Second Edition

PANAP RICE SHEETS

WHO NEEDS GOLDEN RICE?

1.0 WHAT IS GOLDEN RICE?

Golden Rice is a genetically engineered rice with the capability to produce beta carotene, the precursor of Vitamin A. It is called Golden Rice (GR) because of its characteristic orange/yellowish color, the color of carotenoids. This new technology was first developed by Dr. Ingo Potrykus of the Swiss Federal Institute of Technology in Zurich and Dr. Peter Beyer from University of Freiburg, Germany from 1991 to 2000 with an expenditure of about $100 million (Ho 2001; Shiva 2001). It was initially funded by the Rockefeller Foundation, the Swiss Federal Institute of Technology, the European Community Biotech Program and the Swiss Federal Office for Education and Science (Ho 2001).

The production of beta carotene in rice endosperm was made possible by inserting three foreign genes into rice, one from a bacterium *(Erwinia uredovora)* and two from the daffodil *(Narcissus pseudonarcissus).* The initial level of beta carotene in Golden Rice 1 (GR1) was minimal at 1.6µg/g, and this was criticized, but industry heralded it as a solution to blindness caused by Vitamin A deficiency.

Continuous research has improved the level of beta carotene in what is called Golden Rice 2 (GR2) to 31µg/g, using corn as the source of genes (Barry 2007). GR2 is based on the original design, but uses fewer or different genes.

Despite the propaganda surrounding the development and potential use of GR, the level of Vitamin A in it is still very low compared to many natural and cheap foods in the tropics. GR is being heralded as a quick "fix" and miracle cure for Vitamin A deficiency and blindness. However, it is a subject of considerable debate between corporate scientists and biotech industry, which advocate it, and independent scientists, farmers, consumers, and development workers who contest it. The latter see the real purpose behind Golden Rice as a public relations tool by the biotech industry to win acceptance of genetically engineered food and products.

Syngenta bought patent and licensing rights over GR1, but solely developed GR2. It used World Food Day on 16 October 2004 to announce the donation of GR2 to the Golden Rice Humanitarian Board under the same conditions and licensing terms as the previous Golden Rice. The Golden Rice Humanitarian Board, chaired by Dr. Ingo Potrykus, is a public-private partnership responsible for the global development, introduction and promotion of Golden Rice to target countries. This project is sponsored by Harvest Plus which is funded by the Bill and Melinda Gates Foundation, the World Bank, the US Agency for International Development, Syngenta Foundation, the Rockefeller Foundation, and some research institutions.

A Golden Rice Network, based at the International Rice Research Institute (IRRI), is now active in the further development of GR, particularly in breeding the 'golden' trait into local rice varieties. The network comprises IRRI, Philippine Rice Research Institute (Philippines); Cuu Long Delta Rice Research Institute (Vietnam); Department of Biotechnology, Directorate of Rice Research, Indian Agricultural Research Institute, University of Delhi South Campus; Tamil Nadu Agricultural University, Patnagar University of Agricultural Sciences; Bangalore Chinsurah Rice Research Station (India); Bangladesh Rice Research Institute (Bangladesh); Huazhong Agricultural University, Chinese Academy of Science Yunnan Academy of Agricultural Sciences (China); Agency for Agricultural Research (Indonesia); University of Freiburg (Germany), along with Syngenta and other private and public institutions (Barry 2007). Syngenta has "donated" its Golden Rice lines for use by the Golden Rice Network as well as to poor farmers in developing countries. (see 3.3)

2.0 VITAMIN A AND VITAMIN A DEFICIENCY (VAD)

2.1 Functions of Vitamin A in the Body

Nutrients, vitamins and minerals are essential for human health. Vitamin A is very important for good vision, eye health, normal cell function, growth, immune system function, reproduction, fertility, and healthy skin. It also maintains the normal functioning of the glandular and epithelial tissues lining the alimentary canal, and the respiratory and urinary tracts. Vitamin A is responsible for pigmentation in

Mangoes, sweet potatoes and carrots are natural sources of Vitamin A (Photos courtesy of Wikimedia Commons)

the retina of the eye, which is very important for night vision, hence it is also technically known as **retinol**. Vitamin A stimulates the secretion of mucous which protects the eyes and the gut, as well as the respiratory and genitor-urinary tracts (Edmunson and Edmunson 2001). A precursor of Vitamin A from plants is available in the form of beta carotene.

Vitamin A deficiency (VAD) can lead to xerophthalmia (severe dryness of the eye surface) and night blindness, both of which in turn can lead to total blindness in extreme cases. The most vulnerable group is children. As Vitamin A has an anti-infection property, VAD can weaken the immune system and cause predisposition to infectious diseases, as well as a decrease in the capacity of the body to withstand stress (Goodhart 1968).

2.2 Vitamin A and Food Sources

Sources of Vitamin A usually come from animal products which include milk, cheese, cream, eggs, meat, liver, kidney, and fish oil (Institute of Medicine 2001). Vitamin A is soluble in fat and fat solvents, but not in water. This means that adequate fat intake is needed for the absorption and utilization of Vitamin A. Without fats, Vitamin A is simply not absorbed and will be excreted.

Carotene is a component of many plants and can be absorbed by the internal mucosa of the small intestines for conversion to Vitamin A. The most important and abundant of the carotenes is beta carotene which is sometimes called pro-vitamin A because it is more readily converted to Vitamin A compared to other carotenoids. Plant sources include dark green leafy vegetables such as spinach and sweet potato leaves, yellow tubers such as carrots and sweet potato, and yellow fruits like papaya, mango, and melon (Edmunson and Edmunson 2001). Analgae, *Dunaleilla salina,* which is grown in sea waters, can even produce 10,000 times more beta carotene per unit weight than carrots (Tate undated). In other words, natural sources of Vitamin A are abundant in communities with diverse food systems. Some of the common foods that contain high beta carotene, like carrots, are presented in Table 1. Other common vegetables with high beta carotene include spinach, kale, tomato, red pepper, peas, cabbage, broccoli, radish leaves, mint, jute leaves, horseradish, colocasia leaves, swamp cabbage, string beans, collard greens, asparagus, and many more. Fruits with high level of beta carotene include jackfruits, avocado, oranges, watermelon, peaches, and apricots. Vitamin A is also high in animal products like eggs, meat, milk, cheese, cream, liver, kidney, cod, and fish oil.

It has to be emphasized that fat intake is the basic prerequisite for the absorption and utilization of beta carotene, while proteins and Vitamin D enhance absorption of it. The low fat content in the diets of poor families is responsible for the high incidence of VAD (Edmunson and Edmunson 2001). Red palm oil is the only vegetable oil known to be rich in beta carotene that is affordable by poor families. Oil palm is widely grown in some countries like India, Indonesia and Malaysia, but is not easily available in every country and has been largely replaced by imported refined white cooking oils which do not contain beta carotene.

2.3 Conversion Equivalence

The currently acceptable bio-conversion rate of beta carotene to retinol is 12:1 (Nestel et al. 2006). An average of 250 µg retinol activity equivalent (RAE) /day is needed for children up to eight years old, while adults require an average of 500 µg RAE /day (Institute of Medicine 2001). This of course presupposes that sufficient fats in the diet are available and that there are no digestive tract illnesses or parasitism.

There is also a slight change in beta carotene during cooking. Experiments on orange-fleshed sweet potato recorded a 20% reduction of beta carotene after cooking (van Jaarsveld et al. 2005).

Datta (2003), a scientist from IRRI, reported beta carotene losses in Golden Rice to be about 10% after cooking. More systematic analysis of beta carotene losses after cooking is needed for different

Table 1. Selected vegetables, fruits and other food with high levels of beta carotene

Food Source	Beta Carotene Content (μg/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: Golden Rice's beta carotene content is 31μg/g.

food preparations. Then (2009) points out that there seems to be disinterest in generating basic data or even concealing relevant data because after almost ten years of research, systematic data on cooking and the absorption quality of Golden Rice is missing. The website of Golden Rice[1] mentions that "Golden Rice can be cooked just like any other rice" but instead of scientific data, recipes on rice are featured (Then 2009). Interestingly, in the absence of basic data, Golden Rice advocates blame critics for delaying the release of GM rice but do not address their valid concerns.

2.4 Causes of Vitamin A Deficiency

Understanding the causes of Vitamin A deficiency is fundamental to formulating sound solutions to this nutritional problem. Complex factors affecting nutritional deficiencies imply that no single nutrient such as Vitamin A incorporated into food can be effective in addressing such deficiencies.

If food sources of beta carotene are abundant, why is VAD so prevalent? The main reason is poverty and its associated conditions. VAD is one among a range of complex nutritional deficiencies, together with protein calorie malnutrition, iron deficiency anaemia, and iodine, vitamin and micronutrient deficiencies. Poor families are simply too impoverished to access the necessary foods for a balanced diet (Barry 2007).

The bio-availability of beta carotene depends on good digestion, absorption, conversion into retinol, and transport, the technical term for translocation of nutrients from the point of absorption (the intestines) to the point of storage (liver/fat tissues) and point of utilization within the body. Like Vitamin A, beta carotene is fat soluble and therefore fats in the diet are a prerequisite for absorption. Unfortunately, the diets of families in communities where vitamin A deficiency is endemic, have low fat content because they are poor and cannot afford a balanced diet.

Beta carotene requires enzymes in the intestinal mucosa to convert it into Vitamin A. Thus, a functional digestive tract in conjunction with adequate protein, Vitamin D and fats in the diet are prerequisites for absorption and conversion of the pro-vitamin. Protein malnutrition may affect Vitamin A metabolism in three ways. It may interfere with the intestinal absorption of both retinol and beta carotene due to changes in the intestinal wall and depression of digestive enzymes. Secondly, it may adversely affect the hepatic storage of the vitamin as well as the mobilisation and transport from the liver to the tissues. Thirdly, it may impair utilisation at the tissue level (Stoecker and Arnrich 1973).

When Vitamin A intake is low, the surface epithelial tissues of the intestines are compromised, resulting in greater prevalence of diarrhoeal diseases (Edmunson and Edmunson 2001). Individuals afflicted with infectious diseases such as diarrhoea, measles, whooping cough, tuberculosis and hookworm experience VAD because the absorption and utilization of beta carotene or Vitamin A is hampered by these diseases.

Similarly, children suffering from diarrhoea due to unhygienic conditions and dirty water, and individuals with intestinal diseases, will not be able to take up or retain nutrients like beta carotene or Vitamin A. No amount of beta carotene in Golden Rice can solve these complex nutritional and economic problems.

There is also a cultural dimension to VAD. Even when food sources of beta carotene are abundant in many rural areas, VAD is a problem because of the lack of awareness of the nutritional content of food. In many countries in Asia, villagers often sell nutritious food such as eggs, mangoes, papayas, cantaloupes in order to buy popular junk food like carbonated drinks and instant noodles. In some places in Indonesia, yellow corn is sold in preference to white rice while green leafy vegetables are negatively perceived as a poor man's food. In addition, the mono-cropping

[1] Foodwatch. http://www.foodwatch.de/

agricultural technology promoted through the Green Revolution has eroded and to a large extent destroyed the natural biodiverse food systems in most of Asia. This has seriously contributed to VAD.

2.5 Incidence of Vitamin A Deficiency

According to FAO data, there are about 925 million people suffering from hunger in the world today (FAO 2010). But if we include those who appear to have enough to eat but in fact lack essential micronutrients, minerals and fats ("hidden hunger"), the estimate could be much higher (the State of the World estimated in 2000 that the figure then could be as high as two billion).

Hunger and malnourishment are perennial problems of humankind and it is indisputable that VAD is a serious problem. It is estimated that 1.5% of the world's population is afflicted with a 15% reduction in acuity or eye vision (Edmunson 1986). In Asia, VAD is endemic in mainly rice-eating countries like Bangladesh, parts of India, and Indonesia. It is estimated that in Bangladesh, India, Indonesia, and the Philippines, there are 500,000 new cases of xerophthalmia per year, half of them resulting in blindness (Sommer 1981). In India, Chouhan (1977) reported that 40% of blindness cases are due to Vitamin A deficiency, with about 13,000 people, mostly children, going blind each year due to xeropthalmia. Shah (1982) estimated 220,000 cases of keratomalacia (softening of the cornea) in India in 1981, with about 120,000 becoming partially blind and 52,000 becoming totally blind each year.

In Bangladesh, clinical VAD (where signs are already apparent or detectable by physical examination) has a prevalence of 2.1% of the rural population with an additional 12% sub-clinical VAD (early stage or mild form/stage where the symptoms are not yet very apparent) among rural adolescent females (Talukder 2002). It is intertwined with a malnutrition condition in which 50% of adolescents showing thinness and stunting, 75% with anemia, 3% with iodine deficiency, and 47% with vitamin D complex deficiency.

In the Philippines, however, there was a significant reduction in VAD during the period 1998 to 2008, even without Golden Rice. VAD prevalence in children (6 months to 5 years old) was reduced from 38% to 15.2%, in pregnant women from 22.2% to 9.5%, and among lactating mothers from 16.5% to 6.4% from 1998-2008 (FNRI 2008).

3.0 VITAMIN A RICE AS A SOLUTION?

3.1 Current Status of Golden Rice

The development and advocacy of Golden Rice is currently very strong. The governments of India and Switzerland have signed an agreement for the technology transfer of genetically engineered Vitamin A rice (Shiva undated). Local transformation and breeding of Golden Rice is undertaken by local institutions like the Central Rice Research Institute, Punjab Agricultural University, Tamil Nadu Agricultural University, and University of Delhi. The varieties where Vitamin A is being engineered are IR64, ASD16, PR114, and Pusa Basmati (Shiva undated). Golden Rice has also been aggressively promoted in Bangladesh and the Philippines. GR2 was bred by IRRI with BR29 (a popular rice variety in Bangladesh) and field testing began in 2009. In the Philippines, Golden Rice has been bred with two popular rice varieties (IR64 and PSB Rc82) and field testing started in 2010 (Virk and Barry undated). The National Agricultural Research Systems in China and Vietnam are also active in the development of Golden Rice.

3.2 The Problem with Golden Rice

Golden Rice cannot address the biological, cultural, and dietary factors underlying causes of Vitamin A deficiency. VAD is just one among a multiple set of malnutrition problems.

In the digestive system, beta carotene may be converted into retinal or oxidized into retinoic acid (RA). RA, which can accumulate in fat and plasma, and its metabolites are toxic and teratogenic. Vitamin A in low dosages is necessary for health, but at high dosages, it can cause Vitamin A hypervitaminosis[2] and teratogenicity[3]. Vitamin A toxicity can cause abdominal pain, nausea, vomiting, and bulging fontanelle in babies. Chronic toxicity can cause bone and joint pain, hyperotosis, hair loss, dryness and fissures of lips, nausea, hypertension, low grade fever, and weight loss (Shiva 2001).

One argument against GR was the claim that a person needs to consume as much as 9 kg of it in order to meet the daily recommended dosage of Vitamin A (Greenpeace 2001). With GR2, IRRI tried to address this critique by increasing the carotenoid level; however, the question remains if such levels can be translated into the same amount of Vitamin A (conversion rate).

Is the Golden Rice safe from any novel genotypic characteristics that

[2] Vitamin A hypervitaminosis is an adverse physiological effect or abnormal condition resulting from excessive intake of the Vitamin A which can cause liver damage and fatality (Tansey and Worsley 1995).

[3] Teratogenecity means causing birth defects or malformations due to disturbances in the normal growth and development of an embryo, expressed as central nervous system abnormalities and cranial and facial malformation (Ganguly 1989; Hendrickx and Hummler 1992; Rothman et al. 1995)

could put human health at risk? In genetic engineering, pleiotropic (unintended and unwanted) effects are common because the gene transformation process is random in that there could be more than one site of insertion of foreign genes.

The foreign genes are also likely to rearrange or they may be subjected to deletions or repetitions. All these would likely produce new kinds of protein products that are not within the evolutionary history of human consumers, and thus raise the risks of reduced nutrient levels, or enhanced levels of anti-nutrients, toxins or allergens (Ho 2001; NRC, NAS 2004). For example, Zolla et al. (2008) reported that of the 43 proteins monitored, 14 had reduced levels, 13 had increased levels, 9 were shut off, and 7 were newly expressed in transgenic corn.

One does not have to look far for examples of pleiotropic effects of GMOs because the yellow color of the grains of Golden Rice was unexpected. Golden Rice should have been red because lycopene (which is red) was expected to be the product of the two carotenoid biosynthesis transgenes [phytoene synthase (PSY) and bacterial carotene desaturase (CRTI)] used in Golden Rice transformation (Schaub et al. 2005). However, lycopene was never observed in any transformed rice plant. Instead, beta carotene, lutein and zeaxanthin were the products (Schaub et al. 2005).

Very recently, Bt toxin (Cry1Ab) was detected in blood samples taken from mothers' foetal and non-pregnant women's blood (Aris and Leblanc 2011) showing that these toxins are not effectively eliminated in the human body. This finding reveals the high health risk of Bt crops. Even if the source of inserted genes comes from edible crops, there is still a high health risk as illustrated when a previously harmless protein from a bean transferred to a pea caused inflammation in the lungs of mice and provoked reactions to other proteins in the feed (Prescott et al. 2005).

And then there is the potential for ecological change in the environment. Even if rice is self-pollinated, breeders contend that there is still a 10% possibility of out-crossing with other rice varieties. Contamination of varieties can also happen through seed mixing or in the field from volunteer plants (plants that grow on their own from seeds carried in the wind, left in the field from the last harvest, etc.) that are mixed during harvest. The contamination of long grain rice by genetically engineered herbicide-resistant rice (LL601) from the U.S. last year is illustrative of this problem. Moreover, it was reported that GE rice has higher outcrossing with wild rice and weedy rice and the hybrids created from this exhibited higher reproductive rates meaning that weedy rice can become super weeds (International Biosafety Forum Beijing 2008). The danger is that field contamination is irrevocable and cannot be contained.

Consumer resistance is also anticipated because of the yellowish color and perhaps even the texture of Golden Rice. Who will shoulder the losses of farmers if nobody wants to buy yellow rice, either due to the color or due to the rejection of GE food by consumers?

Another technical obstacle is that beta carotene fades with storage (Pelegrina 2007). Carotenoids, by nature, are susceptible to light degradation and oxidation, and losses of Vitamin A during processing, storage and food preparation may be high (WHO 2006). If Golden Rice is to be delivered to Vitamin A deficient locations, timely delivery will have to be addressed and consumers informed of the loss of Vitamin A in storage. Families will have to consume the rice within a specific time frame. This will be impractical in remote communities which often store their own grains for a year's consumption due to limited transportation facilities. Families will thus have to change their consumption patterns in order to get the best out of Golden Rice. What will be the advantage of Golden Rice to traders who usually keep grains in warehouses for a season if it will lose its beta carotene in storage? They would be better off supplying Vitamin A rich vegetables to the consumers.

To produce rice with high pro-vitamin A is undoubtedly a scientific breakthrough, but to claim that it can address multiple nutritional deficiencies and prevent blindness is unscientific. It is an obvious public relations stunt pulled by corporate scientists to garner acceptance of genetic engineering. In fact, Golden Rice perpetuates the industrial model of agriculture which eliminates biodiversity, which in turn is a major cause of decline in dietary diversification, the main cause of malnutrition.

3.3 Who is Promoting Golden Rice?

Is the technology of Golden Rice really free? The technology in the development of Golden Rice involves 70 patent claims on the genes, DNA sequences and gene constructs (Ho 2001). AstraZeneca (now Syngenta) made an agreement with the technology developers (Drs. Potrykus and Beyer) for commercial exploitation of the technology via patents and licensing agreements. It was then announced that the corporate owners of the patents would not collect royalty or technology fees on Golden Rice from "resource-poor farmers in developing countries" who earned less than US$10,000 in farming income (Steinbrecher in press). Only farmers in developed countries would be required to pay royalty fees. But the announcements did not clarify if farmers would be allowed to save seeds for replanting. Neither did the owners abandon the patents, which means that they can change royalty fees at any time.

Golden Rice as a cure for VAD is a naïve technocratic solution to a complex nutritional problem associated with poverty. It masks true and practical solutions by advocating a very expensive and unreliable technology. In the words of Shiva (2001), “the Golden Rice is part of a package of globalized agriculture which is creating malnutrition”, and the scientists advocating Golden Rice perhaps “suffer a more severe form of blindness than children in poor countries”.

However, there appears to be more insidious corporate motives behind the promotion of Golden Rice. Golden Rice research was initiated at a time when genetically modified organisms (GMOs) were being rejected by consumers, farmers, and civil society. Thus, Golden Rice is a Trojan horse to create public acceptance of genetically modified crops and food. Through Golden Rice, biotech corporations are being recast as philanthropic and humanitarian institutions. Consequently, Golden Rice could pave the way for other genetically engineered crops and ultimately change the nature of the food we eat, ensuring widespread corporate control of agriculture and food systems. More recently, IRRI has been at the forefront of pushing Golden Rice. The Bill and Melinda Gates Foundation has provided US$20 million towards its development and eventual commercialization and Helen Keller International has joined the bandwagon by aligning with IRRI to get funding for Golden Rice and conduct efficacy and monitoring studies on it.

The People’s Response

Civil society organizations, farmer groups and people’s movements all over Asia have rallied against the incursion of GE rice/crops/food into the region for years because they represent a violation of the people’s food sovereignty and pose a serious threat to human and environmental health and safety.[4]

Resistance to Golden Rice in the Philippines has been strong. Farmers and consumers have joined non-government organizations in their opposition to it. Coalitions like the ‘No to GMOs’ and RESIST Network are actively campaigning to stop Golden Rice through different fora, dialogues, debates, and mass actions. The issue had been brought to the attention of the Agriculture Committee and some legislators have passed a resolution to investigate the field testing of Golden Rice in the country. Some enlightened legislators have questioned whether Golden Rice is really needed against the background of so many crops and food that have high beta carotene content. The issue of health risks has also been raised as rice is a staple food. For the case of Bangladesh, see the box entitled ‘Resistance against Golden Rice’.

4.0 PRACTICAL STRATEGIES TO COMBAT VAD

A combination of food fortification and supplementation is still the most practical and economical approach to deal with communities afflicted with VAD. Food fortification is usually done by adding Vitamin A to basic food items like noodles, margarine, flour and bread which are commonly consumed by vulnerable sectors. This measure has been done for decades in industrialized countries and some developing countries with fairly good levels of success.

Supplementation is administering Vitamin A via oral intake or injection to children who are deficient in the vitamin. Multi-vitamin capsules or liquid preparations are available in pharmacies or provided for free through UNICEF and government programs. In a nutrition program in Kerala and Mysore in India as well as in Indonesia, a 75 to 85% reduction in the incidence of blindness was recorded. (Tarwotjo et al. 1987; AID 1973). Dietary diversification coupled with education is the

Farmer and consumer groups across Asia have been resisting the incursion of GE rice/crops for years (action in the Philippines, India, and Bangladesh from left to right)

[4] See WORA 2007, WORA 2008, YORA 2009-2010 and CORA 2011 and the Rice Sheet “GE Rice – The Genetic Engineering of the World’s Leading Staple Crop”, all at www.panap.net.

Resistance against Golden Rice – The Case of Bangladesh

Rice, the staple food crop of Bangladesh, covers more than 10 million ha of cropped area and accounts for 94% of food grain production in the country (Nasiruddin 1999). The resistance against Golden Rice was most intense in Bangladesh where it has been introduced in field trials. The first effort to introduce GMOs in Bangladesh was done through a debate organized by the Bangladesh Agricultural Research Council (BARC) in September, 2002. On 29 November, 2004, the then Director General, Bangladesh Rice Research Institute (BRRI) wrote a letter to the Ministry of Agriculture and Chairman NTC Crop Biotechnology for the introduction of Golden Rice seeds in Bangladesh (Akhter 2007). Besides BRRI, the Bangladesh Agricultural University Research Systems (BAURES) in Mymensingh, the Department of Botany in Dhaka University, Bangladesh Institute of Nuclear Agriculture, and Bangladesh Agriculture Research Council (BARC) are also involved in carrying out research on Golden Rice, working in collaboration with the International Service for Acquisition of Agri-Biotech Application (ISAAA), Syngenta, Monsanto and USAID. Local farmers, especially from the Nayakrishi (New Agriculture) Movement, have organized various rallies from 2003 to 2007 at the local and national levels to resist GMOs in general and against Golden Rice in particular as they believe that GM seeds will ruin the traditional seeds, eco-systems and farmers of the country. On 19 February 2006, at least 500 farmers from across the country gathered to form a human chain at the Shahbag crossing and staged a procession vowing to resist GMO seeds in the country. Songs have even been composed by farmers against Golden Rice and Syngenta. *(Abstract from "The Resistance Against Golden Rice in Bangladesh" by Farida Akhter 2007*, unpublished paper) Note: since 2006, local groups have continued to rally against the resurgence of Golden Rice in Bangladesh.

best long-term solution to combat VAD. Vitamin A-rich food is readily available in most of the Asia-Pacific region where more than 100 kinds of green leafy vegetables are commonly part of the local food system. Reintroduction of local vegetables rich in beta carotene has been done in Bangladesh and Thailand.

People with Vitamin A deficiency are generally suffering from complex malnutrition problems like protein, calorie, micronutrient, and vitamin deficiencies. Increasing the food and nutritional security of poor families can be done by producing a wider diversity of crops and livestock for greater nutritional diversity. In Bangladesh, projects on small home gardens with vitamin-rich vegetables and fruits have been carried out by NGOs, the FAO, and farmers and have been found to significantly alleviate VAD. Uncultivated, naturally growing food such as leafy greens, tubers, small fish and animals—collected from agricultural fields, bodies of water, and forest areas—constitutes much of the diet of rural communities and are sources of Vitamin A (SANFEC 2004). In most cases, since the lives of the poor are precarious, land must be given to them to ensure a more secure production of food.

Considering that a teaspoonful of red palm oil per day can meet the Vitamin A requirements of a child, or that two tablespoonfuls of carrots can supply the daily needs of beta carotene for an adult, who needs Golden Rice?

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EMPOWERING PEOPLE FOR CHANGE
PANAP
PESTICIDE ACTION NETWORK ASIA & THE PACIFIC

Pesticide Action Network Asia and the Pacific (PAN AP) is one of five regional centres of PAN, a global network which aims to eliminate the harm caused by pesticides and promote biodiversity-based ecological agriculture. It is committed to the empowerment of people especially women, agricultural workers, peasants and indigenous farmers. PAN AP launched its Save Our Rice Campaign in 2003 in response to the powerful threats arising against rice, the staple food of half the world's population. The foundation of the Campaign is the "Five Pillars of Rice Wisdom": (1) Rice Culture, (2) Community Wisdom, (3) Biodiversity-based Ecological Agriculture, (4) Safe Food and (5) Food Sovereignty. The Campaign is dedicated to saving traditional local rice, small rice farmers, rice lands and the rice heritage of Asia. PAN AP Rice Sheets provide relevant information on the threats to rice and are written from the people's perspective. Enquiries may be sent to: panap@panap.net

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