

2. Functional Foods – Science & Technology

Society's approach to food is changing, with the next major shift focusing on functional foods and smart proteins that promote better health and sustainability

Functional Foods and Smart Proteins in India – Expanded Overview

Concept and Definition

Functional Foods – Functional foods are nutrient-enriched foods that provide health benefits beyond basic nutrition. These foods are fortified or bio-engineered to improve health outcomes or prevent disease. Common examples include vitamin-enriched rice, omega-3-fortified milk, and probiotic yogurt. Technologies driving functional foods include –

1. **Nutrigenomics** – Studies how individual genes interact with nutrients to personalize diet plans.
2. **Bio-fortification** – Breeding crops to enhance nutrient content naturally (e.g., zinc-rich wheat).
3. **3D Food Printing** – Enables customized nutrient delivery for elderly or patients with specific deficiencies.
4. **Bioprocessing** – Uses microbial fermentation or enzymatic processes to improve bioavailability of nutrients.

Smart Proteins – “Smart proteins” refer to biotechnologically produced or alternative protein sources designed to reduce dependence on conventional livestock-based production. They are sustainable, ethical, and resource-efficient protein solutions. Types of smart proteins include –

1. **Plant-based proteins** – Extracts from legumes, cereals, and oilseeds restructured to imitate meat and dairy (e.g., soy-based “chicken” nuggets).
2. **Fermentation-derived proteins** – Microorganisms (yeasts, fungi, algae) used to produce protein ingredients such as dairy or egg analogues.
3. **Cultivated meat** – Animal muscle cells grown in controlled bioreactors without animal slaughter.

Need for Functional Foods and Smart Proteins in India

Nutritional Imbalances – India faces a dual nutritional burden – undernutrition in rural and poor populations, and rising lifestyle diseases in urban areas. Over 35% of Indian children are stunted, indicating chronic malnutrition. Protein deficiency is widespread – average per capita protein intake in India remains below WHO recommendations.

Shift from Food Security to Nutritional Security – Economic growth and changing diets demand a focus on quality and diversity of food rather than just caloric sufficiency. Nutritional security emphasizes access to balanced diets rich in proteins, vitamins, and antioxidants.

Environmental Sustainability Concerns – Traditional livestock farming is resource-intensive and contributes to greenhouse gas emissions. Smart proteins offer an eco-efficient alternative that uses fewer resources (water, feed, and land).

Health and Economic Benefits – Functional foods can combat micronutrient deficiencies like anemia and vitamin A deficiency. Smart proteins can reduce dependence on meat imports, enhance farmer incomes, and promote agritech startups.

Status in India

Policy and Institutional Support – India's BioE3 policy (Bioeconomy for Environment, Energy, and Employment) under the Department of Biotechnology (DBT) promotes innovation in bio-based nutrition and food processing. BIRAC (Biotechnology Industry Research Assistance Council) supports startups and R&D through funding and incubation.

Achievements and Innovations

Bio-fortified crops – Zinc-rich rice (developed by Indian Institute of Rice Research, Hyderabad). Iron-rich pearl millet (developed by ICRISAT, Hyderabad). Vitamin-A enriched sweet potato (supported by ICAR).

Private sector initiatives – Companies like Tata, ITC, and Marico are investing in fortified staples and nutrition-based products.

Smart protein ecosystem – As of 2023, India had over 70 brands offering 377 plant-based meat, dairy, and egg alternatives. Startups such as GoodDot, Evo Foods, and Imagine Meats are pioneering plant-based innovations. Zydus LifeSciences ventured into fermentation-based protein production in 2024. DBT-funded cultivated meat research at the Centre for Cellular and Molecular Biology (CCMB) marks India's entry into the cultured meat space.

Challenges

Regulatory ambiguity – The Food Safety and Standards Authority of India (FSSAI) has yet to establish comprehensive guidelines for smart proteins and bioengineered foods.

Infrastructure bottlenecks – Limited access to fermentation units, testing labs, and biomanufacturing facilities.

Public perception – Skepticism around “lab-grown” or “synthetic” foods limits consumer acceptance.

Global Scenario

Pioneering Nations

Japan – Originated the concept of functional foods in the 1980s under its Foods for Specified Health Uses (FOSHU) regulatory framework.

Singapore – Became the first country to approve cultivated chicken meat for commercial sale in 2020.

China – Integrated alternative proteins and food tech into its Five-Year Plans for food security and innovation.

European Union – Actively promoting sustainable protein production through its Farm to Fork Strategy and the European Green Deal.

Market Trends – Global smart protein and plant-based food markets are projected to reach \$240 billion by 2030, reflecting consumer preference for sustainability and ethics. Investment from global players like Nestlé, Beyond Meat, and Impossible Foods is driving innovation and partnerships worldwide.

Way Ahead for India

Strategic Opportunities

Economic potential – India's agricultural base and biotechnology talent can make it a global supplier of smart proteins and functional foods.

Employment generation – Expanding production can create jobs in farming, food processing, logistics, and retail sectors.

Environmental advantage – Bio-based proteins can lower carbon emissions, water use, and pressure on land resources.

Policy Priorities – Establish a clear FSSAI regulatory framework for novel foods, including safety testing, labeling, and consumer information. Encourage public-private partnerships (PPP) for scaling up bio-manufacturing and pilot plants. Invest in precision fermentation, cell culture, and bioprocessing infrastructure. Integrate smart protein R&D into India's National Nutrition Mission and Make in India initiative.

Social and Awareness Measures – Conduct consumer awareness campaigns about the health and environmental benefits of smart proteins. Involve farmers and small producers in new value chains (e.g., supplying pulses and oilseeds for plant-based protein extraction). Support education and skilling programs in food biotechnology and nutrition sciences.

Conclusion

Functional foods and smart proteins represent a transformative shift in India's nutrition and food security strategy. They align with SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), and SDG 12 (Responsible Consumption and Production). However, India must overcome regulatory, infrastructural, and perceptual barriers to scale innovation sustainably. A comprehensive national roadmap—combining regulation, investment, R&D, and public participation—can help India achieve nutritional self-reliance while ensuring climate-resilient, equitable growth.

Source – <https://www.thehindu.com/sci-tech/health/does-india-need-nutritional-transformation-explained/article70260345.ece>