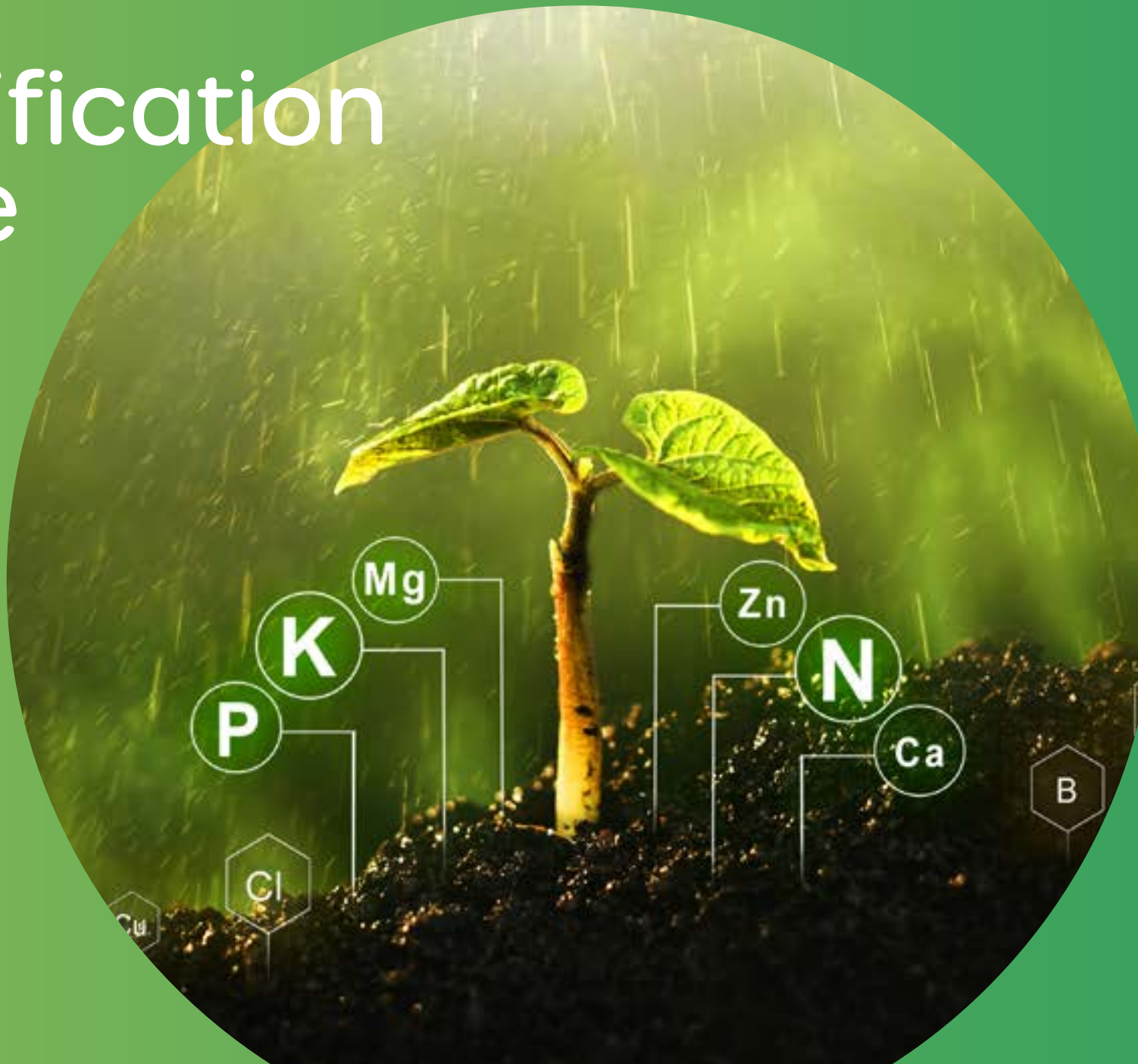
people

food future foundation

Bio-fortification at Scale



Actionable Area

Mainstreaming biofortification in the staple food system to achieve zero hunger and access to safe and nutritious food for all.

Issues

- Hunger and deficiency in various micro-nutrients, which leads to malnutrition, anaemia, stunting and mortality, are major and persistent problems in India. It is home to the highest number of malnourished children, and the child malnutrition rate is unacceptably high. One-third of the people suffering from micronutrient deficiency globally are in India. Micronutrients are required in small quantities and are responsible for vital functions of the human body. The daily intake of micronutrients is far from satisfactory, which costs the country 1% of its GDP.

- More than 6,000 children below five years die each year in India, and over half of them are due to malnutrition caused by lack of Vitamin A, iron, iodine, zinc and folic acid. About 57% of pre-schoolers and their mothers have subclinical Vitamin A deficiency. An estimated 30% of adult males, 45% of adult females, 80% of pregnant females, and 60% of children in India are iron deficient. Due to iron deficiency, India suffers from the highest prevalence of anaemia globally, affecting 40% of the population. According to the Comprehensive National Nutrition Survey (CNNS) of the Union Ministry of Health and Family Welfare in 2019, Folate deficiency was prevalent among 23% of pre-school children and 37% of adolescents. The prevalence of deficiencies of Vitamin B12, Vitamin A and Vitamin D also hover between

Target crops for biofortification: Indian Scenario

Base line and targets

Traits	Parameters	Rice (polished)	Wheat	Maize	Pearl millet
Fe:	Retention after process (%)		90		
(30% EAR)	Bioavailability (%)	10		5	
	Base line (ppm)	2	30	30	47
	Target (ppm) (dry wt.)	15	59	60	88
Zn:	Retention after process (%)		90		
(40% EAR)	Bioavailability (%)		25		
	Base line (ppm)	16	25	25	47
	Target (ppm) (dry wt.)	28	38	38	66
ProA:	Retention after process (%)		50		
(50% EAR)	Bioavailability (%)		12.1		
	Base line (ppm)		0		
	Target (ppm) (dry wt.)	17	17	23	17

Adult women: Fe: 1460 ppm, Zn: 1860 ppm, ProA: 500RE per day
4-6 yrs child: Fe: 500 ppm, Zn: 830 ppm, ProA: 275RE per day
Source: Bouis & Welch, 2010

14% and 31% for pre-school children to adolescents. Zinc deficiency was found among 19% of pre-school children and 32% of adolescents. Indians lose about 2.8 million disability-adjusted life years (DALYs) every year due to zinc deficiency.

- Biofortification can change the situation and hence, warrants its promotion and further scaling up. Biofortification differs from conventional fortification. Biofortification increases micronutrient levels in the edible parts of the crops (seeds, tubers, grains etc.) in plant growth rather than through post-harvest processing of agricultural production. Biofortification improves the nutritional quality of food crops through agronomic practices, conventional plant breeding, or modern biotechnology.

- Biofortification leads to a more nutritionally resilient staple food system. It is a foundation on which to layer industrial food fortification for the remaining nutrients of public health concern un addressed through biofortification. Empirical studies have established that when consumed daily in normal quantities, biofortified crops deliver measurable positive impacts to human health, including non-communicable diseases and nutritional status.

- The Copenhagen Consensus ranked interventions that reduce micronutrient deficiencies, including biofortification, among the highest value-for-money investments for economic development. For every dollar invested in biofortification, as much as $17 of benefits may be gained.

Status

Government Initiatives

- The government of India is a leading advocate for reducing malnutrition by increasing the production and consumption of nutrient-enriched staple foods, particularly biofortified zinc wheat, zinc rice, and iron pearl millet (IPM). 2018 is declared as the "Year of Millets". Farmers were incentivised to grow crops such as 'Nutri-cereals,' which the government recognises as being important to improve both food and nutrition security. That same year, the Indian Council of Agriculture Research (ICAR) took a decisive step by establishing minimum levels of iron and zinc to be bred into all national varieties of pearl millet.

- Since 2006, ICAR-All India Coordinated Research Projects (AICRP) began breeding programs on pearl millet for micronutrients alongside higher yields. Following that,10 iron pearl millet varieties and 9 zinc wheat varieties have been released to farmers to promote their growth and production in India. In August 2020, ICAR took a bold step to help scale up the production and consumption of nutritious biofortified crops in the country. It was announced that 10% of ICAR's Frontline Demonstrations (FLDs) of crops would now include zinc-biofortified wheat and rice varieties. ICAR, Indian agricultural universities and research institutes have developed five varieties of wheat biofortified with zinc.

- Biofortification is also being championed at the highest levels of the government. Recently, Hon'ble Prime Minister of India, Mr Narendra Modi, strongly endorsed staple crop biofortification as a sustainable and cost-effective solution to alleviate malnutrition. In October 2020, he dedicated 17 biofortified varieties of 8 crops to the nation.

- Government of Bihar, India's third most populous state with the lowest per capita income and the highest rate of stunting, committed in 2020 to scale up the production of zinc wheat seeds through public seed companies. The Bihar government also inaugurated in 2020 a "nutritional village" that will cultivate only biofortified crops using organic methods to promote these nutrient-rich varieties.

- Cropsfor biofortification include:

  a. **Ironbiofortification -** rice, beans, sweet potato, cassava and legumes, cowpeas, lentils

  b. **Zincbiofortification -** wheat, rice, beans, sweet potato, and maize

  c. **Provitamin A carotenoidbiofortification -** sweet potato, maize, and cassava; and

  d. **Amino acid and proteinbiofortification -** sorghum and cassava

Civil Society &Commercial Initiatives

- Global Alliance for Improved Nutrition (GAIN) and HarvestPlus collaborate to support the commercialisation of biofortified iron pearl millet in Rajasthan, Maharashtra and Karnataka, and zinc wheat in Uttar Pradesh, Bihar, and Punjab. On one end, the project ensures that biofortified seeds are adequately multiplied and adopted/cultivated by farmers through farmer outreach activities and establishing relations with farmer groups and associations. On the other, it engages with the food processors and key-value chain actors to adopt biofortified grains for existing products and develop innovative food products that are nutritious and appealing to the consumers. The project collaborates with state and national governments to encourage the distribution of biofortified varieties within the social protection schemes.

- The project is also piloting a digital agri-platform for providing end-to-end solutions to the farming community and food processors to commercialise biofortified foods in Rajasthan and Bihar. The platform would be deployed to enable supply chain participants to share information (e.g. inventory data, demand forecasts), communicate and collaborate more effectively. It would be a learning for designing more efficient supply chain structures.

Vision 2030

Leveraging biofortification towards ‘Kuposhan Mukt Bharat’ (Malnutrition free India) by improving access and production of biofortified food products while increasing its outreach to populations through government-sponsored food programs and open markets.

Pathways

POLICY

Create a comprehensive framework integrating biofortification and fortification to address the issues of micronutrient deficiency across the population since they play a complementary role to address malnutrition.

Build a framework for public-private partnerships in research and development, focused on new varieties and seeds. This will require better coordination and collaboration among various subject specialists, namely breeders, biotechnologists, biochemists, seed technologists, agronomists, and post-harvest technologists across various public and private organizations.

Set up a dedicated biofortification department within the Ministry of Agriculture.

Create a clear framework for transgenic biofortification and address ambiguities related to GM policy in India.

Include biofortified products in government-sponsored schemes such as National Food Security Mission, Rashtriya Krishi Vikas Yojana, Public Distribution System, as well as nutrition intervention programmes like Integrated Child Development Services scheme, ‘Mid-day meal’ and Nutrition Education and Training through Community Food and Nutrition Extension Units for mass outreach.

Ensure alignment of biofortification and fortification as a complementary strategy to address micronutrient malnutrition by engaging different stakeholders.

Pathways

IMPLEMENTATION

Improve consumer awareness and include participatory breeding techniques to address the needs and preferences of all farmers, male and female and consumers by addressing the key issues like taste/yield/processing traits in accordance with the existing commercially grown crops in the market.

Introduce nutritional traits like minerals and vitamins into the mainstream to ensure the required levels in crop varieties to be developed in the future. Leverage region-specific nutrient-rich crops such as fruits in the North-Eastern part of India.

Establish strong linkages with the Agri food-processing industry for the dissemination of biofortified crops. Undertake strong promotional extension activities to improve awareness on biofortified crops among the farmers, industry and consumers.

Initiatives like awarding remunerative prices for biofortified grains in the market to encourage the farmers and value chain actors to adopt biofortified crops at scale. Adoption of the 'seed village' model for the cultivation of the biofortified crops by the entire farming community of the village.

Strengthen the seed chain to produce and supply good quality seeds to popularize biofortified varieties of crops for rapid dissemination of nutritionally improved cultivars among the farmers.

Provide technical assistance to Food Industry, especially the small business enterprises, SMEs/MSMEs, to adopt bio-fortification; encourage investments in the private sector for effective production of biofortified staples and establish long-term sustainable markets for biofortified crops.

Expand social infrastructure for interactions and interventions focused on mass awareness of nutrient density of foods at all the three levels- individual, household and community.

Streamlinemessaging around 'nutrition in foods' among consumers for improved impact and understanding.

Develop crop value chain specific communication strategies to encourage adoption of biofortified crops and foods.

Consumer-focused marketing campaigns to build awareness, and hence demand, around the concept and benefits of nutrient-dense bio-fortified foods leveraging digital & social media, influencers, and other mass media tools.

Pathways

KNOWLEDGE & RESEARCH

Institutionalise research by conducting large-scale trials to help in generating data and thus help in the dissemination of biofortified varieties.

A dashboard can be created along with ICAR to have dynamic data available on the scaling up and outreach of the biofortified crops. This can be done at the state level.

Develop or integrate global standards for biofortified crops - seed and grain - and create an eco-system to accelerate and amplify biofortified varieties among the food processing industry.