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Bio Fortification

Parthasarathi V.[1] and Mohamed Yaseen S. K.[2]
[1]B.Sc, Student, Don Bosco College of Agriculture, Sagayathottam, Goa
[2]Assistant Professor, Don Bosco College of Agriculture, Sagayathottam, Goa

SUMMARY

Malnutrition, anemia and hidden hunger are the major problems in recent years. But people are not much knowledge, awareness and money to cure this problem. Thus the bio fortification is the promising only way to improve ¬the status of malnourished populations throughout the world and it is cost effective. But there are many difficulties for developing biofortified crops. To overcome this barrier, the collaboration between plant breeder, nutritional scientist, genetic engineers, and molecular biologist are essential. Plant breeders must aware of both agriculture research in past and potential plant breeding in future to improve nutrition and health. Scientists must refine individual micronutrient status and important cross- nutrient synergy to create awareness and knowledge among people.

INTRODUCTION

For the human body function and development, nutrients are important. Nutrition is defined as "The science of food and its relationship to health" (Nestel *et al*, 2006). It helps to provide energy, body structure and metabolic activities of the body. In world, 840 million people do not have adequate food /nutrition requirement. UNFAO (United Nations Food and Agriculture Organization) reported that 792.5 million people affected by malnutrition among these 780 million peoples in developing countries, 2 million peoples are hidden hunger (Saltzman, 2013). UNICEF& WHO reported that 69% below 5 aged children have malnutrition and less immune power. 30% pregnant women, 43% preschool children have malnutrition, >30% affected by anemia. Hence, nutritive foods are produced with the help of Biofortification leads to satisfy the world food needs.

Biofortification:

Bio fortification is form of two words. Greek word 'Bios' means 'life' and Latin word 'Fortificane' means 'Make strong'. Bio fortification is introduced in the year 1990s by CGAIR (Consortium of International Agricultural Research Centre) and the lead researcher was Dr**.** Howarth Bouis. Bio fortification is the process of improving the nutritional availability of food crops by agronomical practices, Conventional breeding and biotechnological approaches such as genetic engineering and genome editing. By plant breeding, higher level of vitamins, minerals, proteins and healthier fats are produced in biofortified crops to improve public health (Bouis *et al*, 2011).

Main Objectives followed in Biofortification:

To improve following content in plants,

- Protein content and quality
- Oil content and quality
- Vitamin content
- Micronutrient and mineral content

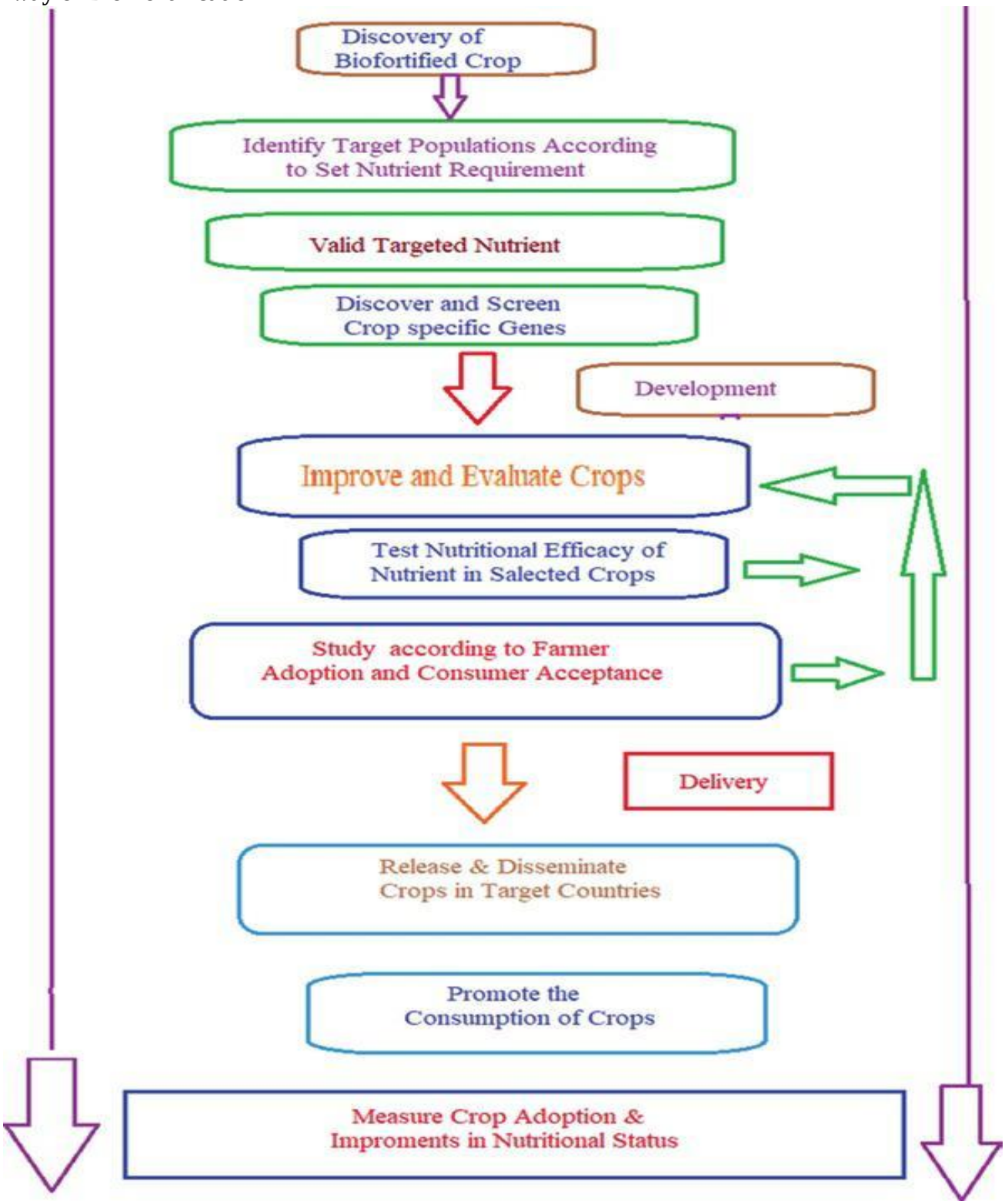
They are all naturally synthesized by plant in basic food materials.

Bio Fortified Crops:

- At 2000, maize hybrid – Protons, shakti, Ratna (Twice amount of lysine and tryptophan)
- Cultivated wheat – by using "Atlass 66" (High protein content variety)
- Madhuban Gajar, a biofortified carrot variety with high β-carotene and iron.

Biofortified Crops	**Nutrients**
Carrot, Spinach, Pumpkin	Vit A
Bitter gourd, Mustard, Tomato	Vit C
Spinach	Iron and calcium
Broad bean, Lablab, French bean, Garden pea	Protein

Pathway of Bio Fortification



Approaches for bio fortification:

There are three approaches,

- Transgenic approach.
- Conventional breeding
- Agronomic approach

Bio Fortification – Transgenic Approach:

Transgenic refers to an organism or cell whose genome has been altered by the introduction of one or more foreign DNA sequences from another species by artificial means. These are achieved through genetic engineering and genome editing. If limited genetic diversity means, we can go for genetic approach. Oilseeds are less genetic diversity, less heritability, linkage drag. Comparatively, oilseeds are most suitable for biofortification by transgenic method.

Some gene sources:

- Phytoene synthase (*psy*)
- Carotene desaturase (*Crt 1*)
- Nicotiamide synthase 1 (*OsNAS1*) and 2 (*OsNAS2*)
- Ferrin
- Example : **Golden rice - High vit-A (β-carotene)**

  Genes involved are phytoenedesaturase (*psy*), carotene desaturase (*Crt 1*), Lycopene β synthase (icy).

Conventional Breeding:

Conventional breeding is defined as crossing together plants with relevant characteristics, and selecting the offspring with the desired combination of characteristics, as a result of particular combinations of genes inherited from the two parents.

I Method – High Nutrient and Desirable Agronomic Trait

Parental lines

High Nutrient × Desirable agronomic trait

A B

↓

F_1 (AB)

(Desirable nutrient and agronomic trait)

Sometimes, limit genetic variations present,

II Method – Desirable Trait in Commercial Variety

Parent lines

Distant relatives × Commercial varieties

A B

↓

F_1 (AB)

(Gene of trait transferred)

Now, new traits are introduced directly by mutagenesis to commercial varieties. Several international organizations have initiated this program.

Example: IR72, Jalmagna– Double iron, 40% zinc content.

Agronomic Approach:

Physical application of nutrients helps to improve the crop nutrient. The mineral and fertilizers passes through solubilization, mineralization from soil to edible plant parts (Cakmak *et al*, 2018). Easily available to plant, simple, inexpensive cure malnutrition. But need attention on environment, level of nutrients applied, method of application and source of nutrients. Plant growth promoting micro organisms used for nutrient mobility from soil to edible portion. They are *Pseudomonas, Rhizobium, Azatobacter* and *Mycorrhizal*.

Successful:

- Se fertilizer to crop –Finland
- Zn fertilizer to crop – Turkey
- Fe fertilizer in irrigation water – China.

Benefits:

- Satisfy he food need of poor people and rural areas
- Sustainable for future
- Increase nutrient quality, crop quality.
- In transgenic, short time to result.
- No post harvest addiction of the nutrients is required.
- The seed of biofortified crops are sown generation to generation without purchase.

Limitations:

- Takes time to improvement.
- Not readily acceptable by the farmers..
- Loss of wild varieties.
- Sometime Undesirable effects may cause due to linkage drag.
- Loss of biodiversity
- Genetic contamination in natural and world.
- Less genetic variability
- Presence of anti nutrients.

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