

## **GOLDEN RICE DEVELOPMENT IN BIHAR: IS IT A SOLUTION OR A PROBLEM<sup>1</sup>?**

A 68-lakh rupees project called “Development of Golden Rice for various agro-ecological zones of Bihar” is currently underway in the Rajendra Agricultural University, Samastipur in Bihar, utilizing funding support available under the Rashtriya Krishi Vikas Yojana (RKVY). This paper attempts to share the main concerns with regard to this genetically modified Golden Rice with key policy makers in Bihar so that it is understood that Golden Rice is no solution to any problem.

### **What is Golden Rice?**

Golden Rice is a GM rice variety produced through genetic engineering, to produce beta-carotene, the precursor to pro-Vitamin A in the edible parts of the plant; it is being developed on the claim that this would address malnourishment problems related to Vitamin A deficiency. Golden Rice has been created by genetically modifying rice with two beta-carotene biosynthesis genes: one from daffodil (psy or phytoene synthase) and another from a soil bacterium (crt1, from *Erwinia uredovora*). These genes have been inserted into the rice genome and are controlled by an endosperm-specific promoter.

The argument given in favour of Golden Rice is that nearly 124 million people mostly in Africa and Asia are affected by Vitamin A Deficiency (VAD) leading to deaths, cases of irreversible blindness etc. Children and pregnant women are at highest risk from VAD. It is noted that current oral and other supplementation methods have their own problems. It is therefore argued that since rice is a staple food for many affected people, genetic modification of rice to produce beta-carotene is a simple solution.

The original Golden Rice produced 1.6  $\mu\text{g/g}$  of carotenoids under greenhouse conditions. It is claimed that field-grown Golden Rice produces 4-5 times more beta-carotene than that is produced under greenhouse conditions. A Golden Rice variety with a maize gene along with the bacterial gene is now reported to produce 23 times more carotenoids than the original Golden Rice – upto 37  $\mu\text{g/g}$ .

### **Actual requirement & availability in Golden Rice:**

Until recently, 6 micrograms of beta-carotene was assumed to equate to 1 microgram of vitamin A when converted in the human body. However, this ratio is now thought to be an overestimate of the production of vitamin A from provitamin A or beta-carotene. Accordingly, it is now estimated that 12 micrograms (to even 21 micrograms) of ingested beta-carotene are required to produce 1 microgram of vitamin A.

There are several factors affecting the bioavailability of provitamin A compounds. Nutritional deficiencies such as of zinc, protein and fat/oil can limit the bioavailability.

On top of that, carotenes are fat-soluble. There needs to be sufficient amount of fat in the diet of the poor people for whom Golden Rice is being prescribed as a solution without which this cannot be assimilated. It is also unclear how much Vitamin A

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<sup>1</sup> A note prepared by Alliance for Sustainable & Holistic Agriculture (ASHA)

degrades after the plant is harvested and at what speed and how much would remain after cooking. It is important to note that no data has been published on the degradation of carotene during storage to this day, lest it pose a question on the efficacy of this so-called solution to VAD.

The argument provided by Dr Vandana Shiva on this subject is as follows: *Since the daily average requirement of Vitamin A is 750 micrograms (avg) and one serving contains 30 grams of rice on dry weight basis, Golden Rice would provide only 9.9 micrograms, which is 1.32% of the RDA. If we take 100 gms as the daily consumption of rice, it would only provide 4.4% of the RDA. In order to meet the full needs of 750 micrograms of Vit A from rice, an adult would have to consume 2.272 kilos of rice/day!*

The main point to be noted is that VAD is a problem of a general lack of balanced diet and therefore, approaches to solve this problem should be more holistic. Poor people at whom this Golden Rice is being targeted can neither afford larger quantities of rice (it is also not clear at what price this Golden Rice might be available) nor can they go looking for different reductionist solutions to different malnourishment problems that they face. Further, without adequate fat and other contents in the diet, this Golden Rice would yield no benefits to such poor consumers.

#### **IPR issues:**

The creation of Golden Rice reportedly involved the waiving off of many IPRs (nearly 70 belonging to 32 different entities) as per the developers, the corporates and universities involved in the development of this rice. Even as it is being said that there is no fee for the humanitarian use of golden rice, it is not clear how this will be operationalised and right now, there is a cutoff being defined between humanitarian and commercial use of Golden Rice. However, the owners of the IPRs did not abandon their patents which leaves the possibility of them changing the royalty arrangements any time in future.

#### **Safety issues:**

Like in other GE crops, Golden Rice also involves imprecise and unpredictable processes. For instance, from the GE inserts, Golden Rice originally should have been red due to the presence of lycopene but to the surprise of scientists, it turned out yellow. In addition, unexpected compounds such as lutein and zeaxanthin were formed in the first generation of Golden Rice. The possibility of these and other unexpected compounds is very real, leading to anti-nutritional, allergenic or even toxic effects in humans, as has been found with other GM crops. Environmental risks include contamination, including with wild and weedy relatives. It has been seen that after such outcrossing with GM rice, some of the weedy rice varieties exhibit surprising characteristics like higher rate of reproduction, lending them an advantage over other plants. Some of the Golden Rice plants of the first generation showed unexplained differences to the respective non-GE control plants: "shorter stature, dark and stay-green nature, late flowering and some of them had a much smaller number of seeds".

On the other extreme is the possibility of over-dose of Vitamin A, which could result from this Golden Rice. Vitamin A in low dosages is necessary for health, but at high dosages, it can cause liver damage leading to fatality. Vitamin A toxicity can cause abdominal

pain, nausea, vomiting, and bulging fontanelle. Chronic toxicity can cause bone and joint pain, hyperostosis, hair loss, dryness and fissures of lips, nausea, hypertension, low grade fever, and weight loss. What if we are unable to control such dosages?

**Reductionist outlook towards nutrition and causes for malnourishment:**

By focusing on a narrow problem, the larger issue of active erosion of diverse, nutritionally adequate, safe foods is being obscured and neglected. Further, the issue of structural poverty which is at the root of such malnourishment is also neglected. Provision of land for food production can go a long way in tackling the problem, for instance. Production of a wider diversity of crops and livestock for greater nutritional diversity in the diet is a key to solving the problem in a holistic and lasting manner.

Food Source	$\beta$ -carotene Content ( $\mu$ g/g)
Carrots	46 - 125
Leafy vegetables	10 - 444
Sweet potato tuber (orange)	200
Sweet potato leaves	11.4
Coriander leaves	11.6
Curry leaves	13.3
Amaranth leaves	2.66 - 11.6
Melon (cantaloupe)	20.2
Mango	4.4
Palm oil	92.8
Liver (goat, sheep)	66 - 100
Cod liver oil	100 - 1,000

Source: Compiled from: Shiva, V. (undated). The "Golden Rice" HOAX – When public relations replaces science. <http://online.sfsu.edu/~rone/GEessays/goldenricehoax.html>

Note: Compare to Golden Rice which contains of 31  $\mu$ g/g  $\beta$ -carotene.

**Alternatives that are sustainable and true:**

Food based strategies include promotion of bio-diversity and development of home gardens. Promoting uncultivated foods is another approach. Dietary diversification coupled with large awareness programs is a key to evolving sustainable answers to the problem of malnourishment including VAD.

Drumstick leaves have 75 micrograms of betacarotene per gram of leaf material and edible jute has 102 micrograms. Indian mustard has 160 micrograms!

Bihar government has a special programme running on promotion of drumstick cultivation. The solution lies right here, to create a massive awareness program on the dietary advantages of this drumstick, rather than pursue the false solution of Golden Rice.

Beta carotene occurs even naturally in some rice varieties and the government has to make adequate documentation of many folk and traditional rice varieties to understand that the solution lies within the existing resources that are safe and affordable.

References:

1. "Vitamin A: Natural Sources Vs. Golden Rice", Greenpeace, February 2001
2. "All that glitters is not Gold: The false hope of Golden Rice", Greenpeace, May 2005
3. "The campaign for GM Rice is at the crossroads: A critical look at Golden Rice after nearly 10 years of development", Christoph Then, FoodWatch, January 2009
4. "Who needs Golden Rice", PANAP Rice Sheets, 2007