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Wheat Biofortification: The Nurtritional Revolution

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Introduction

Biofortification is refers as nutritionally enriched food crops with increased bioavailability to the human population that are developed and grown using modernistic biotechnology tools, conventional plant breeding approaches, and agronomic practices. Nutritional diet is vital for proper growth and development in humans. It helps preventing illnesses, besides keeping up the body metabolism for physical and mental wellbeing. Food provides energy, protein, necessary fats, vitamins, antioxidants and minerals to meet our daily metabolic requirement. Utmost of them can not be synthesized in human body, thus are to be supplemented through diet. There are numerous practicable strategies to enhance micronutrient intake in the human diet involving dietary diversification, mineral supplementation and post-harvest food fortification. Still, these strategies depend on continued investment and infrastructure, and prevalent levels of post-harvest fortification of Fe are frequently inadequate. Biofortification is a forthcoming, effective, bright, cost-effective, and sustainable technique of delivering micronutrients to a population that has limited access to diverse diets and other micronutrient interventions. Wheat as a staple crop is the first and foremost target for biofortification. Wide variation in grain iron and zinc concentrations in wheat and its closely related wild species has been observed that it can be exploited for enhancement of modern elite cultivars.

Global and Indian Scenario

The World Health Organization estimates that around 25% of the world's population suffers from anaemia (WHO, 2008), and an estimated 17.3% of people worldwide are at menace of deficient Zn input and Zn- deficiency leads to estimated yearly deaths of children under the age of five (WHO, 2009). In India 15.2% of people are undernourished among which 38.4% of the children (<5 years) are stunted, 21.0% are wasted and 35.7% of the children are under-weight (Global Food Policy Report 2016).

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Due to anaemia 53% of the adult women and 22.7% of adult men are affected. According to National Family Health Survey-4, 70% of children (<5 years) are estimated to be iron deficient and 38% of children (<5 years) are estimated to be deficient in zinc. It is reported that India loses over US$12 billion in GDP per year due to vitamin and mineral deficiencies.

Strategies to overcome human micronutrient deficiency in wheat

1. **Diversified diet:** A diet including staples, meat/fish, vegetables and fruit is the most "natural" way to improve the diet. More diverse diet may be difficult because of food availability and cost.
2. **Food fortification:** Processed food enriched with micronutrients, for example cereals enriched with micronutrients. This provides a good possibility for people with access to fortified food. Often it is not available for poor and rural population. It is costly and processed with some negative effects.
3. **Food supplements:** Pills that containing one or several micronutrients in high concentration and bio-available from Quick and targeted improvement of deficiencies. This approach needs continuous distribution of the supplements due to this it can be difficult to reach rural people.

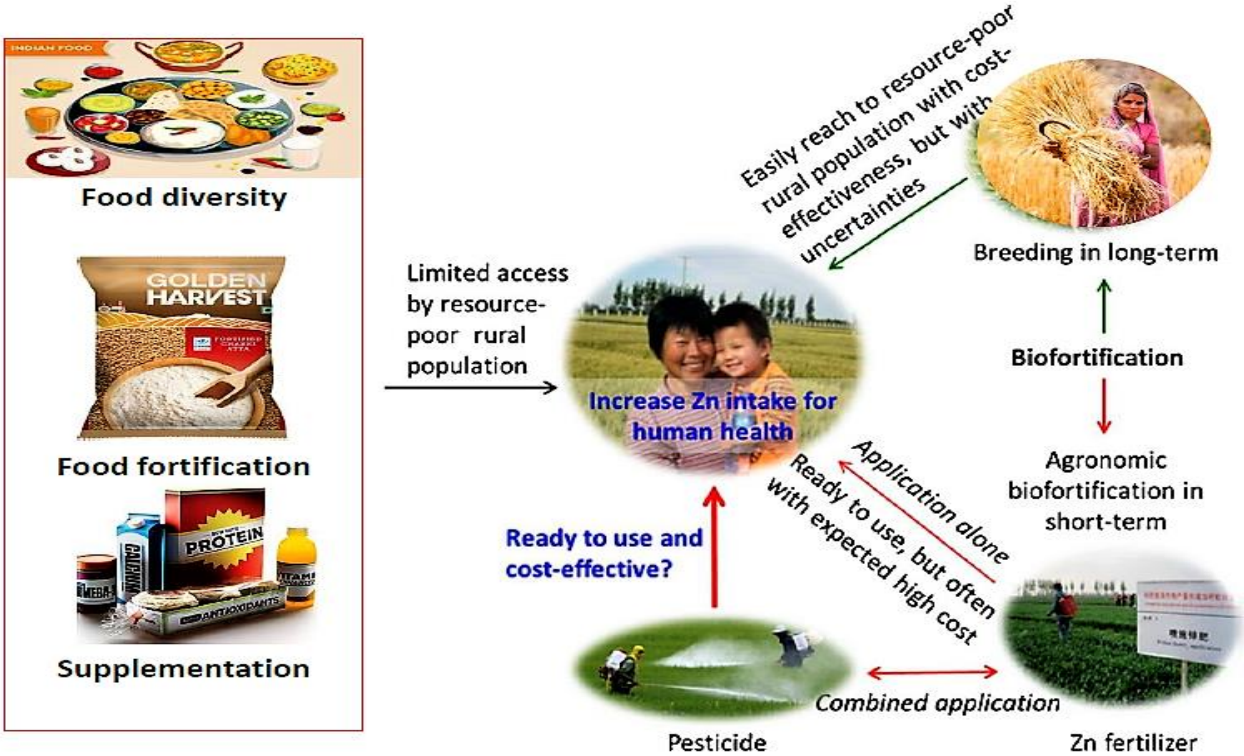

Fig.1: Different strategies to fulfil micronutrient needs of human population

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4. **Genetic/ agronomic biofortification:** This includes new crop varieties with increased micronutrient content and/or application of micronutrient fertilizer Enables farmers/regions/countries to produce their own enriched food sources. The enrichment might be not sufficient and depends on local (soil) conditions; the right dose depends on the local food basket; agronomic biofortification can cause toxicities in the soil, adds extra costs to food production.

Biofortified varieties of wheat

Pusa Tejas (HI 8759): It is a pure line variety with high iron (42.1 ppm), protein (12%) and zinc (42.8 ppm). It is a durum wheat variety suitable for making *chapatti* (Indian bread), pasta etc. It has been released and notified in 2017 for Chhattisgarh, Madhya Pradesh, Gujarat, Uttar Pradesh and Rajasthan. Under timely sown irrigated conditions the average yield of this variety is 50.0 q/ha. This biofortified variety has been developed by ICAR-Indian Agricultural Research Institute (IARI), Regional Station, Indore, Madhya Pradesh.

PusaUjala (HI 1605): It is a pure line variety with high iron (43 ppm), zinc (35 ppm) and protein (13%), and suitable for making *chapatti*. It has been released and notified in 2017 for Karnataka, Tamil Nadu and Maharashtra. Its average yield is 30.0 q/ha under restricted irrigation, timely sown conditions. This biofortified variety has been developed by ICAR-IARI, Regional Station, Indore, Madhya Pradesh.

MACS 4028 (d): It is a pure line durum wheat variety with high protein (14.7%), iron (46.1 ppm) and zinc (40.3 ppm). It has been released and notified in 2018 for Karnataka and Maharashtra. Its average grain yield is 19.3 q/ha under rainfed low fertility, timely sown conditions in Peninsular Zone. It matures in 102 days. This biofortified variety has been developed by Agharkar Research Institute, Pune, Maharashtra, under ICAR-All India Coordinated Research Project on Wheat and Barley.

Karan Vandana (DBW 187): It is a pureline variety Rich in iron (43.1 ppm) in comparison to 28.0-32.0 ppm in popular varieties. Its average grain yield is 48.8 q/ha North Eastern Plains Zone (NEPZ), 61.3q/ha North Western Plains Zone (NWPZ), 75.5q/ha (High fertility). It matures in 120 days (NEPZ), 146 days (NWPZ) & 158 days (High fertility). It is suitable for timely sown irrigated and fertlity conditions in *rabi*. It has been released and notified in 2020 for Punjab, Haryana, Delhi, Rajasthan (excluding Kota &Udaipur division), Uttar Pradesh (except Jhansi division), Jammu and Kathua district of Jammu &

Kashmir,Paonta Valley and Una district of Himachal Pradesh, Tarai region of Uttarakhand, Bihar, Jharkhand, Odisha, West Bengal, Assam and Plains of North Eastern states. This biofortified variety has been developed by ICAR-Indian Institute of Wheat & Barley Research, Karnal.

Conclusion:

Successful efforts have also been made in developing some wheat cultivars with improved levels of grain Zn and Fe content. But, the available information has not been fully utilized in breeding programmes. Strategies will also have to be developed in order to respond to changing climate and agricultural practices, since these will influence adversely not only yield, but also biofortification and bioavailability of micronutrients. For instance, the high temperature and water availability may become a serious constraint. Increase in CO_2 concentration in the atmosphere and reduced fertilizer input may also have an adverse effect on the concentration of grain micronutrients. Therefore, strategies are being developed to produce more with less water and less fertilizer; biofortification and bioavailability should be an important component of all such efforts. We will also have to learn, how changes in gene sequences will influence different traits including biofortification and bioavailability, so that gene/ base editing approaches may be deployed for sustaining the current efforts being made to achieve desired biofortification and bioavailability