GRAINS OF DELUSION:

Golden rice seen from the ground

February 2001

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INTRODUCTION

Rice does not normally contain vitamin A or its precursor, beta-carotene. But a group of European scientists have spent the last decade trying to change this. By inserting two genes from daffodil and one gene from a bacterium, Dr. Ingo Potrykus of the Swiss Federal Institute of Technology and Dr. Peter Beyer of the University of Freiburg in Germany have managed to engineer a beta-carotene pathway into Taipei 309, a japonica rice variety. In August 1999, they unveiled the fruit of their research and named it "golden rice." Shortly afterwards, they signed a deal with AstraZeneca, which agreed to waive technological fees to enable the development of the rice for "humanitarian" purposes. Monsanto was quick to jump on the humanitarian bandwagon by announcing royalty-free licenses for any of its technologies used to further the development of the rice. The small handful of transgenic rice grains produced in Potrykus' laboratory provided a much-needed public relations boost for the biotech industry at a time when genetic engineering is under siege in Europe, Japan, Brazil and other developing countries.

The biotech lobby is selling the idea that genetically engineered (GE) crops, starting with golden rice, will solve problems of malnutrition. This is an ambitious goal for a small grain of rice. The malnutrition agenda is drawing in support from every major agricultural biotech company, the Consultative Group on International Agricultural Research (CGIAR), the US Agency for International Development (USAID), and its main funder, the Rockefeller Foundation. But at the end of the day, the main agenda for golden rice is not malnutrition but garnering greater support and acceptance for genetic engineering amongst the public, the scientific community and funding agencies[1]. Given this reality, the promise of golden rice should be taken with a pinch of salt.

1. PROMISES, PROMISES ...

Golden rice has been met with excitement in every corner of the world. It has become a symbol of all the goodness biotechnology has to offer. Among other things, it is supposed to exemplify how genetic engineering can directly benefit consumers, which the first generation of genetically engineered crops has failed to do. It claims to provide a more sustainable, inexpensive and effective solution to vitamin A deficiency in poor, rice eating countries where drug-based supplementation and fortification have been ineffective. And in a climate where intellectual property rights (IPR) are the subject of controversy and uncertainty, it promises to provide the IPR-laden golden rice technology free of charge to subsistence farmers.

[1] Potrykus I, "The golden rice tale", 23 October 2000, retrieved from the world wide web at http://agbioview.listbot.com on 28 November 2000.

Examples of other nutritionally enhanced crops in the pipeline[2]

Trait	Companies/Institutions involved
Increased levels of beta-carotene in oil-seed rape	Monsanto
Increased bioavailable iron in rice	Swiss Federal Institute of Technology (Zurich)
Improving nutritive value of Andean potatoes by manipulating potato's own genes to block natural but bitter compounds called glycoalkaloids	USDA Agricultural Research Service (ARS); International Potato Center (La Molina, Peru)
High iron corn with less phytic acid, or phytate, than most common varieties (phytic acid is thought to reduce the body's ability to use certain nutrients like iron)	USDA ARS
Low glutenin rice	Orynova (Japan Tobacco)
Lactoferrin-producing rice	Japan Agricultural Cooperatives
Ferritin-rich lettuce	Central Research Institute of Electric Power Industry (Japan)

Freedom to operate or an excuse to corporate?

One of the major selling points of this golden rice technology is that the work has been done within the realm of public research using public funding. But the fact that golden rice has not been developed by and for the industry has come about not by design but default. Dr. Potrykus initially approached Nestle, the world's biggest food company, for funding but was rejected. In retrospect, Dr. Potrykus describes this as "fortunate" because it kept the project open for public funding and the potential for free distribution.[3] But it was more of an afterthought than a plan.

Despite being the result of public research, golden rice is enmeshed in around seventy patents owned by some thirty-two companies and institutions, according to the US-based International Service for the Acquisition of Agri-biotech Applications (ISAAA).[4] Because of the complexity of licensing arrangements, the inventors ceded their rights to Greenovation, a biotech spin-off company from the University of Freiburg, which then struck a deal with AstraZeneca (now Syngenta). According to Dr. Potrykus, a veteran in dealing with multinational companies and an inventor of a number of patented technologies, forging an alliance with AstraZeneca seemed to be the only option available to gain "freedom-to-operate" and speed up the transfer of the technology to developing countries. Hence by a stroke of a pen, AstraZeneca was able to acquire exclusive commercial control over a technology that was developed with public funding and purportedly pursued for a humanitarian cause.

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[2] Japan Innovative Technology Division website at http://ss.s.affrc.go.jp/docs/sentan/index.htm and USDA ARS website at http://www.ars.usda.gov/is/AR/archive/mar00/tort0300

[3] Ibid

[4] Kryder, R. David Stanley P. Kowalski and Anatole F. Krattiger, 2000,"The Intellectual and Technical property Components of Pro-Vitamin A Rice (GoldenRice™): A Preliminary Freedom to Operate Review," *ISAAA Briefs No.20*, ISAAA, Ithaca, NY.

Tangled up in patents

The AstraZeneca deal gives the corporation full commercial rights to the invention worldwide and "non-commercial" rights to the inventors for license-free use by national and international research institutes and resource-poor farmers in developing countries. A resource-poor farmer may sell the golden rice so long as s/he does not earn more than $10,000 a year from it. Any other commercial use of the golden rice technology – using public or private germplasm – and any export from a producer country requires a license from Zeneca on commercial terms.

Many see the deal with AstraZeneca as a rip-off. Despite of the huge number of patents involved, no more than 11 have the potential to serve as a barrier to the deployment of golden rice in countries with the highest levels of vitamin A deficiency, according to the Rural Advancement Foundation International (RAFI). The deal with AstraZeneca not only surrendered a decade of publicly-funded research to commercial control, but – more importantly – it strengthened the North's patent hegemony worldwide.[5]

According to a press release jointly issued by IRRI, the Rockefeller Foundation and Syngenta in January 2001, six out of the 32 or so companies and institutions which own patents on certain technologies used to develop golden rice, had each licensed the technology free of charge. The companies are Syngenta Seeds, Syngenta, Bayer, Monsanto, Orynova, and Zeneca Mogen. Subject to further research, initially in the developing countries of Asia, as well as local regulatory clearances, golden rice will be made available free of charge for humanitarian uses in any developing nation. However, the terms of the free license agreements are still unclear: they appear to cover research, but not release or commercialisation. This lack of clarity casts a huge question mark over how "free" the agreement really is and has huge implications for the accessibility, availability and affordability of golden rice to farmers around the world. Instead of resolving the intellectual property issues around golden rice, the inventors have passed the buck to developing countries and public institutions to sort out the mess themselves.

A "Humanitarian Board" has been established "to help make the right decisions" in any technology transfer agreement pertaining to golden rice. But the 'humanitarian' credentials of board members and their ability to judge the appropriate use of golden rice amongst resource-poor farmers are extremely questionnable. They include the Rockefeller Foundation (New York), Zeneca Agrochemicals, the World Bank (Washington), IRRI (the Philippines) and the inventors themselves. Adrian Dubock, who was formerly the commercial biotechnology manager of Zeneca and is now with Syngenta, serves as the secretary of the board. The board also receives support from ISCB or the Indo-Swiss Collaboration in Biotechnology, which is jointly financed by the Indian Department of Biotechnology (DBT) and the Swiss Development Corporation (SDC).

From Bt rice to golden rice[6]

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[5] RAFI, "Golden Rice and Trojan Trade Reps: A Case Study in the Public Sector's Mismanagement of Intellectual Property," RAFI Communique, September/October 2000,No. 65 available at http://www.rafi.org.

[6] Perlas N. and R. Vellve, 1997, *Oryza Nirvana? An NGO Review of the International Rice Research Institute in Southeast Asia*, Pp.61, 63, 117-118.

The first ever genetically engineered insect resistant indica rice variety also came out of the lab of Dr.Potrykus in the Swiss Federal Institute of Technology (ETH). In April 1995, Dr. Potrykus sent Bt rice seeds containing a gene owned by Ciba Geigy (now Novartis) to IRRI in the Philippines. The package was intercepted by Greenpeace on the grounds that the necessary permit to export the genetically engineered seeds to the Philippines had not been obtained. But a week later, more Bt rice seeds were on their way to IRRI – this time via diplomatic pouch. IRRI's Bt research faced strong opposition from many NGOs in Asia and around the world and also caused tension even within IRRI itself where some of its more ecology-oriented scientists question the usefulness of Bt rice in farmers' fields. According to an IRRI scientist, Bt rice strains have also been sent to India, but up to now no field-testing has been conducted in the Philippines or India.

According to Dr. Potrykus, agreements have already been established with several institutions in Southeast Asia, China, Africa and Latin America and are only awaiting submission of a written confirmation of the "freedom to operate" to the humanitarian board.[7] However, Dr. Dubock refuses to give further information on these agreements. India is being looked upon as a possible model for technology transfer of the golden rice. Golden rice will be introduced in India through ISCB with possible funding from DBT, the Indian Council for Agricultural Research (ICAR) and the World Bank. Last 19 January 2001, Dr. Potrykus arrived at IRRI with the golden rice, where scientists will start transferring the golden rice trait to commercial varieties.

2. A REALITY-BASED ASSESSMENT

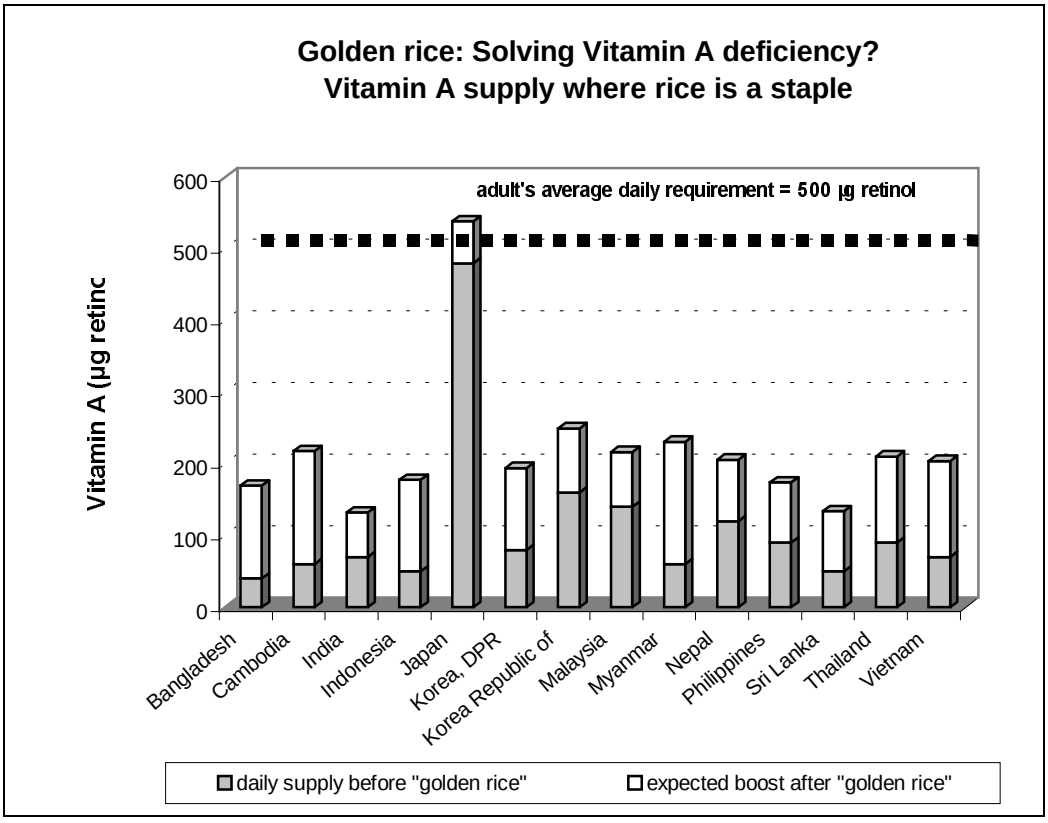
Malnutrition is said to be high in rice-eating populations. But these nutritional problems are not caused directly by the consumption of rice. They reflect an overall impact of multiple causative factors similar to those of other developing countries where rice is not a major staple.[8] Various deficiencies including zinc, vitamin C and D, folate, riboflavin, selenium and calcium occur in the context of poverty, environmental degradation, lack of public health systems and sanitation, lack of proper education and social disparity. Poverty and lack of purchasing power is identified as a major cause of malnutrition.[9] These underlying issues that can never be addressed by golden rice.

The Green Revolution with its inherent bias towards monocultures of staple crops has led to unbalanced patterns of food production in many places. As the UN Food and Agriculture Organisation (FAO) has stated, variety is the key and should be the norm rather than the exception in farming systems. According to Dr. Samson Tsou of the Asian Vegetable Research and Development Center (AVRDC), countries with vegetable consumption of more than 200 grams of vegetables per day do not have vitamin A deficiency as a major problem.[10] Although animal sources are expensive, inexpensive plant food sources are widely available. It only takes two tablespoonfuls of yellow sweet potatoes, half a cup of dark green leafy vegetables or two-

[7] Potrykus I, "The golden rice tale", 23 October 2000, retrieved from the world wide web at http://agbioview.listbot.com on 28 November 2000.
[8] Juliano, B. 1993, Rice in human nutrition, FAO, Rome, P.24.
[9] The Hindu, "Key factor in development: nutrition by Dr. K. Venkatasubramanian", 16 May 2000 accessed in the world wide web at http://planningcommission.nic.in/key.htm on December 2000.
[10] Email communication from Dr. Samson Tsou, Director General, Asian Vegetable Research and Development Center (AVRDC) to GRAIN dated 16 February 2000.

thirds of a medium-sized mango in a day to meet the vitamin A requirement of a pre-school child.[11] This way, not only is the vitamin A requirement being addressed, but a whole range of other micronutrients as well.

With what has been shown so far, 300 grams of golden rice can only provide *at most* 20% of an adult's daily vitamin A requirement (see graph). A child would have a lower requirement of 450 **µg retinol as against 500-600 µg retinol for adults.**[12] But 300 g of rice a day is way too much for a child. In the Philippines, pre-school children consume less than 150 grams of rice a day. In principle then golden rice will only supply a little over 10% of the daily vitamin A needed by pre-school children. And children are the target population in this case.



Whether the beta-carotene contained in golden rice will be bioavailable is yet another question. Dietary fat is needed for it to be absorbed by the body. Unfortunately dietary fat is also limited in rice-eating countries and in fact is being looked at as one possible "hidden" causes of vitamin A

[11] Gilbert C., "Preventing blindness", *Child Health Dialogue*. Appropriate Health Resources and Technologies Action Group, 1997 available at http://www.who.int/chd/publications/newslet/dialog/7/blind.htm

[12] *Preliminary Report On Recommended Nutrient Intakes*, Revised July 13, 2000, Joint FAO/WHO Expert Consultation on Human Vitamin and Mineral Requirements FAO, Bangkok, Thailand, September 21–30, 1998. This level of intake is set to prevent clinical signs of deficiency, allow normal growth, but does not allow for prolonged periods of infections or other stresses.

deficiency itself.[13] There are also important interactions between different nutrients and minerals, which further warrants variety in food intake. Zinc deficiency, for example, may lead to an impairment of vitamin A metabolism. Disease control and hygiene, food selection and preparation will significantly influence absorption and utilisation of vitamin A (and iron). Furthermore, there has been debate over the bioconversion of beta-carotene from green leafy vegetables into vitamin A. Some reports claim that the conversion rate is less than one-quarter of what has been assumed up to now. Should this be the case, the amount of vitamin A made available from golden rice would be almost negligible.

Despite statements being made that there is not a slightest risk of overdosage from golden rice and conceivable risk to consumer health and the environment,[14] no testing has been conducted. According to Dr. Mae Wan Ho, vitamin A poisoning has been known to result from excessive beta-carotene intake in food. Allergenicity has also been raised as a possible issue. Daffodil, which is the source of the genes for the beta-carotene rice, is responsible for an allergic reaction which manifests as "daffodil picker's rash" in some people.[15]

3. CLASHING PERSPECTIVES

According to Gary Toenniessen of the Rockefeller Foundation, "The benefit of having the beta-carotene in the crop is that the delivery system is already there. The current generation of improved varieties is being grown in rural areas not being reached by supplements." But we know too well that the Green Revolution did not reach marginal areas where many of the poor reside, so golden rice is not likely to go there either. According to Dr. Gurdev Khush of IRRI, the golden rice trait will be inserted in commercially grown rice varieties (such as IR64) since these varieties provide 80% of the rice in cities. Will it reach the rural poor? Or will it create a segmented market where golden rice captures a premium due to its added "nutritive" claim? It may be that golden rice will develop as a "specialty crop" in the Philippine market according to one of the leading rice breeders in the Philippine Rice Research Institute. Dr. Emorn Wasantwisut of the Institute of Nutrition at Mahidol University in Thailand goes as far as saying that it may initially start off as a "brand name" crop, in which case accessibility to the poor may be limited.

"Malnutrition is not merely a nutrition problem, it is also a social problem," says Dr. Samson Tsou, Director General of AVRDC. "Income generation, healthy diet and proper education needs to be improved simultaneously for sustainable development," he adds. In terms of priorities, increasing vegetable production may be more effective than improving vitamin A content. In Tsou's view, "The adoption rate of the so called modern varieties of cereal crops is still not very high after 30 years of Green Revolution. To introduce a new type of staple food with color will even take a longer time to be popularised. Just take any other technology, the

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[13] Gillespie S and J Mason, *Controlling Vitamin A deficiency*, ACC/SCN Nutrition Policy Discussion Paper No.14, January 1994, P.36.

[14] Potrykus, I, *Ingo Potrykus Response to Golden Rice Critics*, AgBioWorld dated 28 June 2000, accessed through the web at http://www.biotechknowledge.com.

[15] Conway, G., *Crop biotechnology: benefits, risks and ownership*, Paper presented in an OECD conference: "Assessing the Safety of GM Food" held 28 February to 1 March 2000 at Edinburgh International Conference Center. http://www.oecd.org/subject/biotech/ed_prog_sum.htm.

engineered crop will benefit certain growers and consumers but the vitamin A deficiency will not be resolved by any single technology."[16]

According to Riza Tjahjadi of the Pesticide Action Network – Indonesia, nutrient-enhanced GE crops, such as beta-carotene-enriched or high-iron rice, made available "freely" to poor farmers in the South will not automatically increase rice farmers income. "We can see this because the terms of trade for smallscale farmers in Indonesia have not improved since the Green Revolution, which focused so much on increasing yields of a few selected grains. In reality, we keep facing a crude mismatch when people try to make poverty the target of agricultural technology. Farmers get the rethoric thrown at them, but the livelihood improvements don't follow."

For local groups like MASIPAG (The Farmer Scientist Partnership for Development Inc.) in the Philippines, combating a socio-economic problem with a technofix solution is reliving the Green Revolution – which they have totally turned their backs on. "Pro-vitamin A rice or golden rice is but a prescriptive approach to malnutrition wherein only a few varieties will contain the trait thereby further worsening genetic erosion" warms MASIPAG. "Malnutrition will even reach greater heights, as people will have more unbalanced diets based only on few foods," it adds.

Golden rice will supposedly be freely available to poor farmers. Although the notion of "free distribution" means free from royalties or added cost for the technology, for many farmers, cost does not only translate into monetary terms. For Mr. Afsar Ali Miah, a Bangladeshi farmer, "Nothing comes in free anymore, without its consequence, especially if it is driven by profit motives." He relates this vividly with his experience in the 1960s when Green Revolution seeds were introduced. At that time, the technology was started with all out support from the government and many farmers responded positively making use of the packaged technology of modern high-yielding varieties together with pesticides, and chemical fertilisers and a certain amount of credit. But when the uncertainty and fear of new was mitigated, the government slowly started withdrawing support and the farmers were left to deal with poor soil, lost seeds and declining diversity in the field, and dependency on pesticides and fertilisers. In the process, farmers lost control of their food system. According to Mr. Ali Miah, "Because of pesticides, people are no longer eating what little edible green leafy vegetables (and fishes) there are left in the fields anymore. If we allow this golden rice, and depend for nutrition on it, we might further lose these crops, our children losing knowledge of the importance of other crops such as green leafy vegetables."

The question of whether or not vitamin A deficiency should be addressed is not the issue on the table. But proponents of golden rice have always been quick to raise the morality flag when it comes to questioning the merits and motivations behind the GE approach. According to the CGIAR's Technical Advisory Committee, IRRI should "Continue to campaign for GE as a

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CGIAR's Technical Advisory

Dr. Samson Tsou, Director General, Asian Vegetable Research and Development dated 16 February 2000.

legitimate breeders' tool, using the 'golden' rice as a flagship."[17] In an interview with Dr. Potrykus, he said, "If some people decide that they want blind children and white rice, it's their decision. I'm offering the possibility of yellow rice and no blind children. But the decision what people want to eat is theirs."[18]

However, Farida Akhter of UBINIG, an organisation working with marginalised farmers and weavers in Bangladesh is quick to point out that biotech companies are looking to the poor in developing countries because of the strong opposition to GE crops in developed countries, such as the EU and Japan. According to Akhter, the poor are a good target because they are less powerful and less able to make technology choices. She adds that, "While golden rice is still in its pre-introductory stage, it is being promoted as if the poor have been asked if they wanted it and said 'yes'."

According to Daycha Siripatra of the Alternative Agriculture Network in Thailand and the director of Technology for Rural and Ecological Enrichment, vitamin A deficiency will not be solved by golden rice technology since it does not address the key to the problem of poverty, which is landlessness. "They're cheating us. If the poor had land, they would have better diets. The poor don't need vitamin A. They need vitamin L, that's Vitamin Land. And they need Vitamin M, that's Vitamin Money. Malnutrition is because of poverty, not [a lack of] technology."

4. ALTERNATIVES

IRRI says that the Green Revolution may have actually increased malnutrition among the poor.[19] Consumption of vegetables in most Asian countries has remained stagnant since the Green Revolution and vegetable prices have increased in both real and relative terms.[20]In India, annual rice and wheat production has more than tripled from pre-Green Revolution levels. On the other hand, household consumption of vegetables has dropped 12 percent over the last two decades. Pulse and legume consumption is down even more and is becoming more and more costly, and malnutrition remains high.[21]

Reclaiming the drylands....[22]

17 Systemwide Review of Plant Breeding Methodologies in the CGIAR, IRRI Sub-Panel Report, 27- 31 March 2000, p.10, also available at : http://www.cgiar.org/tac/meetings/tac79/pbirri.pdf

18 From Life, a broadcast program entitled A-OK? And can be accessed at http://www.tve.org/life/archive/life26script.html

19 IRRI, 1999, *Rice: hunger or hope? IRRI Corporate Report 1998-1999, Manila.*

20 Email communication from Dr. Samson Tsou, Director General, Asian Vegetable Research and Development Center (AVRDC) to GRAIN dated 16 February 2000.

21 From a study by Dina Umali-Deininger and Deepak Ahluwali, SASRD on "Improving Household Food and Nutrition Security in India" as reported on *New & Noteworthy in Nutrition*, IssueNo. 35, July 2000. http://www.worldbank.org/html/extdr/hnp/nutrition/nnn/current.htm.

22 Discussion with Dr. Sanyal, DRCSCofficer, who is mainly working in the dry areas. Most of the information in this box was based on his account.

Golden rice proponents say that it will be particularly useful in marginal areas such as drought-prone regions where vegetables usually cannot be grown. But the Development Resource and Service Center (DRCSC) in Calcutta has demonstrated that such regions can be made to produce a rich and varied diet and should not simply be written off in this way.

In many drought-prone areas of Purulia, Bankura, part of Birbhum and Baduria, farmers often migrate to nearby villages after every cropping to earn their living as laborers. In some parts of these districts, rainfall only ranges from 800-1,200 mm and only one rice cropping is possible. Through the efforts of local farmers and the interventions of DRCSC, these arid lands have been transformed into productive and diverse farmland. In home gardens, vegetables are grown year-round. In the fields, rice or corn and pulses are grown during the rainy season; legumes and oilseeds are the main focus in winter. In early summer, some farmers cultivate cowpea, but many leave their lands fallow for at least 2 to 3 months. Farmers were able to bring back life to a once barren land left only to fallow or as grazing land for cattle.
But it wasn't an easy task for the farmers and DRCSC. Careful planning, and the promotion of sustainable agricultural practices such as soil and water conservation techniques, mixed cropping and appropriate crop varieties were critical to achieving success. These interventions helped to increase soil water retention and organic matter content and help prevent the little topsoil there was from draining off to the lowlands.

There are a variety of food plants available in conjunction with other non-plant based food sources that can provide a rich and healthy diet for many people in Asia. To meet the average daily requirement of vitamin A, requires the consumption of only 50 grams of cassava leaves, 73 g of dark green vegetable leaves, 78 g of sweet potato leaves or 133 g of taro leaves.[23] A far more effective approach to treating vitamin A deficiency is surely to focus on the utilisation of these food plants, especially since many of them are fast disappearing in the fields.

According to Ardhendu Chaterjee of the Development Resource and Service Center (DRCSC) in Calcutta, India, the problem of malnutrition is linked not with rice per se, but with the way rice is produced now.[24] "In the past, integrated rice-fish-duck-tree farming was a common practice in wetlands. This does not only meet peoples' food, fodder and fuelwood needs, but it provides superior energy-protein output to that obtained from today's monoculture practice of growing high-yielding varieties. These fields also serve as the hatcheries for many fishes and aquatic organisms, which multiplied and spread to other wetlands. In the rainy season, these lowland rice fields often become connected to the water bodies like lakes and rivers. Agrochemicals applied in the paddy pollute these water-bodies and hence affect the entire food chain, thereby causing a decline in the overall fish, shrimp and frog supply – a resource freely available to the poor. Aquatic weeds which are rich in vitamin A are also becoming scarce." Sadly this is a scenario fast becoming common in most of Calcutta and over the whole Asian region.

In Bangladesh, UBINIG has been working with farmers to seek alternatives to chemical agriculture. Nayakrishi Andolon is a community-based system of organic farming being promoted

[23] *Roots, tubers, plantains and bananas in human nutrition*, FAO, Rome, 1990. Also available at http://www.fao.org/inpho/vlibrary/t0207e/T0207E06.HTM

[24] Personal communication with Ardhendu Chaterjee, Director, DRCSC, 21 July 2000.

by UBINIG and being practiced by more than 60,000 families in Bangladesh.[25] Many of these farmers, especially women, are aware of the nutritional importance of green leafy vegetables including wild species, and are strongly campaigning against the indiscriminate spraying of pesticides. In the villages, a wide range of uncultivated and cultivated plants and fishes are available which have been raised or harvested without the use of chemical fertilisers and pesticides.

Dr. Romy Quijano, a medical doctor who heads the Philippine Action Network, also believes that the sensible approach to preventing vitamin A deficiency is to see that the vulnerable sectors of the population are empowered enough to access natural sources of vitamin A. "Effective nutrition education is much better than adding yet another source of vitamin A which most likely will not be equitably distributed anyway; improving livelihood; providing better health care system; addressing malnutrition, communicable diseases and other illnesses that make children more vulnerable to vitamin A deficiency."[26]

Growing your vitamins[27]

Promoting kitchen gardens can be an effective way of addressing malnutrition. Traditional gardens provide valuable minerals, vitamins and amino acids, which make a substantial contribution to household food security. However, according to FAO's 1996 State of the World Report on Plant Genetic Resources for Food and Agriculture, the contribution of such plants and systems to alleviating micronutrient deficiencies is greatly underappreciated.

SWANIRVAR, an NGO engaged in rural development, has been keen in promoting kitchen gardening for the past 5 years in 9 villages in 24 Parganas, West Bengal. Women were encouraged to grow fruits and vegetables in their backyards to supply or augment the nutritional needs of their families. After just two seasons of her garden, Kobita Mondall relates that, "We have already consumed all that we can, have given some to the neighbours and sold some in the market, and still we're getting something from our backyard." Kobita's garden consists of a 300 square foot plot near their home, planted with more than 30 kinds of fruits and vegetables.

[25] See http://www.undp.org/tcdc/bestprac/social/cases/4-nayakrishi(1).htm for more background information on Nayakrishi Andolon.

[26] Email communication from Dr. Romeo F. Quijano of UP Manila, College of Medicine, to GRAIN dated 12 December 1999.

[27] Personal discussion and visit to Kobita Mondal's village at Dist 24 Purganas, North Calcutta, 23 July 2000.

CONCLUSION

While many doubt the ability of golden rice to eliminate vitamin A deficiency, the machinery is being set in motion to promote a GE strategy at the expense of more relevant approaches. The best chance of success in fighting vitamin A deficiency and malnutrition is to better use the inexpensive and nutritious foods already available, and in diversifying food production systems in the fields and in the household. The euphoria created by the Green Revolution greatly stifled research to develop and promote these efforts, and the introduction of golden rice will further compromise them. Golden rice is merely a marketing event. But international and national research agendas will be taken by it. The promoters of golden rice say that they do not want to deprive the poor of the right to choose and the potential to benefit from golden rice. But the poor, and especially poor farmers, have long been deprived of the right to choose their means of production and survival. Golden rice is not going to change that, and nor will any other corporately-pushed GE crop. Hence, any further attempts at the commercial exploitation of hunger and malnutrition through the promotion of genetically modified foods should be strongly resisted.

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