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February 20, 2026

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“Food security exists when all people, at all times, have a physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.” (Food and Agriculture). It is easy to conclude that food insecurity is lack of access but “hidden hunger” accounts for great insecurity throughout the world; this is not an exception for India. “Hidden hunger” is the absence of vital micronutrients. “The World Health Organization (WHO) defines ‘Micronutrients’ as compounds required in very smaller amounts, <100 mg/d” (Cambridge). These micronutrients include vitamins and minerals that are required for the production of hormones, enzymes, and other substances that manage growth and development. The lack of these essential nutrients remains a persistent barrier to health, cognitive development, and economic productivity in India. Expanding biofortified staple crops, alongside targeted nutrition, and agricultural policies offers a sustainable food-based strategy to strengthen long-term food security.

In between the Arabian Sea, the Bay of Bengal, and the Vindhya and Satpura mountain ranges lies India. The world's seventh-largest country, spans 3.29 million square kilometers, roughly one-third of the United States. However, India uses 61% of its land mass for agriculture, while the United States uses 41.6% (World Bank India; World Bank United States). India is the most populous country, containing around 1.4 billion people. With the amount of land mass and people within, India has great cultural diversity between languages, geographic regions, religious traditions, and social stratifications. Sixty one percent of India's population is considered rural and is currently on a continuous, steady decline. Due to many cultural traditions, oftentimes several generations are living under one roof. Its geography grants it an incredibly diverse climate, from snowy mountain ranges to deserts, India sees it all (Cultural).

Micronutrient deficiencies are a persistent health problem simply because they are highly complex and continuously changing. According to a study done by the World Health Organization, there are six preventable micronutrient deficiencies in India: iodine, folic acid, iron, vitamin B_{12}, vitamin A, and vitamin D. “The estimated overall prevalence was 17% for iodine deficiency, 37% for folic acid deficiency, 54% for iron deficiency, 53% for vitamin B_{12} deficiency, 19% for vitamin A deficiency, and 61% for vitamin D with high heterogeneity” (Venkatesh et al.). As a whole, about 15% of India's population is malnourished, making it home to the largest number of malnourished people in the world (Bouton). Those citizens with deficiencies can be affected by a wide range of symptoms, some of which include: fatigue, vision issues, muscle control issues, mental ability loss, mood changes, nerve disruptions, swelling, bleeding, loss of balance, etc. (Cleveland). Being deficient in a certain vitamin or mineral can lead to greater complications like anemia, scurvy, and rickets (Espinosa-Salas and Gonzalez-Arias).

Micronutrient deficiencies primarily affect pregnant women, lactating women, and young children, because of their greater need for vitamins and minerals (World Health Organization World Food). “In 2018, anaemia contributed to about 25,000 maternal deaths in India, and ‘pregnancy related complications’ were the commonest cause of death in young Indian women between 15-19 years of age”

(Antony). If the child is born, it is likely to suffer from malnutrition before it even reaches the age of five. “According to the 2018 Global Nutrition Report, in 2015, about 21% of all children under five were wasted and 38% stunted” (Bouton).

India has achieved self-sufficiency in grain production; the total production of food grains increased from 51 million tonnes in 1950-51 to 252 million tonnes in 2015-16 (PRS). This was a result of the Green Revolution in the mid-1960s. The goal was, through policy, to achieve national food security for India and self-reliance in food grain production. The Green Revolution increased calories available but its focus on grains unintentionally contributed to present-day deficiencies (Bouton). As grains became more available, they also became a main food source. The little diversity within the Indian diet is also what contributes to the current state of deficiencies. “The average daily calorie consumption in India is below the recommended 2503 kcal across all groups compared, except for the richest 5%... The share of calories from protein sources is only 6-8% in India compared to 29% in the reference diet” (Sharma et al.). That study concluded that Indian diets,across all states and income groups, are unhealthy.

There are lots of contributing factors that lead to the severity of micronutrient deficiencies. As previously stated, there is a heavy reliance on staple grains, which are available and affordable. Another big contribution lies in processed foods. Those that can afford them buy them out of convenience, not knowing the overall impact they have on their health. On top of that, India's soil is also fighting micronutrient depletion; analysis of soil and plant samples has indicated that 49% of soils in India are potentially deficient in zinc and 12% in iron (Singh).

The conflict of micronutrient malnutrition impacts the overall food security in India. Each pillar of food insecurity is affected: “availability, access, utilization, and stability” (Food and Agriculture). Food is widely available within India but it lacks the nutrient density. Although accessible to others, many low-income families can afford calories, but not enough diverse, nutrient rich foods. As a result, utilization is limited, contributing to many of the continuous health problems. Without stabilization, India will remain in an endless loop of micronutrient malnutrition.

“Micronutrient deficiencies can cause visible and dangerous health conditions, but they can also lead to less clinically notable reductions in energy level, mental clarity, and overall capacity. This can lead to reduced educational outcomes, reduced work productivity, and increased risk from other diseases and health conditions” (World Health Organization Micronutrients). By reducing micronutrient malnutrition alone, India would see broad impacts that may lead to national economic growth. Improving cognitive development would result in more reason, understanding, memory, and problem-solving within citizens. By minimizing micronutrient malnutrition, increased workplace productivity would likely follow, as many who suffer from deficiencies struggle with chronic fatigue. Hopefully, the most notable difference to be made is increasing healthy pregnancies to put an end to the intergenerational cycle.

Micronutrient deficiencies are very universal and widespread; the United States itself has struggled with much of the same problems. The Indian government is aware of the issue, has noticed the steps taken by other counties to resolve it, and has taken multiple steps itself to better the “hidden hunger” within its borders. Nutrition education, food supplementation programs, and food fortification are all actions that have been put in place. How are these current programs affecting micronutrient deficiencies?

Nutritional education should be set at the forefront, which is exactly what the World Health Organization and the United Nations Children's Fund are doing, by raising awareness through community level campaigns to educate the general public. Citizens are highly encouraged to eat food from varied food groups that contain a variety of nutrients. Education can only go so far due to cultural barriers. "Several of India's most widely practiced religions include strict dietary laws" (Pew). Support is important for those who may have to accept a change in diet.

"The IFA supplementation program under the Anemia Mukt Bharat (AMB) program is one of the most ambitious nutrient supplementation programs in India" (Ahmad et al.). IFA is a simple abbreviation for iron and folic acid. "In 2018, India launched the AMB strategy that focuses on six beneficiary groups for coverage, six institutional mechanisms for health system strengthening, and six programmatic interventions to accelerate reduction in anemia prevalence." This program is able to reach 26 million pregnant women, 13 million lactating mothers, 73 million school-aged children and adolescents, and 17 million children under 5-69 months (Joe et al.). The program presents iron and folic acid supplements in the form of tablets and syrups. The problems, due to incomplete coverage, not everyone's needs are met. Not to mention the funding involved in supplementation programs. "Furthermore, programmes are not cost-effective" (Dairo and Ige). Supplementation is a short-term solution to a long-term problem.

Food fortification is "the practice of deliberately increasing the content of one or more micronutrients in food or condiments to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health" (World Health Organization Food Fortification). The process of adding micronutrients takes place during the processing and manufacturing of the food. India has many food fortification programs, including Gujarat's Public Distribution System (PDS), Integrated Child Development Scheme (ICDS), and Mid-Day Meal (MDM) (Fiedler et al.). Using fortified flour, these programs have made substantial impacts, between the MDM and ICDS, inadequate vitamin A intakes were reduced by 34% and 74%, and the PDS was able to take adequate iron intakes and reduce them by 94% (Fielder). By using fortification, they are able to add one or more micronutrients without adding to the total cost of the food product. Although feasible, there are major setbacks to fortification like the initial cost of mixing equipment, the price of premix, and maintaining an adequate standard of quality, monitoring, and distribution systems (World Health Organization The Role).

Similar to fortification is biofortification. "Biofortification is the process by which the nutrient density of food crops is increased through conventional plant breeding, and/or improved agronomic practices, and/or modern biotechnology without sacrificing any characteristics that is preferred by consumers or most important to farmers" (World Health Organization Biofortification). Unlike supplementation and fortification programs, biofortification is a food-based solution enabling coverage, cost efficiency, and the quickest means to provide essential micronutrients (Bouis and Saltzman). Expanding biofortification will reduce micronutrition and hidden hunger.

For a meaningful reduction of micronutrient deficiencies within India, using biofortification, a coordinated implementation strategy is essential. Some biofortification practices have been introduced into India, but in order to establish their use, the government is going to play an essential role in investments. Expanding the supply of biofortified seed, as well as improving the distribution, would allow utilization and coverage. Designing policy incentives for farmers would give them a reason to integrate and produce biofortified crops. Using biofortified crops and gradually introducing them into school meal programs would ensure that the youth that needs the nutrients are supplied with them. India is committed to beating micronutrient deficiencies. "The government of India has already taken an important step in

linking agriculture and nutrition and biofortification. Prime Minister Narendra Modi has given a strong endorsement to staple crop biofortification as a sustainable and cost-effective solution to alleviate malnutrition" (Invest).

Micronutrient deficiencies are widespread; to tackle this problem with biofortified crops, a strong implementation plan will need to be set in place. Working not only with the government for funding, like previously mentioned, but also collaborating with organizations and locals will play a fundamental role. The first step would be collaborating with movements like "*One Health.*" As well as the Food Safety and Standards Authority of India, not to mention the part the Ministry of Agriculture and Farmers Welfare will play. Secondly, public-private partnerships will help, especially because biofortification is being introduced as a long-term solution. The next critical step would be supporting those who would be actively raising the crop, largely small farmers. After biofortified crops are being used, researching the impact they are making on the micronutrient deficiencies will either show that the effort proved to be a success or that there is more work to be done. Eventually getting to the place where just monitoring and evaluation is needed is the ultimate goal.

Nutrition in general is complex, micronutrient nutrition is much more delicate and many principles need to be taken into consideration to obtain the end result. It is necessary to take cultural differences into account, creating biofortified food that continuously meets religious requirements and taste preferences. It should also be noted the gender roles that take place during food preparation. Another consideration is the funding and resources to execute this plan. In an effort to achieve financial support, working with government agricultural budgets is a must. International partnerships could be a resource used, as well as working directly with seed companies. Minimizing micronutrient deficiencies is a feasible goal; India has already started working with biofortification, there is existing seed distribution infrastructure, and a very strong supportive agriculture research system (Indian). Using biofortification, India would have a long-term solution to micronutrient deficiencies.

India has made measurable progress through education, supplementation programs, and fortification, but there are still significant advancements to be made with biofortification and policies that support it. Micronutrient malnutrition is still a critical long term threat to food security. According to the World Health Bank, addressing micronutrient deficiencies effectively cost 0.3% GDP, while ineffective methods could waste up to 5% (Darnton-Hill). By expanding biofortification efforts and aligning nutrition-sensitive agricultural policies gives India a sustainable, cost effective, and adaptive strategy to break the intergenerational cycle of hidden hunger resulting in a healthy, strong nation.

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