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Biofortification: Introduction, Importance, and Biofortified Varieties

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INTRODUCTION

"Bio fortification" or "biological fortification" refers to nutritionally enhanced food crops with increased bioavailability to the human population that are developed and grown using modern bio-technology techniques, conventional plant breeding, and agronomic practices. Bio fortification, which can be defined as the process of increasing the content/density of essential nutrients and/or its bioavailability of food with valuable compounds, is a promising means of increasing nutrient intakes. The bio fortification strategy seeks to put the micronutrient-dense trait in those varieties that already have preferred agronomic and consumption traits, such as high yield. Marketed surpluses of these crops may make their way into retail outlets, reaching consumers in first rural and then urban areas, in contrast to complementary interventions, such as fortification and supplementation, that begin in urban centers. Bio fortified staple foods cannot deliver as high a level of minerals and vitamins per day as supplements or industrially fortified foods, but they can help by increasing the daily adequacy of micronutrient intakes among individuals throughout the life cycle (Bouis et al., 2011). Developing nations are having challenges of provision of adequate food for their population. For example, Nigeria is in dire need to feed its teaming population of 140 million that is increasing at an annual rate of at least 2% (Egesi, 2010). This approach not only will lower the number of severely malnourished people who require treatment by complementary interventions but also will help them maintain improved nutritional status. Moreover, bio fortification provides a feasible means of reaching malnourished rural populations who may have limited access to commercially marketed fortified foods and supplements.

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Importance of biofortification

Bio fortification is the genetic or agronomic breeding of crops to enhance their nutritional composition (Uchendu, 2012). Commercial cultivation of genetically modified (GM) crops has been in existence since 1996. About 22 countries are growing GM crops. These include USA, Argentina, Brazil, Canada, China, Paraguay, India, South Africa, Uruguay, Australia, Mexico, Romania, the Philippines, Spain, Colombia, Iran, Honduras, Portugal, Germany, France, Czech Republic, and Nigeria.

❖ **Selective addition of nutrition**

Bio fortification allows selected nutrition to be added into a particular crop through either selectively breeding or altering it genetically. This reduces the need for multiple food to be consumed because most of the required nutrient are incorporated in a single crop. Ex: Golden rice was fortified with vitamin A for consumption by poor people who could not afford more nutritious food.

❖ **Reduces need for overspending on food**

In poor countries where most of them cannot afford to spend more resources on nutritious food, bio fortification comes to rescue. Since nutrition is concentrated on a single source, there is no need to spend on multiple food. The saved money can be used for educational and health needs.

❖ **Enhances human productivity**

Lack of proper nutrients is a major concern that reduces efficiency of working humans. Provision of nutrients in an efficient manner can increase productivity drastically. Increasing productivity will contribute towards economic and social growth of population. (upsciq.com)

Bio fortified varieties of some crops

Rice

CR Dhan 310 (protein rich variety)

•Pure line variety

• Contains **10.3% protein** in polished grain as compared to **7.0-8.0%** in popular varieties

• Developed by ICAR-National Rice Research Institute, Cuttack, Odisha

•Year of release: **2016**

DRR Dhan 45 (zinc rich variety)

•Pure line variety

• High in zinc content **(22.6 ppm)** in polished grains in comparison to **12.0-16.0 ppm** in popular varieties

• Developed by ICAR-Indian Institute of Rice Research, Hyderabad

•Year of release: **2016**

Wheat

WB 02 (zinc & iron rich variety)

• Rich in **zinc (42.0 ppm)** and **iron (40.0 ppm)** in comparison to **32.0 ppm zinc** and **28.0-32.0 ppm iron** in popular varieties

• Developed by ICAR-Indian Institute of Wheat and Barley Research, Karnal

•Year of release: 2017

HPBW 01 (iron & zinc rich variety)

(Pure line variety)

• Contains high **iron (40.0 ppm)** and **zinc (40.6 ppm)** in comparison to **28.0-32.0 ppm iron** and **32.0 ppm zinc** in popular varieties

• Developed by PunjabAgricultural University, Ludhiana under ICAR-All India Coordinated Research Project on Wheat & Barley

•Year of release: 2017

Maize

Pusa Vivek QPM9 Improved (provitamin-A, lysine & tryptophan rich hybrid)

• Country's first provitamin-A rich maize

• High provitamin-A **(8.15 ppm)**, lysine **(2.67%)** and tryptophan **(0.74%)** as compared to **1.0-2.0 ppm** provitamin-A, **1.5-2.0%** lysine and **0.3-0.4%** tryptophan content in popular hybrids

• Developed by ICAR-Indian Agricultural Research Institute, New Delhi

•Year of release: 2017

Pusa HM4 Improved (lysine & tryptophan rich hybrid)

•Contains **0.91% tryptophan** and **3.62% lysine** which is significantly higher than popular hybrids (**0.3-0.4% tryptophan** and **1.5-2.0% lysine**)

• Developed by ICAR-Indian Agricultural Research Institute, New Delhi

•Year of release: 2017

Pusa HM8 Improved (lysine & tryptophan rich hybrid)

• Rich in **tryptophan (1.06%)** and **lysine (4.18%)** as compared to **0.3-0.4% tryptophan** and **1.5-2.0% lysine** in popular hybrids
•Developed by ICAR-Indian Agricultural Research Institute, New Delhi
•Year of release: 2017

Pusa HM9 Improved (lysine & tryptophan rich hybrid)

• Contains **0.68% tryptophan** and **2.97% lysine** compared to **0.3-0.4% tryptophan** and **1.5-2.0% lysine** in popular hybrids
• Developed by ICAR-Indian Agricultural Research Institute, New Delhi
•Year of release: 2017

Pearl millet

HHB 299 (iron & zinc rich hybrid)

• High **iron (73.0 ppm)** and **zinc (41.0 ppm)** as compared to **45.0-50.0 ppm iron** and **30.0 to 35.0 ppm zinc** in popular varieties/hybrids
• Developed by CCS-Haryana Agricultural University, Hisar in collaboration with ICRISAT, Patancheru under ICAR-All India Coordinated Research Project on Pearl millet
•Year of release: 2017

AHB 1200 (iron rich hybrid)

• Rich in **iron (73.0 ppm)** in comparison to **45.0-50.0 ppm** in popular varieties/hybrids
•Developed by Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MS) in collaboration with ICRISAT, Patancheru under ICAR-All India Coordinated Research Project on Pearl millet
•Year of release: 2017

Mustard

Pusa Mustard 30 (low erucic acid variety)

• Containslowerucic **acid (<2.0%)** in oil as compared to **>40% erucic acid** in popular varieties
• Oil content: **37.7%**
•Developed by ICAR-Indian Agricultural Research Institute, New Delhi
•Year of release: 2013

Pusa Double Zero Mustard 31 (low erucic acid & low glucosinolate variety)

• Country's first Canola Quality Indian mustard variety
•Low **erucic acid (<2.0%)** in oil and **glucosinolates (<30.0 ppm) i**n seed meal as compared to **>40.0% erucic acid** and **>120.0 ppm glucosinolates** in popular varieties
• Oil content: **41.0%**
• Developed by ICAR-Indian Agricultural Research Institute, New Delhi
•Year of release: 2016

CONCLUSION

It is well established that biofortification is a promising, cost-effective, agricultural strategy for improving the nutritional status of malnourished populations throughout the world. The results show that bio fortification with mineral nutrients through selecting environmental and agronomic conditions seems to be limited when the effect of the genotype on the grain composition is very strong. Biofortification is yet to be fully scaled-up in a single country, but much evidence and experience has been assembled to support its eventual effectiveness.

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