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Biofortification in Millets – A Sustainable Approach to Combat Malnutrition

Anam Khan
Ph.D Research Scholar, Department of Entomology, College of Agriculture, SVPUA&T, Meerut,

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Introduction

Nutritional insecurity due to micronutrients deficiency is a huge menace to the global population that consumes diet containing cereals. Millets are nutritionally superior because of higher amount of nutrition like minerals, proteins, essential amino acids, and vitamins in their grains. Harvest Plus group realized the significance of millet biofortification and released high iron pearl millet in India to tackle iron deficiency which is produced from conventional breeding method. There is a limitation in biofortification in millets due to presence of antinutrients like phytic acid, polyphenols, and tannins. Gene silencing technology like RNA interference and genome editing tools like [zinc finger nucleases (ZFNs), transcription activator-like effect or nucleases (TALENs), and clustered regularly interspaced short palindromic repeats (CRISPR)] should be used for reduction of these antinutrients.

Objective of Biofortification :

Main objective of biofortification is to lower mortality and morbidity rates associated with micronutrient deficiencies while also improving food security, productivity, and quality of life for impoverished people in developing nations. It further aims at

- ✓ Improved protein content and quality.
- ✓ Improved oil content and quality.
- ✓ Improved vitamin content.
- ✓ Improved micronutrient and mineral content.

Normal growth and development is regulated by plants which act as major source of nutrients. Cereal crops are major source of nutrition for half of the global population, especially for people of Asian and African continent who suffer from malnutrition (White and Broadley, 2005). Biofortification deliver nutrient rich crops at the door steps of poor

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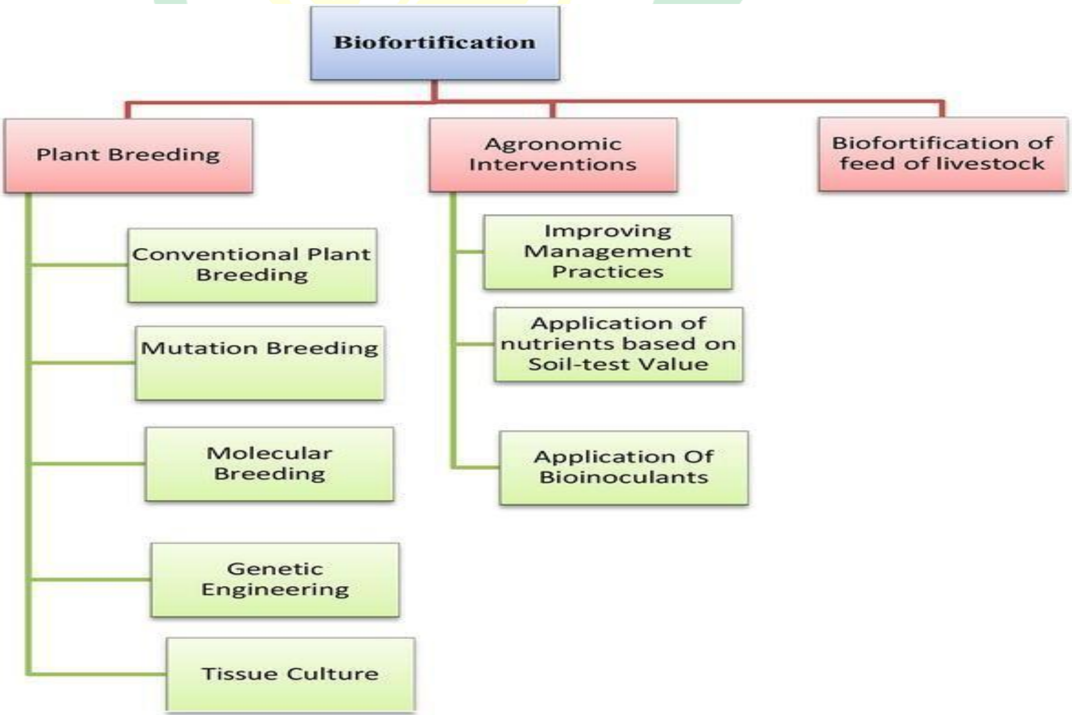
populations, as it is a food-based approach to overcome the nutrient starvation (Bouis et al., 2011). Millets provide 75% of total calorie intake next to cereal grains with an average annual production of 14.2 and 12.4 million tonnes in poor countries of Asia and Africa (O'Kennedy et al., 2006). Production of millets is highest in India, accounting for about 80% of the millet production in world (Food and Agricultural Organization [FAO], 2015).

Millets are called as "small seeded grasses" which include pearl millet [*Pennisetum glaucum* (L.) R.Br.], foxtail millet [*Setaria italica* (L.) Beauv], proso millet (*Panicummiliaceum* L.), finger millet [*Eleusine coracana* (L.) Gaertn], barnyard millet (*Echinochloa* spp.), kodo millet (*Paspalum scrobiculatum*), and little millet (*Panicum sumatrense*). Pearl millet produce 95% of the production among all other millets.

Methods of Biofortification:

Biofortification in millets can be achieved through two strategies: (1) by enhancing the accumulation of nutrients in milled grains and (2) by reducing the antinutrients to increase the bioavailability of minerals. In order to block the biosynthesis of antinutrients and to facilitate nutrient accumulation in edible portions, genetic engineering and genome editing tools are given much importance. Some methods of biofortification are listed below:



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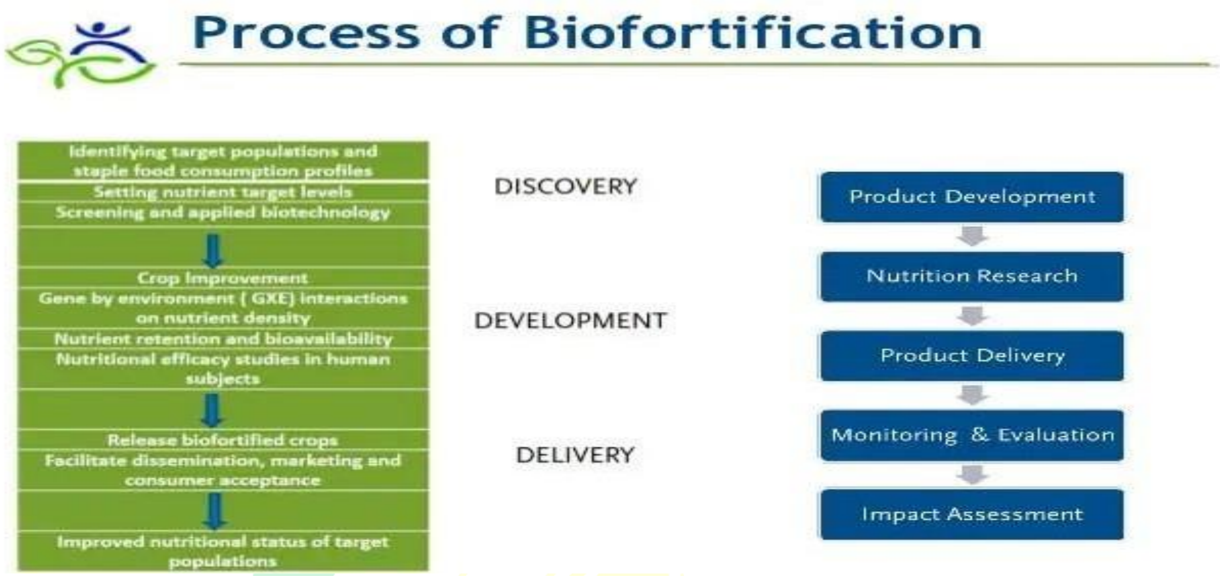
Process of biofortification



Role of Organizations in Biofortication:

CGIAR centers send promising biofortified varieties to national agricultural research systems **(NARS)** for thorough performance testing and adaptation to local farmers' needs and specific growing conditions. National governments release successfully tested and approved varieties for farmer use. Multipliers play a key role by producing sufficient volumes of high quality biofortified planting material to meet demand from farmers.

Harvest plus: Harvest Plus is part of the CGIAR and is based at the International Food Policy Research Institute (IFPRI), a CGIAR research center. It promotes and develop biofortified food crops that are rich in vitamins and minerals which will improve the nutrition and public health and it aid in providing global leadership on biofortification evidence and technology.

Biofortification Features:

- ✓ Biofortification was a food-based technique developed primarily to address widespread vitamin A, and micronutrients like iron, and zinc deficiencies, which are most prevalent inlow-income nations.
- ✓ Biofortification is largely aimed at the poor people in rural areas , who depend significantly on locally produced core foods as their source of primary nutrition and often unable to afford commercially processed fortified foods due to financial

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or market constraints.

- ✓ Biofortification technique has the potential to be sustainable, because planting material canoften be kept, recycled, and disseminated to other farmers.
- ✓ The recurrent expenses of maintaining biofortified crop yield are expected to be modest, once initial development and dissemination are completed.
- ✓ Main objective of biofortification is to lower the mortality and morbidity rates associated with micronutrient deficiencies and thereby improving the food security, productivity, andquality of life of poor people in developing nations.

Major areas of biofortification consideration:

Acceptance by consumers, bioavailability, and efficacy are the major areas of biofortification consideration.

Nutritional significance of millets:

Millets are highly nutritious in nature. About 80% of millet grains are used for food, while the rest is utilised for feeding animals and for prepation of alcoholic products (Shivran, 2016). Due to high fiber and protein content, millets are beneficial for people suffering from diabetes and cardiovascular diseases (Muthamilarasan et al., 2016). They possess phenolic acids and flavonoids, that play a vital role in lowering blood glucose levels and promoting health (Hegde et al., 2005; Dykes and Rooney, 2006, 2007; Chandrasekara and Shahidi, 2010, 2011; Kim et al., 2011; Kunyanga et al., 2012). Pearl millet is rich in Fe, Zn, and lysine (17–65 mg/g of protein) compared to other millets (McDonough et al., 2000; Hadimani et al., 2001).

Millets are superior to rice and wheat as they contain a high amount of proteins, dietary fibers, iron, zinc, calcium, phosphorus, potassium, vitamin B, and essential amino acids (Hegde et al., 2005; Saleh et al., 2013). The presence of antinutrients like phytates, polyphenols, and tannins reduce the bioavailability of mineral by chelating multivalent cations (Oberleas, 1973; Gupta, 1980; Kumar and Chauhan, 1993; Abdalla et al., 1998; Abdel Rahman et al., 2005).). Reduction in antinutrients during plant growth and development is therefore a promising strategy to improve the bioavailability of minerals from nutrient-rich millets.

Millets exhibit vast genetic variability for iron, zinc, and calcium when compared to other cereal crops (Muthamilarasan and Prasad, 2015). Moreover, millets are drought tolerant crops (O'Kennedy et al., 2009), resistant to pests and diseases (Tsehaye et al., 2006; Reddy et al., 2011).

Biofortified hybrids of Pearl millet:

ICMH 1202 (AHB1200) ICMH 1203 (HHB299) ICMH 1301 (DHBH1211)

Fig. These biofortified hybrids of Pearl millet released by ICRISAT contain higher Zinc (Zn)and Iron (Fe) content.

Conclusion:

Biofortification is a sustainable and cost-effective approach to address malnutrition. It focus on the main cause of the malnutrition. Biofortified pearl millet provide food along with nutritional security in dryland poor households. Biofortified cultivars are being developed through conventional breeding. Thus, grains and foods produced from such cultivars are accepted by the consumers and they do not face challenges imposed by the food regulations.

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