Title: ***Golden Rice can save millions of lives every year***

Adrian Dubock, general manager of the project, explains how to make it happen

The lack of vitamin A kills 2 million children under 5 every year. The problem has a solution, rice which provides a plentiful source of vitamin A: Golden Rice. But to develop and introduce Golden Rice where it is needed has been a long and difficult process that is still going on.

CIB talked to Adrian Dubock, general manager of the project, about the history of the project, the difficulties that have been and are being faced to make it available to farmers and consumers and what could be done to make it happen.

CIB: When did the Golden Rice project start and why?

Adrian Dubock: Dietary vitamin A deficiency is a huge developing country problem. It is responsible in total for an annual death toll probably greater than those other scourges - all diseases - HIV/AIDS (about 1.8m deaths in 2009), TB (about 1.7m deaths in 2009) and malaria (about 0.75m deaths per annum) and it may contribute to some of these deaths.

In the absence of vitamin A the human immune system is impaired so that common diseases, especially childhood diseases, become lethal. Another impact of vitamin A deficiency is that vision may be impaired, in some cases irreversible blindness, often followed by death, occurs. Young children and mothers are particularly vulnerable to the deficiency as their bodies have so many other physiological strains. Dietary sources of vitamin A are animal products such as meat, milk and eggs. Plants never contain vitamin A. Animals, including man, make vitamin A from the carotenoid pigments in plant food, especially beta-carotene. Beta-carotene is also responsible for the colour in carrots and many other coloured fruits and vegetables.

Many people in rice consuming societies eat little else, for one reason or another. There are often economic reasons why a more varied diet is not consumed. White rice is almost completely the macronutrient carbohydrate with a little protein. Essential micronutrients, such as iron and zinc are present only in very low amounts, and pro-vitamin A carotenoids are completely absent.

Alternatives for improving the vitamin A status of individuals, communities and populations include education about the value of dietary diversity, the value of home gardening, and since the early 1990's the provision of vitamin A capsules via health networks in countries. Nevertheless, these interventions are insufficient, as the statistics show. The World Health Organisation (2005) state that globally 190 million children are at risk of vitamin A deficiency, and that 23 – 34% of under 5 child mortality, and 40% of maternal mortality could be prevented by access to a universal source of vitamin A.

The latest – 2009 – UN under 5 years annual child mortality figure is 8.1m. So 23 – 34% is 1.8m – 2.8m preventable child deaths annually which have to be added to preventable maternal mortality. And more than half the world's population of 7 billion people has rice as its staple, often essentially only food.

The totally unacceptable scale of preventable vitamin A deficiency can also be appreciated as follows. You will recall the shock, suffering and sympathy elicited by the 2001 '9/11' attacks on the Twin Towers in New York, the Asian tsunami of 2004, and the 2011 Fukushima tsunami. Every single day vitamin A deficiency kills about the same as died from the 2011 Fukushima tsunami. On every day which passes vitamin A deficiency kills 4 or 6 times as many people as died in the 9/11 attack. And each and every month, year in year out, vitamin A deficiency kills about the same number of people as those who died in the terrible 2004 Asian tsunami centered on Indonesia.

In 1992 the UN International Conference on Nutrition commented that in addressing nutritional problems the first priority is for locally based food strategies. Supplementation, for example with vitamin A capsules should be considered an interim measure. A recent 2011 review article has urged that the benefits of vitamin A supplementation are so clear and so profoundly beneficial that no more trials are justified. Efforts should concentrate on getting a source of vitamin A to populations who need it.

The original idea for a yellow rice to combat vitamin A deficiency came from a rice breeder, Peter Jennings in around 1984. Subsequently the Professors Ingo Potrykus and Peter Beyer started research at their labs in Germany and Switzerland to try to create such a rice. As there was no rice variety which contained carotene in its endosperm, there was no variation to improve on using conventional breeding technologies. Other tissues of rice contained carotenoids, but not the grain. The scientists wanted endosperm also to produce carotenoids.

At the time most people considered the quest would be unsuccessful and so funding for the research was difficult. Nevertheless by using genetic engineering and rice transformation to introduce the new genes the inventors' teams had by the end of the decade been successful. Three introduced genes (subsequently reduced to 2) demonstrated that rice endosperm could produce beta-carotene. The amounts expressed initially were quite low, although we now know sufficient to make a significant difference to reducing vitamin A Deficiency.

At that time (in 2000) I started talking to the inventors because the company I worked for Zeneca (which became Syngenta) was interested in commercial rights to their technology.

CIB: What happened then?

Adrian: The inventors, Professors Potrykus and Beyer were always clear from the outset that they wanted to donate their technology free of charge to benefit

resource poor people in countries where Vitamin A deficiency was a problem. Through negotiation, and resulting cross licenses and commitments to future support, including regulatory support and exchange of improved technology, we were able to satisfy the inventors' altruistic requirements and at the same time the company's commercial interests by defining the different "markets" and agreeing rights.

I also negotiated on behalf of the inventors with other companies to include their third party technology - which may have been used in the inventive process - in the licensing for the inventors humanitarian purposes only.

Together we established a network of public sector Golden Rice licensees in developing countries interested to collaborate for the humanitarian aims of the project. We also formed a Humanitarian Board of volunteers from different fields of expertise to assist us in guiding the strategy for Golden Rice and to make the Golden Rice trait available free of charge within national regulations. A website; www.goldenrice.org was established to facilitate communication about the project to a very interested global audience and reduce the onerous task of the inventors repeatedly answering similar questions from different interested individuals and the press.

CIB: How do you feel now working in this project?

Adrian: We are excited by the demonstrated potential for Golden Rice in its current form to significantly reduce vitamin A deficiency in rice consuming societies. We have data proving that Golden Rice can be as effective as preformed Vitamin A in capsules, or milk or eggs as a source of Vitamin A, and that only 40g a day of dry Golden Rice when cooked and consumed will save lives and sight.

At the same time we are frustrated because of the over-burdensome bureaucracy which accompanies genetically engineered crops and which therefore delays Golden Rice. The people suffering from vitamin A Deficiency need help as soon as possible, and as a biofortified staple crop Golden Rice has the potential to provide it with no extra cost or logistical impediment.

In India two separate years of delay were caused first by political suspicion of the project causing delay before necessary agreements could be signed, and then before gaining permission to import Golden Rice seed requested by Indian rice breeders.

In almost all countries extraordinary conditions are required for initially growing genetically engineered crops. These include expensively constructed glasshouses, screen-houses or other isolation facilities, with full filtering of any of water, air and soil as well as plant material. The design, funding and building of these facilities is "justified" by (scientifically unproven) concern about the safety of genetically engineered crops, and in the case of screen houses to

prevent pollen flow. And of course the whole process causes significant delay, even when funds are available.

Rice breeding stations are able in open fields to grow different rice varieties (there are more than 20,000) distinctly with no more than 25 – 50cm spaces (and no barrier) between the rows. This is because rice pollen effectively doesn't flow due to the biology of rice reproduction.

Nevertheless, as a genetically engineered crop, all the above containment was initially required in Europe and Asia for Golden Rice. Although the first field trial of Golden Rice could be conducted in 2004 in the USA, in Asia open field plot growth was not possible until 2008.

CIB: And what is the status of the project right now?

Adrian: In March 2009, the Humanitarian Board were able to make, on the basis of comprehensive data from agronomic and human bioavailability studies, the decision to select one Golden Rice transformation event to distribute to all the countries for incorporation into their local rice varieties through breeding. This strategy had earlier been accepted to reduce costs and increase the speed of availability of Golden Rice for adoption.

As of today, October, 2011, more than two and a half years on, the selected Golden Rice seed has been supplied to research institutes in only two countries: India and Philippines.

The inventors and the public sector Golden Rice licensees in other countries are very frustrated by this slow progress, at a time when multiple rice breeding programmes could be underway in multiple countries. All licensees already have the legal ownership of the Golden Rice trait. They need the physical materials. And use of the same physical materials – the same transformation event even in different varieties of rice - is effectively mandated by the regulatory environment.

CIB: Why is it so slow?

Adrian: Significant delays to the project are and have been caused by a number of factors, mostly arising because of human suspicion, and in some cases fear of activist attack. The suspicion arises from the idea that genetic engineering is of more concern for environmental and human health than other forms of plant breeding. There is zero evidence that crops created using genetic modification are any worse, or better for human or environmental health than crops bred using other technologies.

The Convention on Biodiversity ("recognising poverty alleviation as the priority of development") arising from a heavily activist influenced UN environmental meeting (The Rio 1992 "Earth Summit") and the related (extremely

precautionary) Cartagena Protocol resulted in a witch-hunt for suspected theoretical environmental problems associated with GMO's. More than $100m was subsequently paid by the UN Environmental Programme in GMO crop risk assessment training. (But interestingly, no investments in training to quantitate benefits have been made. Isn't risk a relative measure?)

At the time many activist NGO's thought that genetically engineered crops should be opposed as part of their anti globalization agenda. Simultaneously the (then rich) European population, after decades of successful agricultural subsidy and related cheap and plentiful food, increasingly were remote from agricultural production. When they thought about agriculture at all they preferred a romantic vision of low intensity agriculture to the industrial farming needed for the bountiful harvests, low cost food and preservation of wildlife land which they, at the same time, appreciated. In this environment European countries found it useful to amplify GMO concerns as part of protectionist policies for European agricultural production where subsidizing production was becoming too expensive. There is evidence that the European Union funded activist opposition to lobby the same EU against genetically modified crops!

All these forces together have resulted in suspicion of the technology of genetic engineering when applied to crops (but interestingly not to food processing or pharmaceuticals) which undermines much of the thinking and related actions of governments, philanthropists, and companies and many of the individuals within them. More objectivity is required by society to turn potential benefits of Golden Rice, or related projects, into real ones.

In such a climate of suspicion gaining support for the research and development is extremely challenging. The Rockefeller Foundation has been a funder of the project on three occasions during the past two decades. The private sector, especially Syngenta, has also been very supportive, as has USAID. Within the last year the Bill and Melinda Gates Foundation have started to fund Golden Rice. Were a wider country funding focus possible it would encourage national expenditure and healthy competition between the collaborating public institutions, and ultimately increase speed of adoption through earlier political internalization of the Golden Rice project.

Of course, for all supporters, individual, national, or company or philanthropic, we are all very grateful.

I've been working on this project for ten years and that seems like a long time! But Potrykus and Beyer have been working on it for 20 plus years. And they know it works! It's a brilliant piece of science. It is at it appears – a couple of professors working with public institutions, with minimal administration, to bring a major life saving technology, which has been improved by the private sector, to Vitamin A deficiency sufferers free of charge for the technology. This is what it is. It's pure, and it should not be unjustifiably impeded. It's extremely frustrating to be held up, but all we can do is keep trying to make progress.

CIB: Is there a better way?

Adrian: In the mid 1960's Norman Borlaug in the "Green Revolution" helped many countries through plant breeding to achieve higher staple crop yields and thereby offset the effects of fast population growth. The very easy international transfer of seed between countries facilitated rapid breeding programme progress and benefit sharing between the collaborating countries. This is as it should be with a public good for the public good. In the mid 1960's the public good was fungal disease resistant dwarf wheat variety seeds from Mexico.

A modern example of a public good for the public good is Golden Rice seeds. We need to be able to internationally cooperate as easily now as in the 1960's to biofortify staple foods, whatever the technology used to create them.

CIB: Will people accept GR?

Adrian: The Golden Rice story and prospects are so clearly beneficial, that any time that I've talked to anybody about this project, they become instant supporters. This includes the former Director of Friends' of the Earth, in Europe. I and Golden Rice got a very hard time at a Friends' of the Earth conference in 2002. But in a public meeting in 2010, he said, "On the basis of what I've heard today, I see nothing against Golden Rice."

When you say "Look, you can have this rice, its yellow, it grows the same as the other rice, it processes, stores, cooks and tastes the same. It doesn't cost more than white rice. And when you or your children eat this much every day, you won't die from lack of Vitamin A or go blind. Would you like it?" What's the answer you're going to get? We have asked these questions of poor villagers – farmers and consumers in countries affected by vitamin A Deficiency. They say "Yes please, we'd like to try it." The answer, for them, is a no-brainer.

CIB: And how it the project in India right now? Can people use the seed?

Adrian: No, Golden Rice seed is currently with three research institutes. All are Golden Rice licensees of the inventors' technology. Two of the institutions are part of the Indian Government and one is a university. They are introgressing the Golden Rice trait into locally adapted rice varieties, and then the regulatory process has to be gone through in India. But the sooner you start, the sooner you finish in any venture, and it is good that India is now getting on track.

CIB: And in the Philippines?
Adrian: If we can get all the nutritional work done soon to support the health and nutrition communities with data, I think we can be with farmers in 3 or 4 years. The medical as well as the agricultural authorities have well established internationally recognised mechanisms for approving research. Strategy should not be determined by concern about criticism.

CIB: How do you see your role in this project?

Adrian: I see my role as a catalyst. I know what needs to be done. I know what sort of institutions need to do it. I know what the materials are. I know what the steps that can slow things down are. And therefore, by going to a country and making people aware, and talking with them, informing them how they can make progress, I perform a catalytic role, and then it's down to the country.

The Humanitarian Board can give the countries support as needed. We have rice breeders, molecular biologists, regulatory, marketing, nutrition, intellectual property and development people. We have all kinds of experts and if any of the countries need help or training, you know, any sort of support in those fields, then we can arrange it for them either from the Humanitarian Board or from another Golden Rice licensee institution.

We may not have any finance, but finance may not be the main problem. For such a problem as this, often the issue is about catalyzing the recognition that there is a solution to a problem and managing, maybe assisting, country budgets.

I was in Lao PDR recently and they have a huge problem with vitamin A deficiency. And there are all sorts of United Nations (UN) agencies there. They all have strategies and plans. When I walked into the office of the UN World Food Program for a prearranged meeting, I was told "Well, as a UN agency, we don't have anything to do with GMOs." I said, "Why not?" and then had to start the whole education process. The overt attitude was quickly retracted, but it demonstrates the underlying suspicion and that's very disappointing.

But you know all of the Laos people that I spoke to were very enthusiastic: the Women's Union, the National Institute for Agricultural, Forestry and Crop Research, the Ministry of Science and Technology, nutritionists, all of them. I'm hopeful we can support them and get a Golden Rice program going there. And malnutrition is a huge problem for that country. Apart from stunting and wasting, micro-nutrient deficiency, iron and vitamin A are the two big ones. Lack of vitamin A kills people. Ninety nine percent of people in Laos eat rice every day and this technology can be in their rice for free. Laos introduced iodine into salt and saw a dramatic reduction in goiter and related problems very rapidly. They know the benefits of micronutrients, and know they can do it. Even if many villages in Laos have no road connection to them, they don't need roads for this intervention, once they've got the seed. The technology is in the seed and they are almost all rice growers.

CIB: Can you talk a little bit more about the benefits of the Golden Rice?

Adrian: The main advantage is that thanks to the inventor's donation, there is no cost associated with the technology. And as the technology is in the seed the nutritional benefit can benefit anyone consuming the Golden Rice yield from

planting it. There is no logistical impediment to distribution of the seed, and therefore the nutritional benefit. Farmers are free to sow, grow, harvest, store, consume and sell locally their Golden Rice, as well as any other rices they choose to grow. Of course initially seed has to be delivered to the farmers by the public sector managed seed system as for new rice varieties. And farmers and consumers have to be educated. After this, communities can be relied on to disseminate the nutritional benefit. No factory is needed. No road infrastructure. No cold chain. No more money for cultivation or purchase than for other rices. No special processing. No special packaging. No aid agencies, philanthropic or government funding. Golden Rice will be available to the people who can benefit from it and completely sustainable.

Another benefit is that Golden Rice contains beta-carotene and you cannot overdose on beta-carotene at the levels found in a crop plants food matrix, including Golden Rice. If the body has too much beta-carotene, it excretes it. Conversely, pharmacological doses of micronutrients as supplements may have adverse health effects.

The other benefits of Golden Rice are that it's benign. It's yellow, it contains beta-carotene, and apart from that, it's the same as conventional rice. And beta-carotene is ubiquitous in the environment and a normally balanced diet.

There's no additional cost for the nutrition in Golden Rice, either to the grower or the consumer. There's no difference to white rice , except it's yellow. Each grain is labeled – even for illiterate people or in countries with multiple languages and ethnicities - each grain is yellow.

CIB: Is Brazil involved in this project?

Adrian: Some years ago, we had an interest from a university in north-eastern Brazil, because they grow rice there, they have a lot of poor people and they have a lot of vitamin A deficiency. We also had discussions with EMBRAPA. We are now at the stage where we would be delighted to be in touch with them again. They could join in the international program, they could be provided with free with the Golden Rice seed containing the lead event for introgression into locally adapted rice varieties and the free regulatory package in due course. And Golden Rice could be here in Brazil for development with the Brazilian nutritional and health community. Maybe there are other areas in Brazil. There is chronic vitamin A deficiency in lots of parts of Brazil, but we don't know whether it occurs in rice-eating communities or not. But anywhere it is: drop me a line!

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