

## Case Study

# Food fortification as a complementary strategy for the elimination of micronutrient deficiencies: case studies of large scale food fortification in two Indian States

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The burden of micronutrient malnutrition is very high in India. Food fortification is one of the most cost-effective and sustainable strategies to deliver micronutrients to large population groups. Global Alliance for Improved Nutrition (GAIN) is supporting large-scale, voluntary, staple food fortification in Rajasthan and Madhya Pradesh because of the high burden of malnutrition, availability of industries capable of and willing to introduce fortified staples, consumption patterns of target foods and a conducive and enabling environment. High extraction wheat flour from roller flour mills, edible soybean oil and milk from dairy cooperatives were chosen as the vehicles for fortification. Micronutrients and levels of fortification were selected based on vehicle characteristics and consumption levels. Industry recruitment was done after a careful assessment of capability and willingness. Production units were equipped with necessary equipment for fortification. Staffs were trained in fortification and quality control. Social marketing and communication activities were carried out as per the strategy developed. A state food fortification alliance was formed in Madhya Pradesh with all relevant stakeholders. Over 260,000 MT of edible oil, 300,000 MT of wheat flour and 500,000 MT of milk are being fortified annually and marketed. Rajasthan is also distributing 840,000 MT of fortified wheat flour annually through its Public Distribution System and 1.1 million fortified Mid-day meals daily through the centralised kitchens. Concurrent monitoring in Rajasthan and Madhya has demonstrated high compliance with all quality standards in fortified foods.

**Key Words:** micronutrient malnutrition, staple food fortification, India

## INTRODUCTION

Food fortification is one of the most cost-effective and sustainable strategies to deliver micronutrients to large populations.<sup>1</sup> In many situations however, a combination of different, complementary strategies may be needed. Combining behaviour change communication to diversify diets with provision of supplements to some vulnerable age groups such as pregnant women and small children form a good complement to staple food fortification. Together these strategies have contributed significantly to the elimination of several nutritional disorders in industrialised countries. However, addressing micronutrient deficiencies through large scale food fortification poses certain challenges in developing countries. This paper presents the experiences of Global Alliance for Improved Nutrition (GAIN) and its partners in introducing staple food fortification in two states of India and focuses on demonstrating the feasibility of such an intervention. This paper highlights the key activities needed to implement large scale food fortification programs, the challenges associated with food fortification, the feasibility of scaling up staple food fortification through commercial channels on a voluntary basis and the potential of introducing fortified foods through public funded programs. The assistance from GAIN is towards technical and limited financial support for capacity building for production, quality assurance and quality control, awareness generation

and monitoring and evaluation of staple food fortification and related activities. Project support from GAIN will conclude in December 2015.

## FOOD FORTIFICATION APPROACH

The approach to introduce fortified products is based on the Program Feasibility Assessment and Design as outlined in the Program Cycle approach<sup>2</sup> (GAIN Working Paper Series no. 4). It includes:

- Selection of micronutrients for fortification,
- Selection of food vehicles for fortification,
- Deciding on the levels of fortification, and
- Selection of delivery channels.

### *Selection of micronutrients for fortification*

The burden of micronutrient deficiencies in India is high. Iron, vitamin A and iodine deficiency disorders are particularly high.<sup>3</sup> The National Family Health Survey - 3 (NFHS-3) report shows that seventy percent of children aged 6-59 months are anaemic. Also, 55% percent of

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women and 24 percent of men were found to be anaemic. Although there are state differences, high prevalence of anaemia is found in every state. In addition, the intake of the foods rich in essential nutrients is low. India has a national program that provides vitamin A supplementation (200,000 IU every six months) to children 12-59 months through the Integrated Child Services program (ICDS). NFHS-3 reports that the coverage is low, with just one-quarter of children below 5 years receiving vitamin A supplements in the six months before the survey. Coverage of iron supplementation is also extremely low with just about 5% of 6-59 month old children receiving an iron supplement from ICDS as per the NFHS-3 report.

The Technical Reports (23 and 26) of National Nutrition Monitoring Bureau (NNMB)<sup>4</sup> and the Consumer Expenditure Survey conducted by the National Sample Survey Organization (NSSO)<sup>5</sup> on food intake showed that the median intake of vitamin A was grossly deficient as compared to the Recommended Daily Allowance (RDA) in all the 10 states and the proportion of households consuming <50% of RDA ranged from 75-86%. Also, the median intake of dietary folate was much lower than the RDA and the proportion of households consuming >50% RDA of dietary folate was just about 17%- 25%. Several recent studies have highlighted the existence of widespread Vitamin D deficiency (about 80%) among the overall population at all ages and in both sexes, residing both in rural and urban India.<sup>6-8</sup>

Two Indian States - Rajasthan and MP - were selected for implementation of this project, based on widespread micronutrient deficiencies in these states. The key health and nutrition indicators in these two States and their comparison with the national average are given in Table 1. As can be seen, all the indicators of women and child nutrition in these two states compare poorly with the national average.

### **Selection of food vehicles for fortification**

The selection of food vehicles for fortification was based on the consumption pattern of staple foods that lend themselves to fortification, ease of fortification, incremental costs of fortification and the capacity and the willingness of the food industry to initiate fortification.

As per the 66<sup>th</sup> Round of Household Consumer Expenditure Survey Report, 2011,<sup>9</sup> Rajasthan and MP have a fairly high consumption of wheat across population groups. The per capita consumption of wheat, oil and milk is higher than the national average in Madhya Pradesh (MP) and Rajasthan as shown in Table 2. The per capita expenditure on milk and milk products in these two states is relatively high and penetration of edible oil is almost universal. The survey also showed that the expenditure on fruits, vegetables and eggs, fish and meat,

which are the major sources of micronutrients, is quite low in both states. High levels of consumption of wheat and near universal penetration of edible oil and wheat helped select these food vehicles for fortification. Milk fortification would have limited geographical reach, but was still pursued as it requires little additional effort.

A quick survey of the wheat, oil and milk industry revealed that the two States have a large industry of wheat, oil and milk. (Table 2) Legal provisions exist for fortification of wheat flour, oil and milk, although these are not mandatory.

The cost of fortification of these commodities is nominal. The additional cost due to fortification works out to approximately INR 0.05 per kg/wheat flour which costs around INR 15 (0.3% of the cost of wheat flour), INR 0.07 per kg/ oil which costs around INR 70 (0.1% of the cost of oil) and INR 0.02 per litre /milk costing around INR 30 (0.06% of the cost of milk).

The food industry in both states showed interest in fortification and was one of the key factors in the selection of states for the project. In addition, to widen the professional networks and the partnerships and also to review the progress of the ongoing projects and to identify critical determinants of success and failures, State Food Fortification Alliances were formed, which include representatives from the government, civil society organisations, private sector and the academia.

Wheat flour fortification targeted only the organised sector, the Roller Flour Mills (RFM) and large stone-grinding mills, chakkis. These are estimated to handle about 25 to 30% of the total wheat milled. Although the major product from these mills is low extraction flour called maida, about 25 to 30% of the output is in the form of high extraction flour, which is sold as packaged "Atta". A small pilot project is also underway in Rajasthan that supports flour fortification (Atta) through small chakkis (local mills in the unorganized sector). Since it is in the initial phase, it is not included in this paper.

MP and Rajasthan are two major oil producing states in India. Over 60% of the market share of edible oil in the country comes from the organised sector.<sup>10</sup> The oil industry is more concentrated than wheat and the oil industry is also more sophisticated compared to wheat milling. Hence, from a fortification standpoint, the edible oil sector is easier to work with than the wheat sector.

Consumption of milk and milk products is universal among all population groups as well as age groups, though only 15% of the total milk production in the country comes from the organised sector, mainly from the Dairy Cooperatives. This constitutes 30% of the marketable surplus<sup>11</sup> and it mostly caters to the milk requirement in the urban and peri-urban areas.

**Table 1.** Nutritional status indicators in MP and Rajasthan and comparison with the average for India

States (NFHS 3)	Under-five Stunting (%)	Under-five Wasting (%)	Low Birth Weight (%)	Chronic Energy Deficiency in women of reproductive age (%)	Under-five Anemia (%)	Anemia WRA (%)
Madhya Pradesh	25	30	21	27	29	20
Rajasthan	15	24	27	23	21	15
India	23	23	16	18	19	18

**Table 2.** Fortifiable vehicle consumption and industry assessment in MP and Rajasthan

	Madhya Pradesh	Rajasthan	India
Fortifiable food vehicle			
Wheat (g/day)	200 g	250	160 g
Oil (g/day)	20 g	20	14
Milk (availability) (g/day)	287 g	538 ml	281 g
Estimated number of wheat mills in the organized sector	28	42	1150
Estimated annual milling capacity	3.8 million MT (30% atta* high-extraction flour)	1.2 million MT (30% atta)	12-15 MMT
Oilseed production (9 oil seeds)	5.8 MMT (24%)	5.1 MMT (21%)	24.731 MMT
Milk dairies	9	23	Over 400
Milk production in liters/day	0.6 million	1.7 million	127900 million

### **Deciding on the levels of fortification**

The Guidelines on Food Fortification with micronutrients by the WHO and FAO of 2006<sup>12</sup> and the WHO Recommendations on Wheat and Maize Flour Fortification, Meeting Report: Interim Consensus Report of 2009,<sup>13</sup> largely formed the basis for deciding on the compounds and levels of fortification. This was further modified based on other considerations like costs, industry acceptability and willingness. The concentration and the compounds used in the project in the two states are given in Table 3. The fortificants used for wheat flour fortification are different in Rajasthan and Madhya Pradesh, because the wheat flour in Madhya Pradesh absorbs more moisture and FeSO<sub>4</sub> (Ferrous Sulphate) as a fortifying compound was leading to discoloration. In addition, considering high levels of vitamin A deficiency in Madhya Pradesh, vitamin A was included as one of the fortificants in addition to iron, folic acid and vitamin B-12.

### **Selection of delivery channels**

In India, there are two major delivery channels for staple foods, the commercial channel and the government-supported public distribution system (PDS). The Public

Distribution System (PDS) sells cereals to populations below the poverty line in fixed quantities and at highly subsidised rates. Some States also provide edible oil through the PDS at subsidised prices, when the market prices go steep or when the demand for edible oil goes up during special occasions like festivals. Two other programs provide supplemental food: the Integrated Child Development Services (ICDS) program caters to children below 6 years, pregnant and lactating women and the Mid-day Meal (MDM) program provides supplemental food to primary school children. Voluntary fortification through commercial channels was selected in both the states while in Rajasthan, support was also provided for fortification through MDM and ICDS. PDS was involved in distributing fortified wheat flour in Rajasthan.

### **ACHIEVEMENTS**

In both states all the food processing units partnering in the project were upgraded to enable fortification. The mill staffs were trained on appropriate fortification processes and quality control protocols. State specific “communication strategies” were developed by experts and based on these, effective community awareness campaigns and advocacy campaigns for the key stakeholders were undertaken, as a part of the project.

**Table 3.** Levels of fortification and compounds used

Compounds	Levels
Fortification level in Madhya Pradesh for wheat flour	
Iron (as NaFeEDTA)	5 ppm
Iron (as Electrolytic iron)	50 ppm
Folic Acid (as folic acid)	1.3 ppm
Vitamin B-12 (as Cyanocobalamin)	0.01 ppm
Vitamin A (as Vitamin A palmitate)	1.5 ppm
Fortification levels in Rajasthan for wheat flour	
Iron (as Ferrous sulfate)	30 ppm
Folic Acid (as Folic acid)	1.3 ppm
Vitamin B-12 (as Cyanocobalamin)	0.01 ppm
Oil Fortification in Rajasthan and Madhya Pradesh:	
Vitamin A (as Retinyl palmitate)	25,000 IU/kg of
Vitamin D-2	2,000 IU/kg of oil
Milk Fortification in Rajasthan	
Vitamin A (as Retinyl acetate, water miscible)	2000 IU/L of milk
Vitamin D-2	400 IU/L of milk

### **Madhya Pradesh**

Wheat flour fortification in MP started in November 2011 with participation from two roller flour mills. By 2013, twenty millers were fortifying the atta (high extraction flour) from their roller flour mills. On average 14,000 MT of fortified wheat flour is produced every month. As per the ‘Consumer Expenditure Survey, 66<sup>th</sup> Round’ of Government of India, per capita consumption of wheat in MP is 200 grams per day. Hence with the current production of 16,000 MT of fortified wheat flour produced within the state, about 2.7 million persons are benefiting.

The Edible oil fortification project was launched in MP in February 2013. MP produces about half of the total quantity of soybeans grown in the country (1.2 million Metric Tons in 2011-12). Refined soybean oil is the preferred and most commonly used cooking oil in MP and has 78% of the oil volume share in rural and 63% in urban MP.<sup>14</sup>

Fifteen oil refiners are currently participating in the project and about 15,000 MT of oil is fortified with vitamin A and D-2. In the next few months, the total quantity

fortified will go up to 25,000 MT per month. Per capita annual consumption of oil is about 7.3 kg and the project will reach approximately 41 million persons with fortified soybean oil. In MP fortified soybean oil is available in 750 towns and 73% of the branded soya bean oil is fortified.

### **Rajasthan**

Wheat flour fortification in Rajasthan started in February 2012. About 30 millers have been fortifying the atta (high extraction flour) from their roller flour mills. In Rajasthan, the government also introduced fortified wheat flour through the Public Distribution System, supplying fortified wheat flour to people at a subsidized price, thus reaching the economically weaker sections.

An average of 78,000 MT wheat flour is being fortified per month. With an estimated consumption of 250 g of wheat flour per day (based on the 'Level and Pattern of Consumer Expenditure Survey, 66th Round' of Government of India), the fortified flour is currently reaching about 11.2 million persons. This covers people reached through the commercial market channels as well as people reached through the government supported Public Distribution System.

Edible oil fortification in Rajasthan started in November 2012. Currently, five production units in the state are fortifying edible oil (Soybean and mustard) with vitamins A and D. Currently about 10,000 MT of oil is fortified every month and this is expected to go up to 18,000 MT in the next few months, reaching about 25 million people.

Milk fortification in Rajasthan started in June 2013. Currently, twenty one dairy cooperatives in Rajasthan are fortifying low-fat milk with vitamins A and D. The total average amount of milk fortified per month is about 48 million litres, reaching 8 million persons at an average consumption of 200 ml per person per day.

The cost of the fortified foods on account of fortification has not increased since the capital investment and premix costs have been borne by GAIN. The premix support is provided on a sliding scale such that the entire premix cost will be borne by the manufacturer by the end of 3 years.

Social marketing and communication is one of the key components and central aspects of the project. The focus has been on creating public awareness of the importance of good nutrition, micronutrient malnutrition and strategies available to address these. Print, radio and electronic media are used to communicate the messages on benefits of fortification and to inform the population about the availability of fortified foods. Point-of-sale promotion of fortified foods has been the focus for the industry-led promotion. Various activities to engage with key stakeholders to ensure sustainability and scaling-up of food fortification have been well received. The industry has launched their product promotion with emphasis on added vitamins and minerals as true value addition. This has led to about 16-20% increase in sales. It is therefore hoped that fortification becomes the industry norm and is sustained.

Advocacy efforts by the project team led to the formation of a State Food Fortification Alliance (SFFA) which is advocating and encouraging fortification and

thus creating an enabling environment for fortification of staple foods like oil, wheat flour, rice that can be mainstreamed into the public funded programs. In addition, SFFA would also work towards promoting fortification of other foods that are marketed through the commercial, open market channels and are commonly consumed by all, such as bread, biscuits, noodles, pasta, and other bakery products.

The project is also working with the Food Safety and Standards Authority of India and the National Institute of Nutrition to create a positive and enabling environment that would encourage and promote legislation on mandatory fortification of both refined edible oils and milk with vitamins A and D.

A consumption survey is underway to assess the reach and the consumption of fortifiable food vehicles, the results of which would provide information to the industry and encourage it to expand the portfolio of foods to be fortified.

The quality of fortification and their vehicles is ensured through internal and external quality control measures. Internal quality control is implemented through strict adherence to standard operating procedures and further validated through simple laboratory tests at the production level. In addition, as per Quality Assurance and Quality Control (QAQC) protocols, an independent, quantitative evaluation of fortified food samples from each partnering food processing industry is carried out in both the states by external laboratories. The compliance has been encouraging, with almost 80% of the wheat flour samples and 100% of oil and milk samples conforming to the label claim.

A concurrent monitoring study by the Indian Institute of Health Management Research, Jaipur from January to March 2013 studied all the four components of the project viz. production, distribution and supply; quality control; monitoring and evaluation; and social marketing and communication activities. (Personal communication)

Production units for all fortified food vehicles (wheat flour, oil, milk) were studied and the monitoring of social marketing and communication activities covered wholesalers, retailers and consumers. The monitoring included a sample of 13 flour mills, 4 oil mills, 1 milk-producing unit, 557 wholesalers and retailers and 1741 consumers spread across 18 districts in Rajasthan. The technical compliance of the fortification process with respect to process and quality assurance was as per the defined standards in most in the production units, with minor deviations, many of them pertaining to the placement of equipment. In only two wheat flour mills, sub-optimal fortification was observed. The premix supply was found to be regular and uninterrupted, with just four production units (wheat flour mills) reporting shortage of premix at least once during the reference period. This was however made good by transferring the premix from the central storage depot. The quality assurance and control systems were largely in place and all QAQC protocols were being adhered to. However, in four flour mills, iron test kits were not available for the spot-testing of the presence of iron in the product. The external quality monitoring by the designated independent lab was very regular and sufficient at all the production units. Social marketing and

communication activities were found to be in place as reported in the management information system. High levels of awareness were observed among wholesalers, dealers and retailers.

Refresher trainings were organized for all producers for ensuring proper fortification.

## DISCUSSION

Food fortification is considered a cost-effective and sustainable strategy for the prevention and control of micronutrient deficiencies.<sup>15-21</sup> The focus of this paper is on demonstrating operational and technical feasibility of staple food fortification in a developing country setting. One of the major challenges for staple food fortification in countries like India is the way staple foods are produced, processed, procured and consumed. Lack of industrial concentration and large segments of the population being outside the reach of commercial markets are the major challenges for food fortification. In the absence of a mandatory provision and low levels of awareness on the benefits of fortification, non-fortified food has a cost advantage.

### *Industry structure*

In the wheat milling industry, the Indian market is largely dominated by innumerable local flour mills (chakkis), but these neighborhood chakkis are now facing competition from the organized sector with branded products in the market. Packaged atta in India has a low market share, but is steadily rising. However, increasing urbanization, income levels and education levels are driving a gradual shift towards packaged foods.<sup>22</sup> The same is the case with milk, with the share of the organised industry expected to rise rapidly, especially in urban regions. Wheat flour that is produced in roller flour mills comprises around 30% of the flour produced and is generally sold in consumer packs. This is sold through organised retail channels and is likely to be consumed by the middle class as well as higher income groups that access such shops. While this may not reach the poorest of the poor, it still remains a good strategy and a good vehicle for fortification as micronutrient deficiencies are not limited only to those belonging to the poor households as shown by NFHS 3. Sixty-three percent of children under five and 56% of children in the wealthiest households have anaemia. Forty-six percent of women from the wealthiest households have anaemia. Therefore fortified foods would be beneficial to all who can access them. Also, these roller flour mills produce refined flour (low extraction flour) that is used in the bakery industry. Penetration of bakery products in India is nearly universal. Fortification of this low extraction maida (refined flour) is being discussed with the industry and once achieved, there is potential to reach much larger numbers of people, through over 60,000 bakeries, and 20,000 traditional and local food manufacturing units.

Fortification of the high extraction wheat flour in India is a not a new idea. It is recommended in many policy documents in the country as a complementary strategy to be followed for the control and prevention of iron deficiency. In the state of West Bengal, fortified wheat flour was distributed through the public distribution system in

Darjeeling sub-division, commencing in the year 2000. This paved the way for expansion of wheat flour fortification in many other states and also expansion to other parts of West Bengal. It is estimated that 2.2 million metric tons of wheat flour is fortified every year in India in the States of Delhi, Rajasthan, Madhya Pradesh, Andhra Pradesh, Kerala, and West Bengal together.

In India, the government has mandated fortification of only two food items: salt with iodine and hydrogenated fats with vitamin A. For voluntary fortification, one of the main challenges is the cost difference between fortified and non-fortified products and the consumers' willingness to pay for the increased cost due to fortification. This is particularly challenging in countries with a large proportion of poor people, who tend to choose the lowest-cost product.

Staples like wheat flour and oil, which are mainly marketed through commercial channels, and the food industry play on large volumes and very low profit margins. Fortification of foods has its incremental costs, however marginal these may be, and when food fortification is not mandatory, there is no level playing field, and hence this would not be attractive to the industry. However, in the current projects the initial support to the industry led to the availability of fortified staples in the market. Sustained marketing campaigning and advocacy is helping in increasing awareness on benefits of fortified staples to tackle malnutrition. This has led to rapid scale up due to increased demand from the wholesalers and retailers to place fortified staples at their shelves. Industry partners have observed an increase in sales and feel good about their contribution to improving the nutritional status of the masses. All this would aid in fortified staples becoming the industry norm as the project ends.

Another concern commonly associated with fortification is the degree of loss of nutrients during cooking. There is enough evidence to show that cooking losses by following Indian cooking practices is minimal in fortified staple foods. The stability of vitamin A is greater in oils than in any other food and oil facilitates the absorption of vitamin A by the body.<sup>23</sup> Cooking losses range from 5% during boiling or simmering to 20% when the food is fried.<sup>24,25</sup> Favaro et al. found 99% retention of vitamin A when oil was added to rice and cooked for 15 minutes and 83% retention of vitamin A in beans boiled for 90 minutes.<sup>24,25</sup> The stability of vitamin A in oil, stored in sealed containers is excellent.<sup>25</sup> In sealed and opaque containers that protect vitamin A and oil from light and air, losses of vitamin A have been found to be negligible for up to a year. The same authors found almost no loss through 9 months in sealed containers at 23°C. They also measured the stability in open cans stored in the dark as well as exposed to light for 10 hours a day. After 30 days, 92% of the vitamin A could be recovered from cans left in the dark and 83% from the cans exposed to light. Losses are estimated at 5% during shipping and 10% during open storage in the field.<sup>25</sup> Atwood et al.<sup>26</sup> found that an average of 98% vitamin A survived shipment to Indian ports and inland distribution points in sealed containers. They reported recovering an average of 70-88% of the original vitamin A after 30 days from open pails exposed

to light, air and temperature of up to 35° C. The stability of vitamin D-3 is similar to that of vitamin A, with little or no loss experienced during processing or storage.<sup>27</sup>

The middle and lower-middle class Indian consumers form the largest segment that buys local brands of staple foods from the retail market. In this segment, there is very low awareness about the scale and consequences of micronutrient malnutrition and hence poor demand for fortified products. This consumer category is not yet very discerning with respect to value addition as is the case with food fortification. The price of a food commodity is the major consideration for this consumer segment and hence “pricing” becomes the major challenge faced by the food industry in undertaking “voluntary” fortification of staple foods, which operates on thin margins due to high competition. Demand generation campaigns are therefore important to create consumer awareness about the “added nutritional advantages” of consuming the fortified foods. This would lead to increased demand, and consequently an increased sale of the fortified food products, thus strengthening the commitment of the industry to continue and sustain fortification of their food products. Consumer awareness is needed to achieve the long-term goal of consumer-driven fortification, and systematic social marketing will play an important role to achieve this. The health messages for iodised salt in the United States provide a good example. The fortified product is labelled, “This salt supplies iodine, a necessary nutrient,” and the non-fortified product says, “This salt does not supply iodine, a necessary nutrient”. The challenge is more critical in the developing world, where vast sections of the population are illiterate and food selection is based on price rather than quality.

Deficiencies of micronutrients are widespread and many suffer from multiple micronutrient deficiencies, with diets lacking the ideal diversification needed to provide all nutrients in adequate amounts. In such a scenario, encouraging the policy environment for voluntary fortification of one or more staple foods (salt, oil, milk and wheat flour) and other commonly consumed processed foods that meet at least 10% -30% the RDIs would help bridge the nutrient gap.

In both MP and Rajasthan fortification of wheat, oil and milk through the organised sector and the marketing of these fortified products predominantly through commercial channels have made a good beginning. With increasing urbanisation and disposable incomes, the sale of packaged wheat flour is steadily increasing. Having the private sector voluntarily fortify flour could also lead to other wheat products being fortified, which reach larger sections of the population. An enabling environment that encourages voluntary fortification and increasing demand from well informed consumers is a prerequisite for success of voluntary fortification. GAIN projects in both MP and Rajasthan have attempted to create the enabling environment to sustain voluntary fortification.

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#### AUTHOR DISCLOSURES

Authors declare no conflict of Interest in the manuscript.

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## Case Study

# Food fortification as a complementary strategy for the elimination of micronutrient deficiencies: case studies of large scale food fortification in two Indian States

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## 食品強化作為消除微量營養素缺乏的互補策略：印度兩州大規模食品強化的個案研究

印度微量營養素營養不良的負擔非常高。食品強化是提供大族群微量營養素最符合成本-效益及永續的策略之一。由於營養不良的高負擔、企業有能力且願意引進營養強化的主食、標的食物的攝取模式以及有利的環境，全球營養改善聯盟(GAIN)支持 Rajasthan 及 Madhya Pradesh 兩州的大規模、自願性、主食類食物強化。高出粉率輾磨麵粉，食用大豆油及來自合作廠商的牛奶被選作為強化載體。依據載體的特性及攝取量，選擇微量營養素及其強化量。仔細評估能力及意願後，完成企業招募。生產單位配備必要的強化設施，工作人員經過強化及品質管制的訓練。按照制訂的策略，進行社會行銷及傳播活動。在 Madhya Pradesh 州，所有利益關係者成立一個州立食品強化聯盟。每年有超過 260,000 百萬噸食用油、300,000 百萬噸麵粉以及 500,000 百萬噸牛奶被強化及行銷。在 Rajasthan 州，經由公共發送系統每年也發送 840,000 百萬噸強化麵粉，及透過中央廚房每日發送 1.1 百萬份強化午餐。同步監測 Rajasthan 和 Madhya 兩州，顯示達到高度符合強化食物的所有品質標準。

**關鍵字：**微量營養素營養不良、主食食品強化、印度