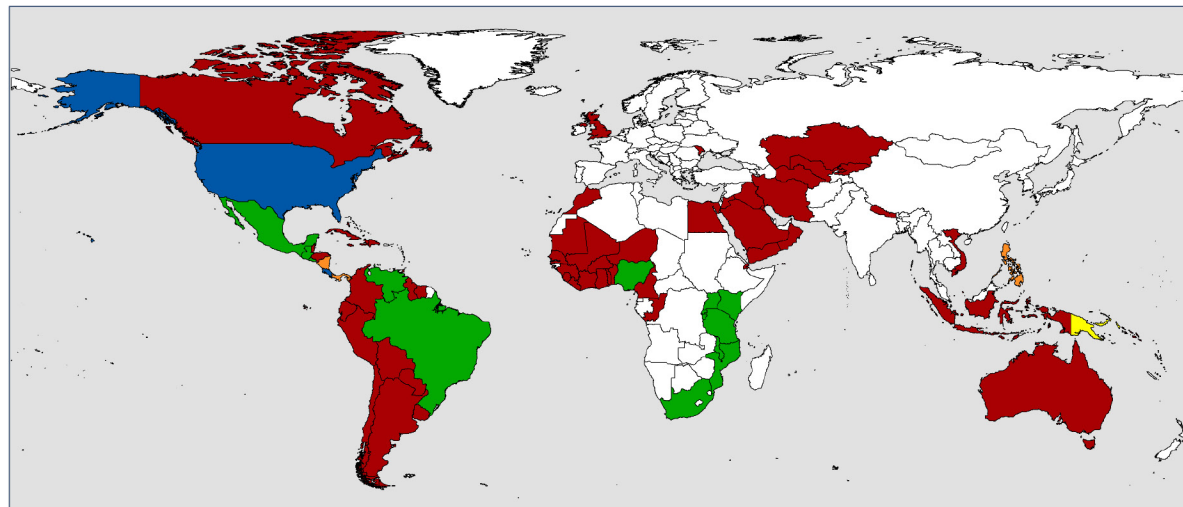
Though most nations fortify foods voluntarily, globally, there are many countries that mandate fortification of common food vehicles. 86 countries have mandated fortification of at least one industrially milled grain – wheat flour, maize or rice<sup>7</sup>.

Many countries have mandated fortification of other food vehicles as well, for example, Canada introduced mandatory iodization of salt in 1949. In Australia, it is mandatory to fortify edible oil, spreads and margarine with vitamin D and wheat flour used for bread with thiamine and folic acid. It is also mandatory to use iodized salt in making bread. Ethiopia has a national law on salt iodization. Vietnam practices fortification of fish sauce with iron since 2005 which has shown a positive impact.





## Industrially milled flour and rice fortification legislation

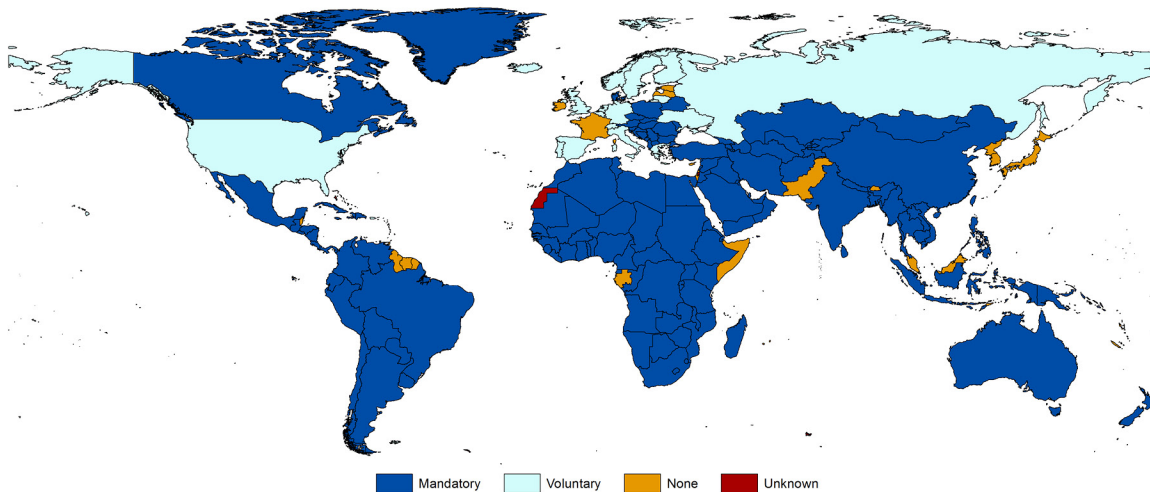


- Wheat flour – 66 countries
- Rice – 1 country (Papua New Guinea)
- Wheat flour and maize flour – 14 countries
- Wheat flour and rice – 3 countries (Nicaragua, Panama, Philippines)
- Wheat flour, maize flour, and rice – 2 countries (Costa Rica and the United States)
- No grain fortification legislation

\* Legislation has effect of mandating grain fortification with at least iron or folic acid.

Source: Food Fortification Initiative ([www.FFInetwork.org](http://www.FFInetwork.org)) May 2016

## Legislation for salt iodization (June 2016)



Source: Iodine Global Network, 2016









# Food fortification in India



India's history of food fortification dates back to 1950s when vanaspati fortification with vitamin A was mandated and it continues till date. In 1986, a national policy of universal salt iodization was adopted and subsequent legislation in 2005, both at the national and the state level, which prohibits the sale of non-iodized salt for human consumption.

India also takes pride in its strong policy framework for food fortification. The National Nutrition Policy (1993) identified and placed fortification of essential foods as a short term direct nutrition intervention and states that essential food items shall be fortified with appropriate nutrients. Promoting food fortification has been a part of the 10th, 11th and 12th five-year national plans of the country.

***In India, salt, wheat, rice, milk, and oil are identified as appropriate vehicles for fortification.***







# Fortifying Salt



Every year nine million pregnant women and eight million new-borns are at risk of iodine deficiency disorders (IDD) in India<sup>8</sup>.

IDDs are linked to iodine deficient soil. Due to glaciations, flooding, rivers changing course and deforestation the iodine present in top soil is constantly leached. This in turn leads to deficiency of iodine in crops grown on iodine deficient soil with consequently low iodine in the diet for livestock and humans.

## Quick Facts

### IDD

Iodine Deficiency Disorders (IDD) comprise of a range of disorders including goitre, hypothyroidism, cretinism, brain damage, intellectual disability, psychomotor defects, hearing and speech impairment, abortion and still births.

13.5

### INTELLIGENT QUOTIENT (IQ)

Children born in iodine deficient areas have 13.5 IQ points less than those in iodine sufficient areas

### Totally preventable

A majority of the consequences of IDD are invisible and irreversible, but at the same time, are totally preventable. IDD constitute the single largest cause of preventable brain damage worldwide

### 1.2 Billion People

In India, due to lack of iodine in the soil and therefore in the diet, all 1.2 billion people are at risk of IDD and around 264 million people are at high risk

92%

Currently, 92% of the population consumes iodised salt in India.

### 4 Billion

Adequate salt iodisation in India has saved 4 billion IQ points in the last two decades

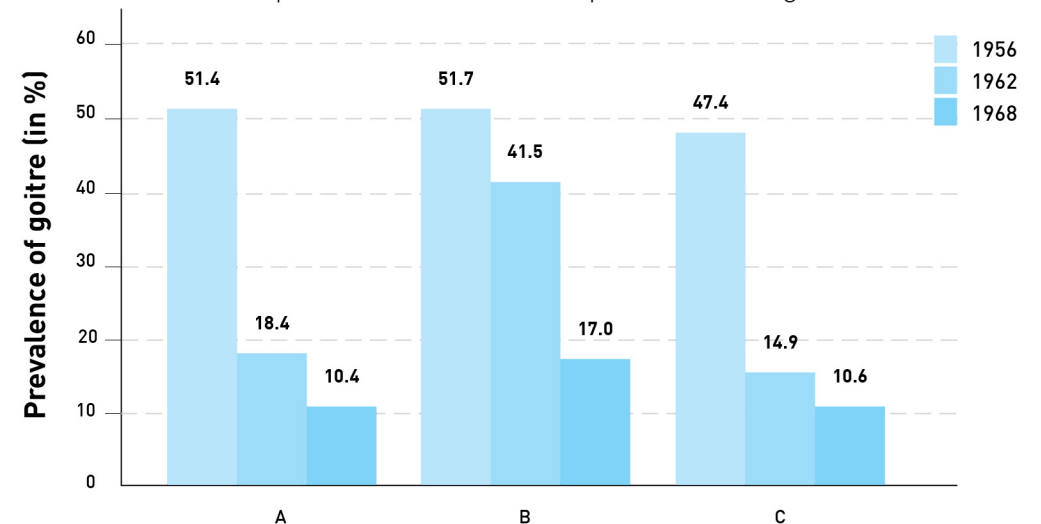
## Programming

India was one of the first countries in the world to start a public health programme to address iodine deficiency disorders based on salt iodization. A national policy of universal salt iodization was adopted in 1986 in India and subsequent legislation, both at the national and the state level, prohibits the sale of non-iodized salt for human consumption.

## Evidence

A landmark study in Kangra Valley region, Himachal Pradesh<sup>9</sup> was conducted from 1956 to 1972. A progressive and significant decline in prevalence of goitre was observed in Zone A (potassium iodate) and Zone C (potassium iodide) populations by 1962. Thereafter, iodized salt was provided to Zone B also which was consuming non-iodized salt. Subsequent checks demonstrated a decline in goitre prevalence in this population as well, which was directly attributable to the introduction of iodized salt in the diet.

Impact of fortification on prevalence of goitre



Source: Sooch and Ramalingaswami, 1965

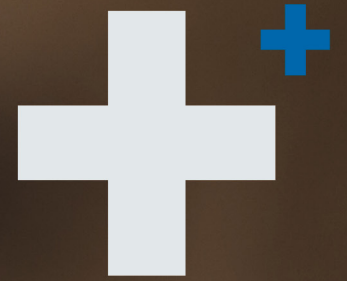
<sup>8</sup>Coverage Evaluation Survey (CES), 2009

<sup>9</sup>Sooch and Ramalingaswami, 1965



“Salt iodisation is a public health success story in India with its focus on research to policy to program and partnership; it has several valuable learnings and lessons for other fortification and nutrition programs in India. To take forward food fortification agenda in India we need to move from contention to collaboration, confusion to coordination and intention to implementation” -

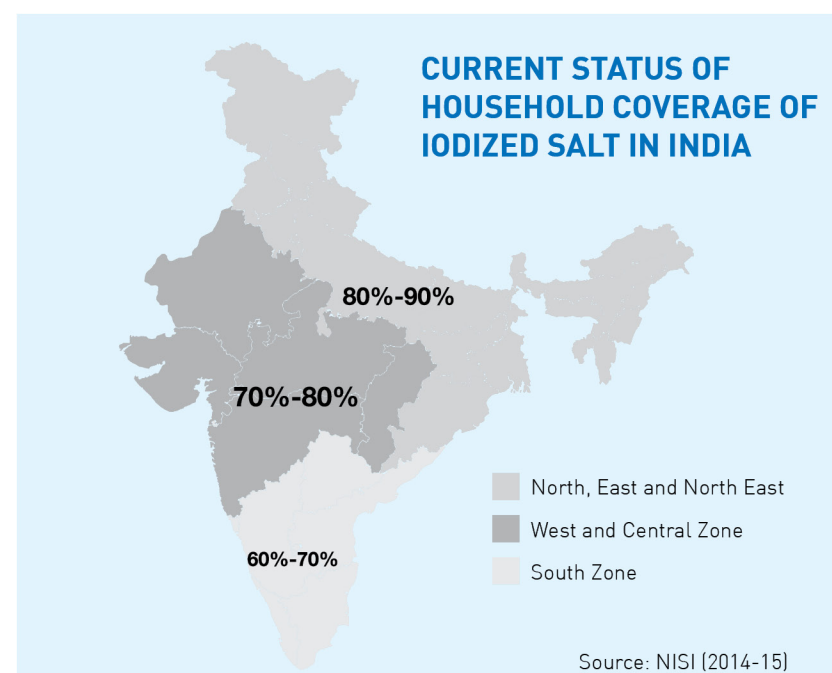
Dr. Chandrakant S Pandav, Professor,  
Community Medicine, AIIMS





## Universal salt iodization – A success story for India

In the 1960s, India was among the first countries in Asia to implement mandatory salt iodization practices with early fortification policies, forcing traders to sell only iodized salt. In 2000, the ban on selling only iodized salt was lifted – drastically increasing consumption of non-iodized salt. Iodized salt consumption decreased within five years with approximately half of Indian households consuming non-iodized salt. As a result, the ban was reinstated in 2005. With increased availability and improvement in iodization practices and packaging, effective monitoring and heightened consumer awareness, fortified salt coverage is 90 percent and 78 percent is adequately iodized (National Iodized Salt Intake Survey, 2015). IDD control programme in India is a public health success story. Iodized salt production in the country was less than 2,00,000 metric tonnes (MT) per year in 1980s, which is now 6.4 million MT per year, well in excess of the national requirement of 5.2 million MT per year (Salt Department Annual Report, 2014-15).



## Double Fortified Salt: Iron and iodine fortified salt – the next breakthrough for tackling iodine and iron deficiency in the country.

Dual fortification of salt with iodine and iron could be a sustainable approach to combat iodine and iron deficiencies. India's National Institute of Nutrition (NIN) has pioneered the development of double fortified salt (DFS). NIN has also taken the initiative to transfer the technology to iodized salt manufacturers in the country and provides continuous quality control support. The Micronutrient Initiative has developed DFS with encapsulated iron. In 2009, the Ministry of Health and Family Welfare has endorsed the addition of iron in double fortified salt at 0.8-1.1 ppm (mg/g of salt).

Evidence: The efficacy of DFS in reducing anaemia and iron deficiency is proven. DFS providing 3.3-mg ferrous fumarate per kg of iodized salt led to significant improvements in haemoglobin, ferritin, soluble transferrin receptor and body iron among female Indian tea pickers in a period of nine months<sup>10</sup>. DFS has been evaluated in the controlled trials in tribal communities and in residential school children in both urban and rural setting with positive impacts.

### Technology

India possesses sound technology to produce DFS which is stable, bioavailable, effective and safe. There are many technologies available to make DFS, prominent being the NIN technology and Micronutrient Initiative technology. Both are available in India and many iodized salt producers have access to the technologies and capability to produce DFS.

### Potential to scale

The Ministry of Women and Child Development has directed the mandatory use of DFS in the ICDS and MDM national programmes (2011). In terms of its reach, DFS can reach the most vulnerable children through MDM, ICDS (150-180 million) and general population through open market channels. The cost that was a major barrier has been brought down and DFS is now available at Rs.7.5 to Rs. 12 per kg.

<sup>10</sup>Haas et al., 2014





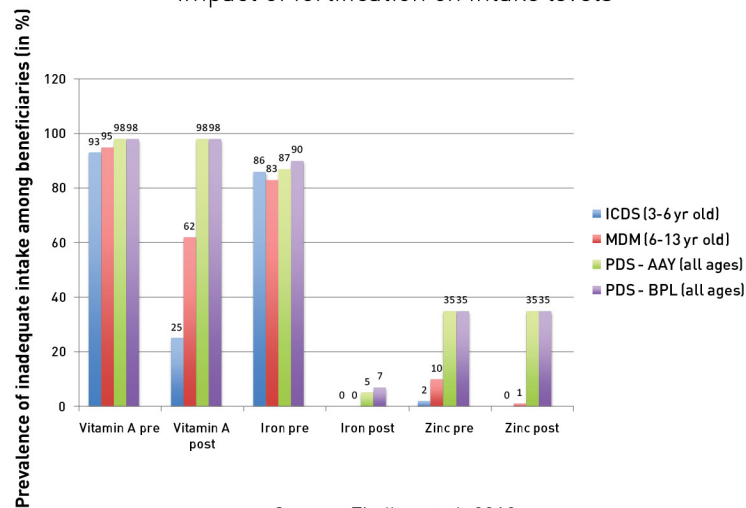


# Fortifying Wheat



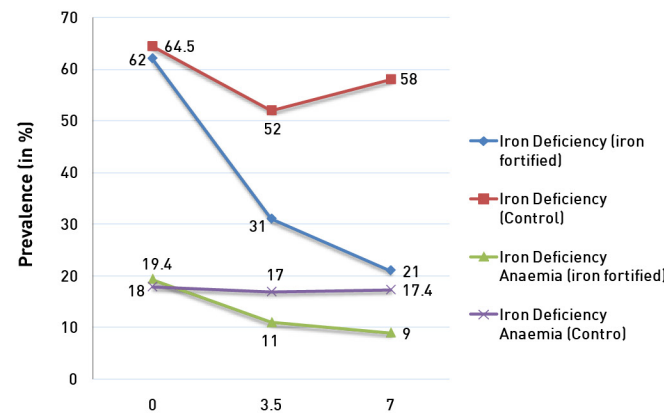
An average Indian derives his calorie intake through cereals. Wheat occupies second position in terms of consumption after rice. Per capita wheat consumption in India is approximately 50 kg/year<sup>11</sup>.

Impact of fortification on intake levels



Source: Fiedler et al, 2012

Impact of fortification on prevalence of ID and IDA



Source: Muthayya et al, 2012

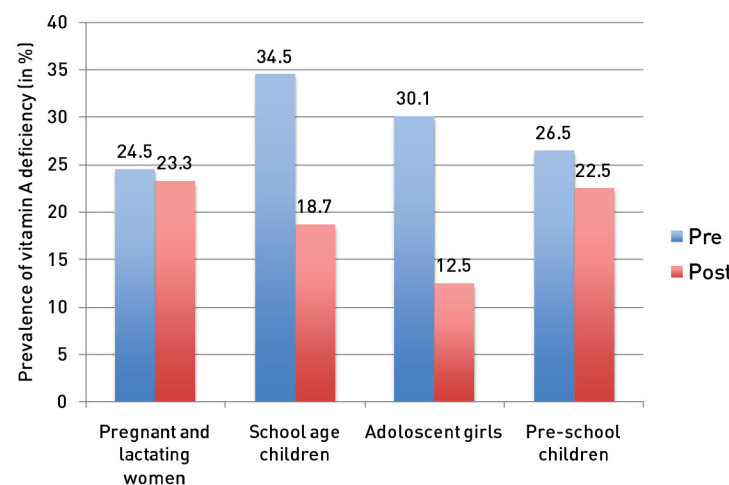
## Evidence

Consumption of fortified wheat flour especially with iron and B vitamins is found to be an ideal and cost-effective medium to supplement the diets of general population with essential nutrients. Wheat flour fortified with iron (NaFeEDTA) was found to be efficacious in reducing iron deficiency anaemia (IDA) and iron deficiency (ID) prevalence among school aged children in Bengaluru and Pune<sup>12</sup>. Gujarat's model provided evidence that multi-micronutrient deficiencies can be dealt with the provision of fortified wheat flour through the government's social safety-net schemes<sup>13</sup>.

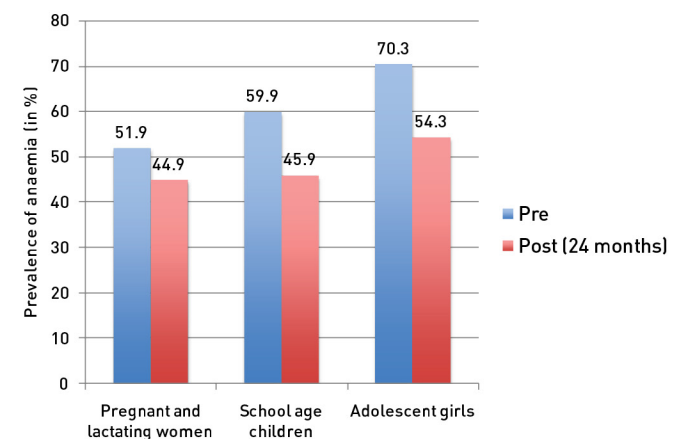
## Impact of wheat flour fortification in West Bengal

The Government of West Bengal undertook a pilot wheat flour fortification project in Darjeeling in 2000. It demonstrated significant reduction in anaemia and vitamin A deficiency at end of two years. The flour was fortified with iron, folic acid and vitamin A and was distributed to the population below poverty line through targeted PDS.

Impact of fortification on prevalence of vitamin A deficiency



Impact of fortification on prevalence of anaemia



<sup>11</sup>National Council of Applied Economic Research, 2014

<sup>12</sup>Muthayya et al., 2012

<sup>13</sup>Fiedler JL et al., 2012





“If India has to become a country of reckoning in near future, its population from now, has to have foods replete with nutrients to give positive push for growth and productive results. The most certain way to keep this going is through fortification of basic staple foods that cost a trifle compared to the huge costs to nation in its absence more so to reduce morbidity and inject positive health trends to its population. History of other nations is a pointer to this basic fact which we have skipped all throughout, to realize now. It is a humanity need more than spirituality.”-

Dr. SK Nanda, Former Additional Chief Secretary, Government of Gujarat (mandated wheat and oil fortification in the State in 2006).



## Programming

Voluntary wheat flour (aata/maida) fortification standards were notified in the 1970s. Many state governments like Rajasthan, Madhya Pradesh, West Bengal, Kerala, Gujarat, Tamil Nadu, Andaman and Nicobar Islands, Haryana and Jammu have experience in providing fortified wheat flour in the public health programmes or through market channels.



### States have used social safety net schemes as a medium to distribute fortified wheat flour

- Government of Delhi marketed about 15,000 MT of fortified wheat flour per month through 400 outlets under the “Bhagidaari” scheme from 2012-2014.
- Union territory of Chandigarh distributed around 1800 MT of fortified wheat flour through PDS in 2009.
- Punjab distributed approximately 40,000 MT of fortified wheat flour through PDS to all APL population in the state.
- Telangana Foods produce flour based fortified foods that are supplied to ICDS children in Telangana and Andhra Pradesh.
- In Haryana, the state government started the ‘panjiri’ fortification plant in 2016 which is catering to children from a number of neighbouring districts.
- In Gujarat, ‘Fortified Atta’ was launched in association with the Gujarat Roller Flour Miller Association and the Government of Gujarat, through which fortified atta was supplied through government channels.
- Rajasthan distributed about 75,000 MT of fortified wheat flour through PDS per month during 2012-13.

## Technology

In India, 80-85 percent of wheat is processed in the unorganized sector in the chakkis to make atta, whereas only 15-20 percent of the wheat is processed in the roller flour mills which produce white flour (maida), semolina and resultant atta. The technology of flour fortification in a roller flour mill is simple, available and quality control procedures are well established. India also has experience with chakki level fortification. The cost of fortification of wheat flour is around 5-8 paise per kg.

## Potential to scale

Gujarat introduced 604,000 MT of fortified wheat flour into their social safety net programmes in 2006, the sales of roller flour mills and chakkis increased by 43%. Fortified wheat flour distributed through existing government channels has a potential to contribute significantly towards reduction of anaemia; distribution of the fortified product in the open market as well can help to fight the vitamin and mineral deficiencies at a cost affordable by all.



“Multiple channels and strategies are required to address the problem of iron deficiency anaemia. The newer products such as double fortified salts, sprinklers, ultra rice and other micronutrient candidates or fortified candidates should be explored as an adjunct or alternate supplementation strategy” –

Union Ministry of Health and Family Welfare, 2007





# Fortifying Rice

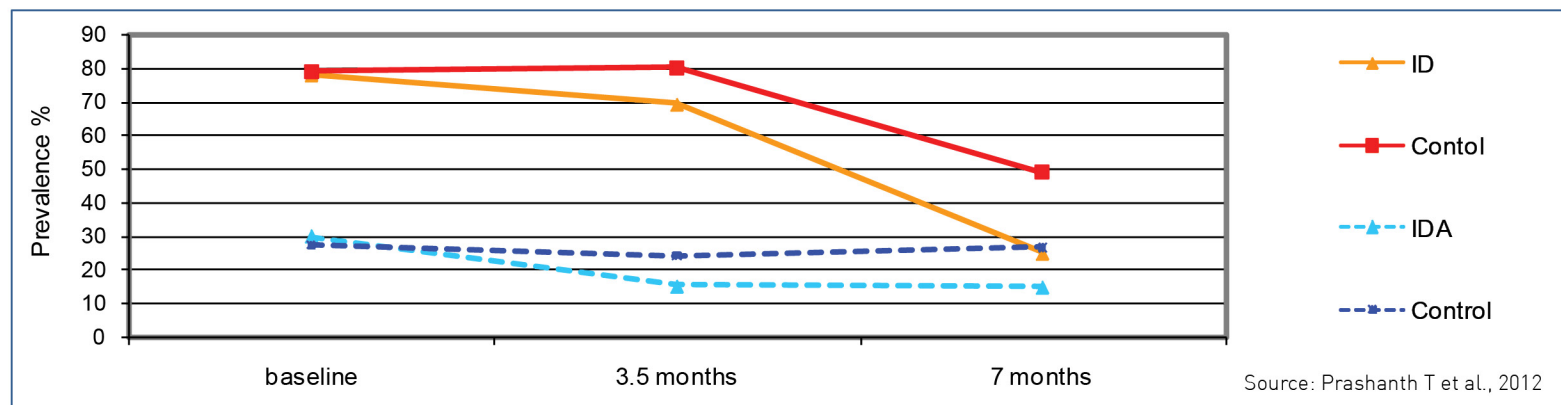


India is the world's second largest producer of rice, next to China, with a production of about 106.65 MMT. Rice is the staple food for two-thirds of Indians with consumption of approximately 95 MMT. The people of rice eating states consume 260 grams of rice per day. It meets 31 percent of the population's total energy intake and is source of income and employment to more than 100 million farming families in rural India.

## Evidence

A study among school children conducted by National Institute of Nutrition and Department of Biotechnology revealed a significant increase in mean serum ferritin (iron stores) levels (8.17 Hg/dL) after consumption of fortified rice<sup>14</sup>. A significant reduction in the incidence of morbidity among children was observed in the experimental group. St. John's National Academy of Health Sciences, Bengaluru also reported an increase in the haemoglobin concentrations of children consuming iron-fortified rice whereas there was no increase in the control group<sup>15</sup>. Community level projects in Andhra Pradesh, Rajasthan and Odisha have shown successful results.

Impact of rice fortification on prevalence of ID and IDA in children (6-13 years old)



<sup>14</sup>Radhika MS et al., 2011

<sup>15</sup>Prashanth T et al., 2012





“The Department of Biotechnology strongly supports innovation. In the field of nutrition, one of our efforts have been to build evidence around efficacy of extrusion technology to fortify rice. Our findings suggest that it is the most efficient method in a way that is viable for mass fortification and distribution. DBT is also working on developing indigenous extrusion technology. Fortified rice has the ability to reach the most vulnerable population and improve their nutritional status thereby combating malnutrition and improving health and productivity.”-

Dr. Rajesh Kapur, Department of Biotechnology.



## Programming

Successful examples of fortified rice distribution in centralized and decentralized kitchens of the midday meal schemes exist.

### A successful example from Vizag's centralised kitchen

In the central kitchen at Vizag, 61,000 children were fed fortified rice for more than a year in 2010-2011. The pilot was done to determine the technical and operational feasibility of integrating fortified rice in the midday meal scheme. The pilot was successful as fortified kernels were able to withstand Indian conditions of transport, cooking, usage with no change in taste, color, odour, homogeneity and nutrient composition. Shelf life was studied. Fortified rice was well accepted by the children. The pilot concluded that distribution of fortified rice through centralized kitchens could be easily integrated thereby making it feasible for large scale adaptation.

### A successful example from Odisha's decentralised kitchens

In the Gajapati district of Odisha, hot meals cooked using fortified rice were given to 97,790 school children in a decentralised model of the midday meal programme from December 2012. Endline evaluation in 2015 reported reduction of anaemia from 65 percent to 45 percent. Mean haemoglobin levels increased by 0.56 g/dl. It was also found that the acceptability of fortified rice was high as compared to the IFA tablets. The district has now taken up this initiative on its own.

## Technology

There are many technologies available to fortify rice. Extrusion technology is used in India made available by PATH and DSM. The Department of Biotechnology is also working towards developing an indigenous extrusion technology. The cost of fortification of rice is 30-80 paise/kg of rice.



## Potential to scale

Rice fortification is currently underutilized in India even though effectiveness has been clinically tested and operational feasibility has been well demonstrated in the safety net programmes and through open market channels. Rice fortification may be considered as having the highest potential to fill the gap in current staple food fortification programmes as it is the staple food of 65 percent of the Indian population and reaches the most vulnerable section - with the highest uptake in the government safety net programmes.



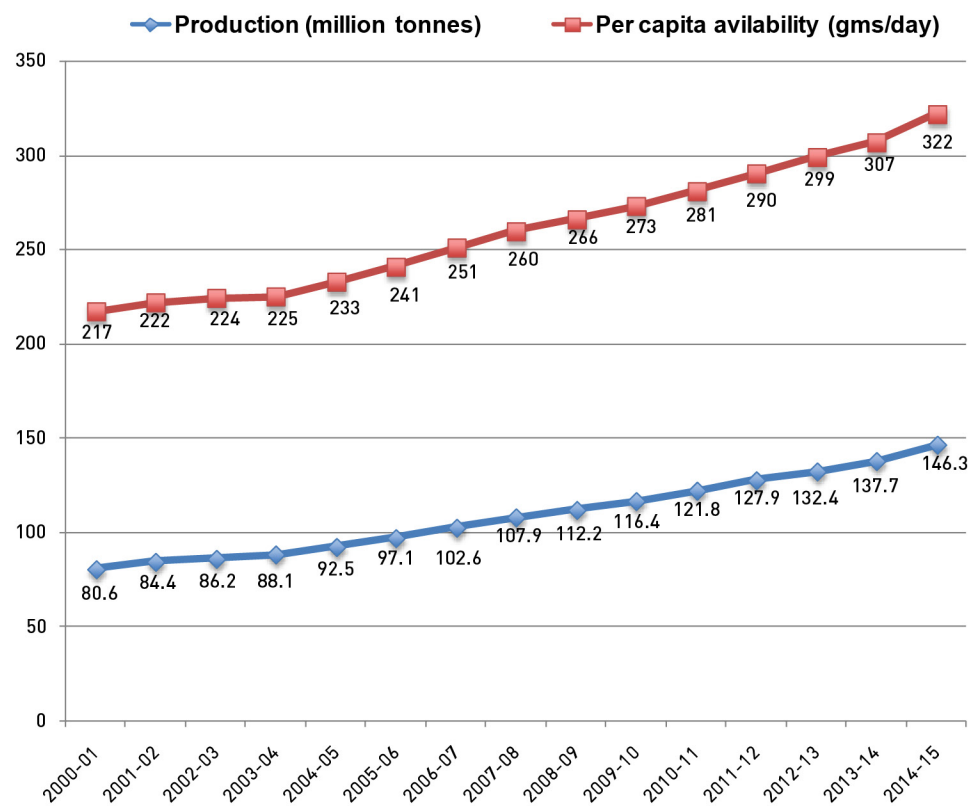




# Fortifying Milk

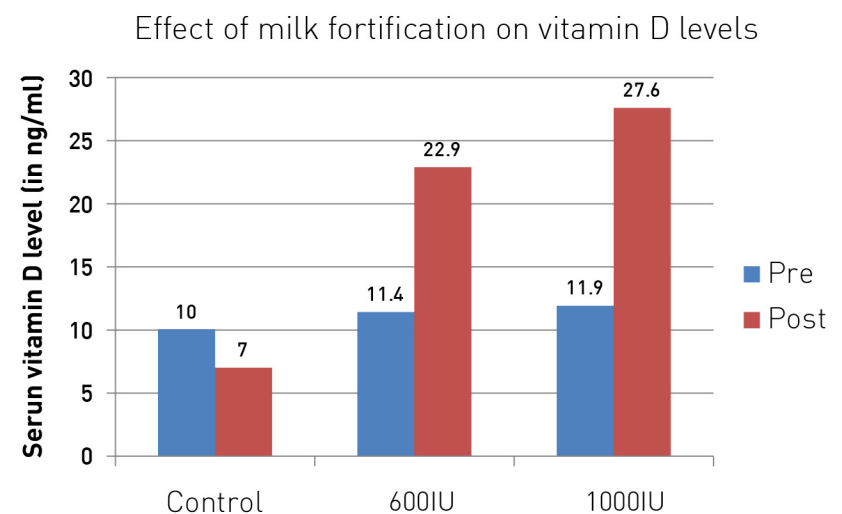
Milk is a rich source of high quality protein, calcium and of fat soluble vitamins A and D. Vitamins A and D are lost when milk fat is removed during processing. Many countries have a mandatory provision to add back the vitamins removed as it is easily doable. It is called replenishment as the nutrients lost during processing are added back.

India is the largest producer of milk in the world with 146.3 million tonnes of production and per capita availability of 322 grams per day<sup>16</sup>.



## Evidence

Consumption of fortified milk by children in India has shown encouraging results. Studies suggest that the intake not only increased mean serum vitamin D levels but also morbidity rates were decreased (18 percent lower incidence of diarrhoea, 26 percent lower incidence of pneumonia, 7 percent fewer days with high fever and 15 percent fewer days sick with severe illness). There is ample evidence from our country which shows that fortification of milk with vitamin A and D is an effective and safe strategy to reduce related deficiency diseases<sup>17,18</sup>.




<sup>16</sup>National Dairy Development Board, 2016

<sup>17</sup>Sazawal et al., 2007

<sup>18</sup>Khadgawat et al., 2013





“For over three decades, Mother Dairy is committed to nourish its Indian population by providing them with vitamin A and vitamin D fortified milk at highly competitive prices. We proudly say that we take this as our social responsibility and bear the cost of fortification without any financial assistance from the government.”

Nagarajan Siva Ramakrishnana, Managing Director, Mother Dairy



## Programming

During 1980s, the Department of Food, Government of India introduced a scheme of fortifying milk with vitamin A at 2000IU/L for toned/double toned milk to prevent nutrition blindness<sup>19</sup>. The government reimbursed the cost of vitamin A premix to the dairies for fortifying milk for three years, after which the dairies were asked to reabsorb the cost. The total quantity of milk fortified with vitamin A during 1988-89 was 3.2 million litres per day. Even today, Mother Dairy continues to fortify its 9 lakh litres of bulk vended milk (BVM) every day. Rajasthan Cooperative Dairy Federation started fortifying milk in the year 2013 with vitamin A and D and has demonstrated a successful model of providing these essential vitamins to millions of people in Rajasthan.

## Technology

The technology to fortify milk is simple, well-established, available and the cost of fortification is low. Vitamin A and D premixes are widely available in India and cost of fortification is mere 2-4 paise for fortification/ litre of milk.

## Potential to Scale

The dairy industry in India has progressed from a situation of scarcity to that of plenty. The potential of fortified milk to reach masses is tremendous as per capita production is projected to increase to more than 350 ml/day by 2020. Considering that the organised sector processing accounts for around 20 percent of the total milk production, there is potential to produce 29.3 million tonnes of fortified milk per annum.

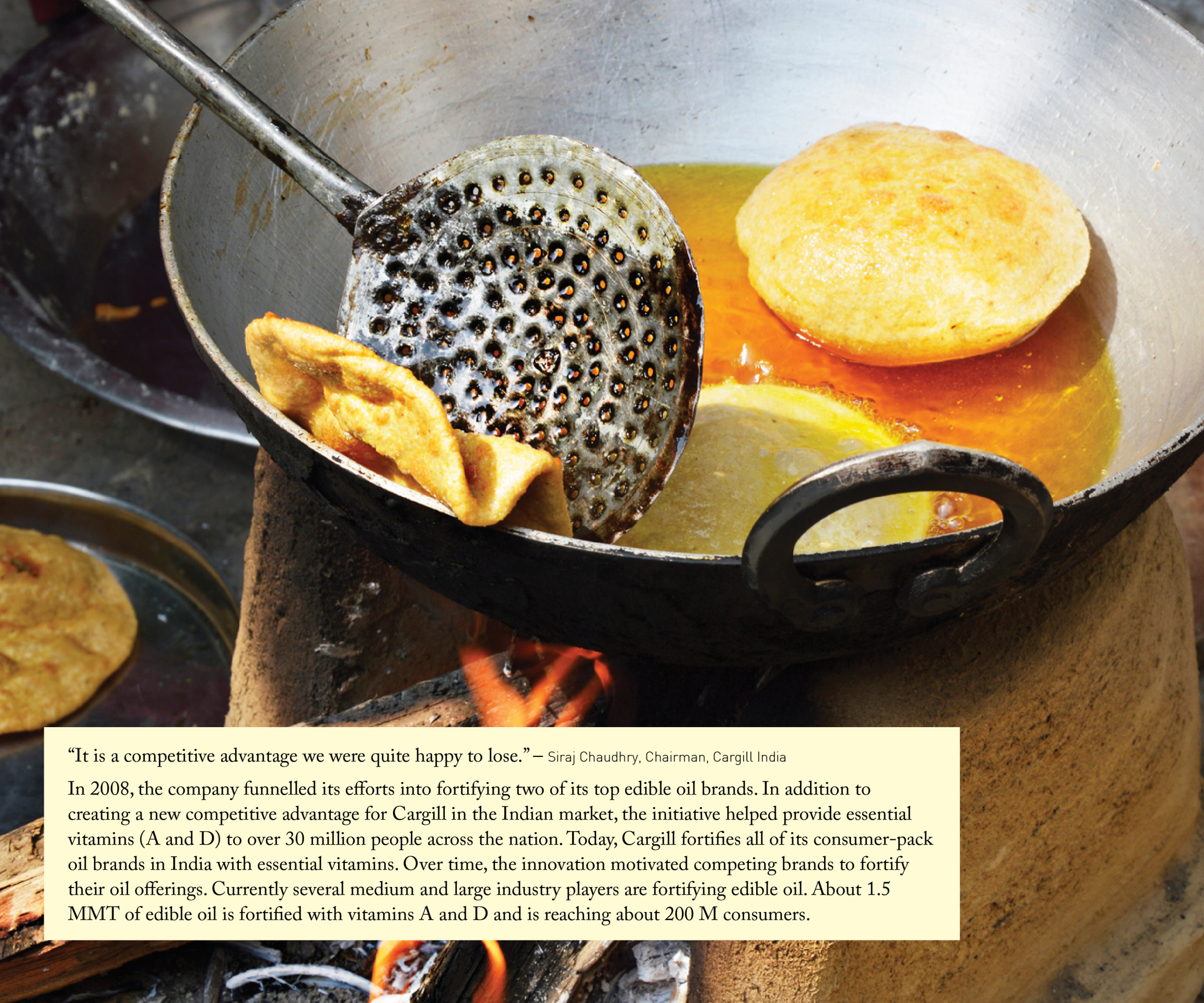
The Task Force on Micronutrients (iron and vitamin A) organized by Department of Biotechnology and National Institute of Nutrition in 2007 recommended that “all toned and double toned milk should be fortified with vitamin A so as to replace the amount of vitamin A lost during the process of toning.”



<sup>19</sup>Government of India notification. Milk Fortification with Vitamin A, 1984







“It is a competitive advantage we were quite happy to lose.” – Siraj Chaudhry, Chairman, Cargill India

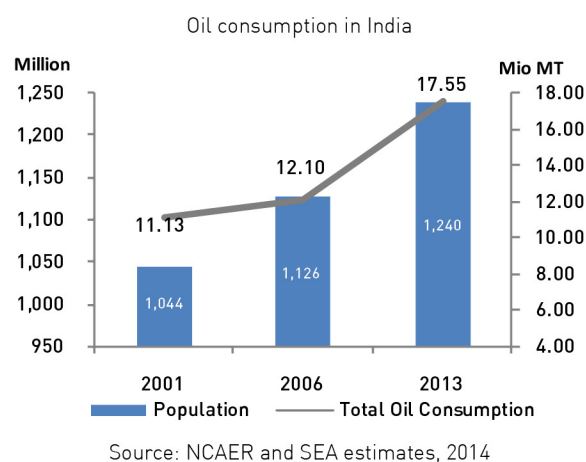
In 2008, the company funnelled its efforts into fortifying two of its top edible oil brands. In addition to creating a new competitive advantage for Cargill in the Indian market, the initiative helped provide essential vitamins (A and D) to over 30 million people across the nation. Today, Cargill fortifies all of its consumer-pack oil brands in India with essential vitamins. Over time, the innovation motivated competing brands to fortify their oil offerings. Currently several medium and large industry players are fortifying edible oil. About 1.5 MMT of edible oil is fortified with vitamins A and D and is reaching about 200 M consumers.



# Fortifying Oil



Edible oil is consumed by almost everyone. The edible oil industry in India is booming as per capita consumption has increased from 4 kilograms to 7.7 kilograms per year in rural areas and from 6.6 to 10 kilograms in urban households from 1987-88 to 2009-2010<sup>11</sup>.



Edible oil has almost 99% penetration in Indian households thus, making it a potent vehicle for fortification with fat soluble vitamin A and vitamin D.

Stability of vitamin A in soyabean oil during cooking

Food	Type of cooking	Amount of vitamin A		Recovery (%)
		Before cooking	After cooking	
White rice	Boiled	330	300	100
Kidney beans	Boiled	180	150	83
Kidney beans	Pressure cooked	120	120	100

## Evidence

Fortification of edible oil with vitamin A and D is technically feasible, well proven, and established in India. 70-88 percent of vitamin A was recovered even after 30 days from open pails exposed to light and air at the Indian ports. During Indian cooking as well the levels have been found to be stable. When oil was added to mixture of rice, beans and pulses for Indian feeding programs, around 93 percent of vitamin A was retained after 15 minutes and 90 percent after 30 minutes of cooking<sup>20</sup>. Even with deep frying pakoras in vanaspati at 200° C, retention ranged from 71% after 5 minutes, to 41% after 15 minutes<sup>21</sup>. The stability of vitamin D is found to be similar to that of vitamin A as little or no loss is reported during processing or storage<sup>22</sup>.

<sup>20</sup>Atwood et al., 1995

<sup>21</sup>Gopal and Ketyum, 1956

<sup>22</sup>OMNI, 2005







## Programming

Fortification of vanaspati with vitamin A has been obligatory in India since 1953. There is a government notification stating that no oil will be sold loose in the market, which is an advantage for the sale of packaged fortified oil. Government of Gujarat has made oil fortification mandatory in the state since 2006. Successful models of fortification of cooking oil products with vitamin A and D already exist and are operating in the Indian market.

## Technology

The technology of fortification is simple and easily achievable by producers. As these are fat-soluble vitamins, they permit easy and cost-effective addition without the need for elaborate equipment and can be uniformly distributed in oil<sup>23</sup>. Dosing technology for adding anti-oxidants and other micro ingredients to oil is routine<sup>24</sup>. While for many oils a temperature of 40-50° C is required to assure uniform mixing, the threshold to ensure uniform liquid state for soybean oil is less than about 25° C. Producers generally report minimal adjustments to add vitamin A, D, E. Since other additives are often used, personnel and technology are already in place<sup>25</sup>. The additional cost due to fortification is 7 paise per litre of oil with vitamin A and D.

## Potential to Scale

The edible oil industry is growing at a compounded annual growth rate of 5.44%. In 2014-15, the availability of edible oils in India was 21.7 million tonnes<sup>26</sup>. The demand for edible oils is projected (projections for 2020) to rise between 22.8 and 29.4 million tonnes in the near future in tandem with the average per capita income growing at 4-6%<sup>11</sup>. Over 60 percent of the market share of edible oil in the country comes from the organised sector. Large quantities of oil is purchased and used in the government financed food supplementation schemes like the Midday Meal and the Integrated Child Development Services Scheme. The vast network of PDS is paving way for fortified oil being readily available at the door step of the poorest segment of the population.

### Fortification of cooking oil is a win-win for consumers and the industry

Asha Soni hails from Indore, she works with a packaging unit of a leading manufacturer of soyabean oil in Madhya Pradesh. She says “For me, working in this industry has been a win-win. Not only do I earn a stable income that enables me to adequately provide for my family of eight but more significantly I am now aware of an affordable way to keep them in good health.”



<sup>23</sup>Greig, 2002

<sup>24</sup>Nagy, 1995

<sup>25</sup>Bagrianskyand Ranum, 1998

<sup>26</sup>DFPD, 2015



# Fortification is the future

Vitamin and mineral deficiencies are widespread in India, and affect all sections of the population across states and socio economic groups. The impact extends beyond considerations of only health. Food fortification is a proven and cost-effective strategy and has helped the West to eliminate vitamin and mineral deficiencies. However, food fortification is a grossly underutilized strategy in India. The potential is huge. Setting standards for fortification of by the Government of India and FSSAI is an essential step in the right direction. This will saves lives and help children to grow to their true intellectual potential. We know what to do, whom to target and how to do it.

“Fortification is not new to India; it has existed in the country for a very long time. We have evidence which tells us that fortification of staple foods is safe, efficacious, cost-efficient, easy to implement and can reach the most vulnerable. The strategy is an attractive option for reducing the health care costs related to nutritional disorders. It is time to fast track our progress and move in a direction where fortified food is available and easy to access by all.” – Dr. Soumya Swaminathan, Director General, ICMR



“Micronutrient deficiencies are our hidden enemies. Some of these nutrients (e.g .,vitamin D) do not occur in natural foods. In a country like India, where much of the urban population is seriously deficient in vitamin D, milk and oil fortification is a simple and easy method to combat this problem. Fortification is an idea whose time has come- the sooner we adopt it, the better it is for our people.”– Dr. Ambrish Mithal, Padma Bhushan recipient, Chairperson, Division of Endocrinology and Diabetes, Medanta



*We would like to thank PATH and TATA TRUSTS for their technical support in developing this handbook. We extend our gratitude to POSHTIK Network for sharing their experience on fortification.*  
*Photo credits: PATH, GAIN*



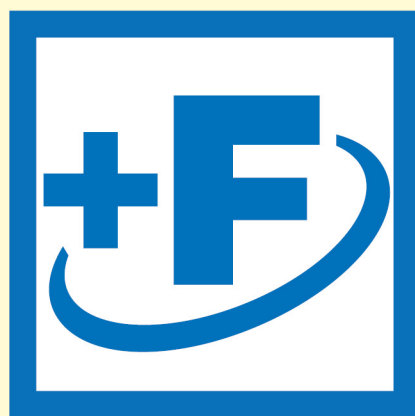
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**SAMPOORNA POSHAN  
SWASTH JEEVAN**



**FOOD SAFETY AND STANDARDS  
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