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Nutritional security through crop Bio-fortification

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Bio fortification is the idea of breeding crops to increase their nutritional value. This can be done either through conventional selective breeding, or through genetic engineering. Bio fortification differs from ordinary fortification because it focuses on making plant foods more nutritious as the plants are growing, rather than having nutrients added to the foods when they are being processed. This is an important improvement on ordinary fortification when it comes to providing nutrients for the rural poor, who rarely have access to commercially fortified foods.As such, bio fortification is seen as an upcoming strategy for dealing with deficiencies of micronutrients in low and middle-income countries.

Goal of bio fortification:

- The goal of bio fortification is to contribute to reducing the high prevalence or specific nutritional deficiencies, especially of zinc, iron and vitamin A.
- This is so achieved by improving the micronutrient content of staple food crops that are produced and consumed by these populations and hence, if bioavailability is demonstrated, increasing the adequacy of micronutrient intakes.

Golden rice:

Golden rice is a variety of rice (*Oryza sativa*) produced through genetic engineering to biosynthesize beta-carotene, a precursor of vitamin A, in the edible parts of rice. It is intended to produce a fortified food to be grown and consumed in areas with a shortage of dietary vitamin A, a deficiency which each year is estimated to kill 670,000 children under the age of 5 and cause an additional 500,000 cases of irreversible childhood blindness. Rice is a staple food crop for over half of the world's population, making up 30–72% of the energy

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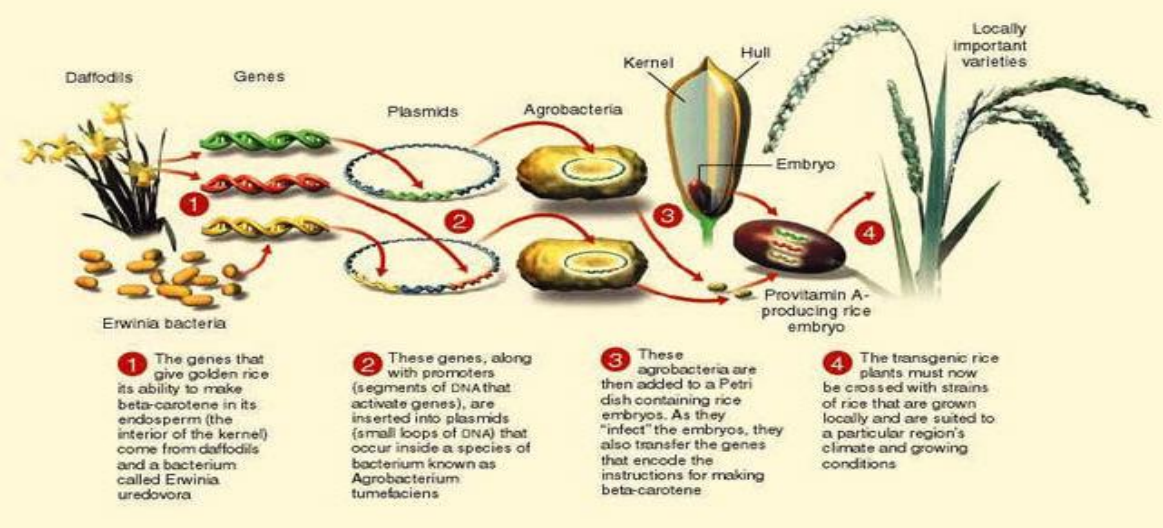
intake for people in Asian countries, making it an excellent crop for targeting vitamin deficiencies.

Golden rice project:

A japonica variety of rice was engineered with three genes necessary for the rice grain to produce and store beta-carotene. These included two genes from the daffodil plant and a third from a bacterium. Researchers used a plant microbe to ferry in the genes into the plant cells. The incorporation of these genes allows the rice plant to modify certain metabolic pathways in its cells to produce precursors of Vitamin A, which was previously not possible.

A four step process:



Quality protein maize (QPM):

Quality protein maize (QPM) originally developed in the late 1990s at CIMMYT Mexico possesses roughly twice as much usable protein as normal maize grown in the tropics. The improved quality of the protein in QPM is due to enhancement in lysine and tryptophan – the two limiting amino acids that are known to be regulated by *opaque*2 gene and associated modifiers. QPM has widely been adopted for cultivation in the developing world to fight protein malnutrition. In India, QPM was released for commercial cultivation almost a decade ago by introducing QPM lines from CIMMYT.

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Quality protein maize for nutritional security:

Rapid development of short duration hybrids through molecular marker assisted breeding.

- In order to shorten the period required for development of QPM hybrids through the conventional method of backcrossing, marker assisted selection can be used.
- Few molecular markers were already known within the o2 gene and these makers were capable of detecting the o2 gene even in heterozygous state.
- To convert normal maize hybrid into QPM hybrid, a promising hybrid, viz. Vivek Maize Hybrid 9 (developed by Vivekananda ParvatiyaKrishiAnusandhanSansthan, Almora) was selected for converting into QPM.

Amino acid Profile of non- QPM

(Vivek Maize Hybrid 9) and QPM hybrid (Vivek QPM 9)

Hybrid	**Vivek Maize Hybrid 9**	**Vivek QPM 9**	**Percentage increase/ decrease over Vivek Maize Hybrid9**
Protein	9.5	8.5	-10
Tryptophan	0.59	0.83	41
Lysine	3.25	4.19	30
Leucine	14.10	12.36	-12
Histidine	2.57	3.15	23
Methionine	1.84	1.91	3.8

Vivek QPM 9 yielded more as compare to Vivek Maize Hybrid 9 in the multi-location yield trials. Vivek QPM 9 has further been found suitable for cultivation under organic farming.