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Golden Rice – the Partitioning of Influence

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Abstract

In the past decade significant scientific progress has been made with the Golden Rice project. Significant increases in carotenoid have been achieved. Micronutrient malnutrition has been recognised as a major factor in total world malnutrition. What could be responsible for the continuing slow progress of the project? The answer may be related to the confluence of three influences on world society's attitudes to genetically modified crops: The Convention on Biological Diversity, the Precautionary Principle, and some NGO's opposition to GM technology.

Syngenta, Biotechnology, Developing Countries, Golden Rice, CBD, Precautionary Principle, NGO, Micronutrient Malnutrition

Introduction

A paper at the 2003 ICABR conference asked why very little public sector progress has been made in delivering GM crops to impoverished farmers in developing countries for local use and sale (Dubock, 2003). It was concluded that the usual reply to this question ("intellectual property rights") was incorrect: that the requirements for success were more complex. Political will was emphasized as one element of importance . It was suggested than an amalgam of skills from both the public and private sectors could be usefully applied to bring velocity to such projects, and the authors experience from (especially) the humanitarian Golden Rice project was used to illustrate one way of bringing these attributes together.

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A recent paper (Cohen, 2005) has described the very broad scope of crops, traits, transformation events and developing countries involved in GM crops being conducted by public sector research institutes. The dearth of public sector product development capacity, regulatory capacity, and product introductions is again noted.

Progress with Golden Rice and positive influences on humanitarian project progression.

Dr Peter Jennings, in 1984, had the idea during a Rockefeller Foundation sponsored meeting at IRRI, (Toenniessen, pers. com.), which led eventually, with significant and prolonged support and encouragement from the Rockefeller, to the Golden Rice breakthrough of Potrykus and Beyer (Ye et al 2000). The pace of scientific and technological development of Golden Rice has continued since then. Syngenta has developed, as part of its now discontinued commercial programme, transformation events with higher expression levels of pro-vitamin A, than the original proof of concept research, and donated them for use by the humanitarian Golden Rice project.

The first of these SGR1, was field trialled in the US in 2004, and is in the hands of public sector rice breeders in India and the Philippines. The open field trial of several events, including SGR1, in southern USA narrowly missed being destroyed by hurricane Ivan, and yielded SGR1 Golden Rice grain expressing between 4 and 8 μg carotenoid per g of rice endosperm. A taste trial detected no abnormal taste. Golden Rice from this location will be used for several other important tests including retention of carotenoids under different storage conditions and the effect of cooking on carotenoids.

Syngenta Golden Rice 2 ("SGR2") transformation events have also been developed, which have more that twenty times the carotenoid of the initial proof of concept work (Ye et al, 2000), and very high levels of β-carotene. (Paine et al, 2005). These have also been donated by Syngenta to the Golden Rice Humanitarian Board and network for humanitarian uses. Although in many countries rice constitutes 40% of the daily diet, (Bouis pers.com.) in rural Bangladesh almost 80% of the daily diet consists of rice (Figure 1. Bhargava et al, 2001.)

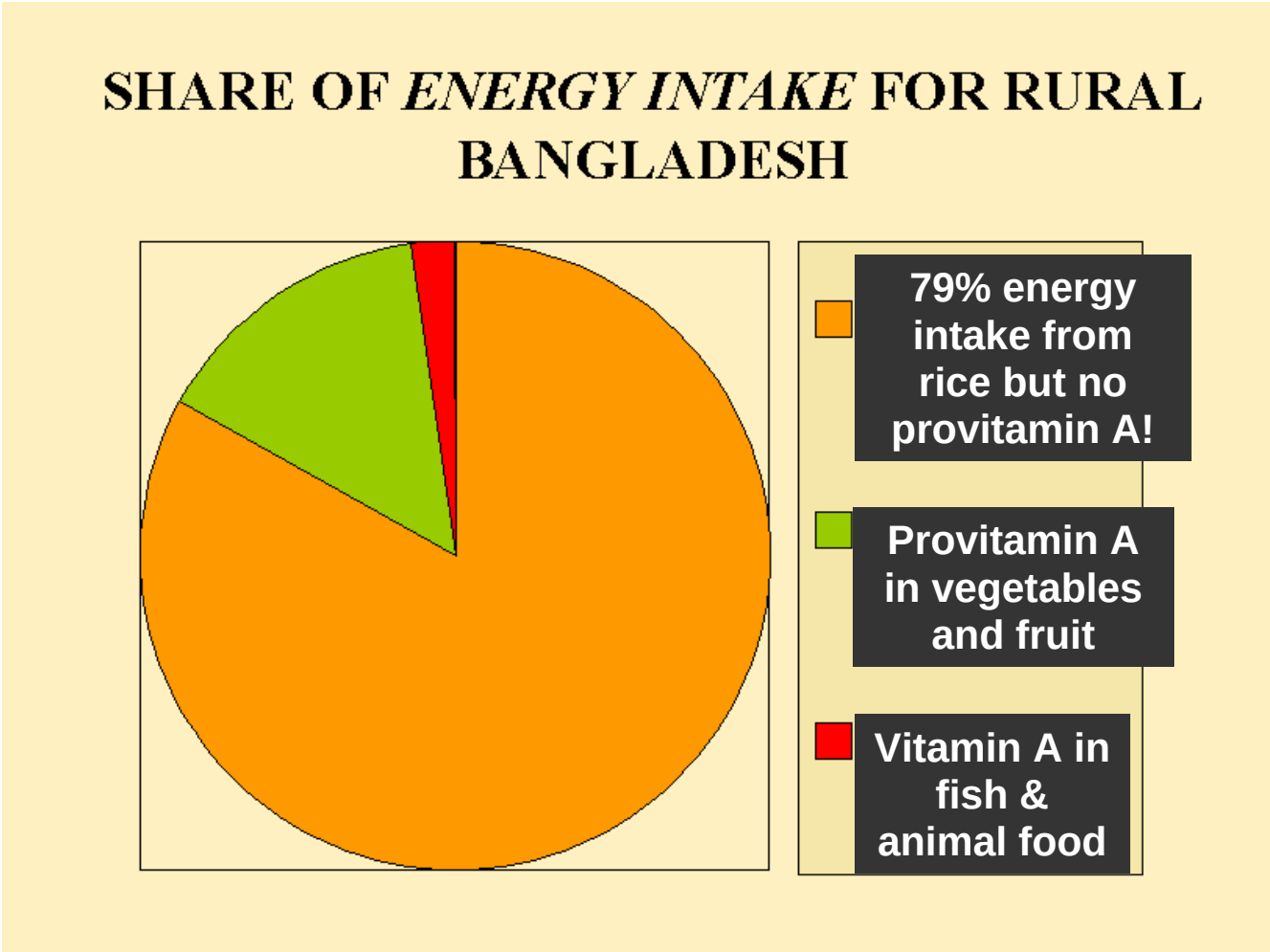

Figure 1. The importance of rice in the diet in rural Bangladesh. White rice has no pro-vitamin A. (From Bhargava, A., H. Bouis, and N. Schrimshaw. 2001)

Bouis (pers. com.) has calculated the contribution of SGR2, (after making allowances for various factors such as losses in cooking and bioavailability effects), to satisfying pro-Vitamin A requirements of adults and children in Bangladesh. (Figure 2)

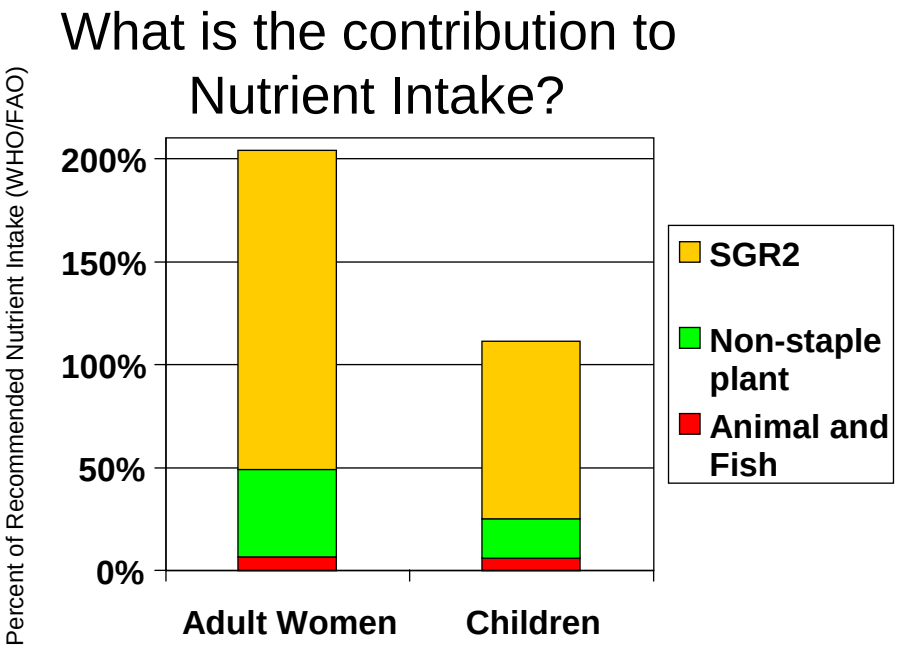

Figure 2. The contribution to daily pro-Vitamin A requirement of adult women, and children, in rural Bangladesh from Animal and Fish sources, Non-staple plants, and SGR2 GoldenRice. (H Bouis, 2005, unpublished.)

It is clear that with SGR2 replacing white rice in the diet, a very significant decrease in the morbidity and mortality from Vitamin A Deficiency is to be expected.

Within the Golden Rice network (see Dubock 2003 for more detail) in Asia the several Syngenta Golden Rice transformation events, and others, will be investigated in parallel. Informed event selection will then be made, in the light of a variety of studies being conducted in parallel with rice breeding work. At that stage the intent remains to select the most suitable transformation event (and destroy the rest) and use the selected event to introgress into locally adapted rice varieties important for each area where VAD is a problem. The purpose of this 'single transformation event' strategy, developed by the Humanitarian Board, (see www.goldenrice.org), is that regulatory costs should be saved, and speed of product delivery increased.

The potential economic impact of the introduction of Golden Rice in Asia has been estimated, (incidentally without any knowledge of the high expressing Syngenta transformation events), in a World Bank Policy Research Working Paper as in excess of $15.0 billion annually – due to raised agricultural productivity – with a negligible impact on exports, as most Asian rice is grown for local consumption. (Anderson, Jackson and Nielsen, 2004).

In a more general analysis - the Copenhagen Consensus, (Economist, 2004) - a panel of eminent economists made cost: benefit comparisons, including issues of ethical and

humanitarian urgency, of many different projects from a wide variety of disciplines for developing countries. Addressing malnutrition, by providing micronutrients, was ranked as the second most worthy of 17 projects, second only to addressing HIV/AIDs.

The scientific progress with Golden Rice is encouraging and the research continues. Also encouraging is the appreciation by economists that micronutrient enhancement can be so important for nutritionally impoverished societies. These are positive influences for the project.

But the Golden Rice projects humanitarian aims, welfare and related economic benefits will remain only potential, unless an approved product can be delivered for farmers to grow. This still appears to be several years away. The original 2003 question, mentioned above: "why has very little public sector progress has been made in delivering GM crops to impoverished farmers in developing countries for local use and sale?" still needs to be answered.

What are the negative influences on humanitarian project progression?

There appear to be three major negative influences on rapid progression of Golden Rice to an approved product which can be used. The first of these is an intergovernmental agreement: the Convention on Biodiversity, and particularly its interpretation. The second is principally a European governmental philosophy: the 'precautionary principle', and, again, particularly its interpretation. And the third is the vociferous opposition to GM crops, of (some) NGO's, and their impact on 'political will', important in developing countries for GM crop acceptance (Dubock, 2003).

These three have become entwined in a way that causes a severe impediment for scientific research not only with genetically modified biological materials, but also with conventional plant varieties. (At least two CGIAR centers, CIP and IRRI, have reported that since the CBD came into force, movements of plant varieties from and to their gene bank collections of potatoes and rices respectively, have been noticeably reduced.) Regulation, including movement between research centres, of biological materials has become overwhelmed with paperwork and a process disproportionate to rational need. This problem seems to be accepted by almost everyone, including those individuals working within the process in both the public and the private sector, but as individuals acting alone, none are able to change the direction. These regulatory processes result in serious attempts to provide scientific methodology and data in support, (see for example, Kuiper, 2004) however irrational the regulatory process itself is. It is not, perhaps, for the scientist, who needs grant money for research, to question the goose which is laying the golden (grant) eggs. The scientist is merely responding to a need society thinks it has.

The difficulties the regulatory processes cause are more easily managed by the private sector. But not without cost: financial to the companies, and ultimately their customers, and an economic disincentive to invest in transgenesis with minor crops, which may nevertheless be very important crops to parts of global society. Where these complex and costly processes are particularly onerous, is for the public sector, where taken

together, they have the result of delaying, or preventing, poor people (with no politically heard voice) from accessing technologies potentially useful for their well-being, or even for life itself, and perhaps an economic benefit (increased productivity) which could help lift them out of poverty too.

It is hard to imagine that this effect was intended, by either of the groups responsible.

The CBD

The 1992 Rio Earth Summit, led to three United Nations Conventions:

Convention on Biological Diversity (http://www.biodiv.org/)
and two others:
Convention on Climate Change (http://unfccc.int/)
Convention to Combat Desertification (http://www.unccd.int)

Signed by 150 government leaders, the Convention on Biological Diversity ("CBD") is dedicated to promoting sustainable development. "Conceived as a practical tool,…….. the Convention recognizes that biological diversity is about more than plants, animals and micro organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live". The main intent is to benefit people, and peoples living standards. The CBD is intended to be about people.

In association with the CBD is the Cartagena Protocol on Biosafety, now with 119 signatory countries. The intention of the parties when the Cartagena Protocol was agreed was that both risk and benefit should be considered in taking decisions relating to biological materials, including GMO's, and this is clear form the language of the protocol itself (P van der Meer, formerly UN-GEF, pers. com.). However, the UN is currently promoting the idea, in its training for the creation of bioregulatory systems being put in place in about 100 developing countries, that only risk assessment (and not benefit) is mandated by the Protocol (C Briggs, UN-GEF, pers. com.) Thus the UN is training developing country governments to create government departments that are for risk assessment only. But, independently of the intent of the parties to the CBD, and its language, how can risk be assessed without consideration of benefit?

The Precautionary Principle

What the European Commission wrote in its communication on the Precautionary Principle is, quoting from the summary (M Cantley, pers.com):

"Where action is deemed necessary, measures based on the precautionary principle should be, *inter alia*:

- *proportional* to the chosen level of protection,
- *non-discriminatory* in their application,

- *consistent* with similar measures already taken,
- *based on an examination of the potential benefits and costs* of action or lack of action (including, where appropriate and feasible, an economic cost/benefit analysis),
- *subject to review,* in the light of new scientific data, and
- *capable of assigning responsibility for producing the scientific evidence* necessary for a more comprehensive risk assessment.".

This was pretty much how biotech risk assessment and management was handled in the developed world, 1973-1986, and in some areas, still is (M Cantley, pers.com).

Nevertheless, the Precautionary Principle is widely represented to mean "if there is a risk, however small, then don't take it." This is the case despite representations that anyway this is not sensible for society (for example, Dubock, 2000).

"NGO's"

"It is 'values' which drive the NGO movement There is a moral underpinning based on the "solidarity and compassion for the fate and well being of others: a sense of personal responsibility and reliance on ones own initiative to do the right thing: the impulse towards altruistic giving and sharing: the refusal of inequality, violence and oppression." (Civicus, 1994; Cohen 2005).

Cohen (2005) has derived a composite definition of NGO's: "independent, non-profit, non-violent, voluntary organizations operating at the local, national, and/or transnational levels that are neither governments nor business"

The Golden Rice Humanitarian Board (www.goldenrice.org) fits both definitions above. It includes individuals from both the public and private sectors. The humanitarian Golden Rice project has received free technology donations from half a dozen companies, including Bayer and Monsanto, as well as several Syngenta companies, operating from three continents.

NGO's have no monopoly on the values described above.

Sustainability (2003) note that the Not-for-Profit sector is now the size of the 8th biggest economy in the world, worth $1 trillion annually; much, much bigger than the biggest "giant multinational" (an appellation frequently used by NGO's) involved in agribusiness which has annual sales a little over $7.0 billion. The report also notes that NGO's have been instrumental in directing international attention to the importance of poverty reduction and human rights and that NGO people prioritize ethical, social and environmental issues in different ways to those people "in the [non-NGO] system"; and feel a sense of outrage when these values are offended.

It is paradoxical that NGO's opposed to GMO's, by their actions would deny a potentially life-giving technology, GoldenRice, being available to the disadvantaged,

despite the NGO common values, quoted above. Perhaps this was in the mind of Benedict Haerlin, Greenpeace anti-GM campaign leader, when he said at a French meeting earlier this decade, that GoldenRice presented a moral dilemma for Greenpeace. His honest statement, reported in UK newspapers as "Greenpeace makes U Turn" was quickly retracted by Green Peace's London office.

The "assess risk only" interpretation of the Cartagena Protocol, referred to above, together with the "any risk is too much" interpretation of the Precautionary Principle, allows for easy stimulation of unsure government departments, to do nothing, by NGO's opposed to the technology. The three insidiously undermine political will. And some NGO's persist in their denigration of the genetic engineering technology, on its own, independently of its specific application or the facts. There have been no substantiated problematic issues associated with GMO's despite extremely intensive global observation of very significant usage (see for example American Soybean Association, 2005). Many benefits have been described, for example for African Bt cotton (Cabanilla et al, 2003) and also China with Bt Rice (Huang, 2005). And the continuing growth of GM crops (C James, 2005) underlines the utility of the technology.

It is also interesting to observe that the definition of GMO's to which some NGO's object has been narrowing over the last 8-10 years. To begin with any plant which had been subject to genetic manipulation was considered a GMO. Subsequently, the term GMO excluded the use of genetic techniques applied to seed breeding; only transgenes were included in the term. (It appears that there may be, in some quarters more recently, a tendency to regard only transgenes created for profit to be included in the GMO definition!)

Sustainability's (Beloe et al, 2003) report makes fascinating reading about the challenges facing NGO's. NGO's are very trusted by society, much more so than governments, or companies or media. (The report also notes that some NGO's are employing PR companies, and generally also have a symbiotic relationship with the media). That trust is based on honesty and vision. It is a "highly perishable commodity". One trend which could undermine NGO's is what Sustainability call the "Perfect Storm" which would ensue when a leading NGO is discovered to have misled the public for years.

It has recently been noted in Asia, that currently, as a new development, the media are often not reporting Greenpeace's press releases against GM crops.

Die Welt (5 April '05) a serious German newspaper criticized, point-by-point, Greenpeaces press release on GoldenRice 2. Here is a translation of the final paragraph: "There cannot be enough different strategies for a solution and growing traditional varieties is one of them. Here, Greenpeace could provide concrete financial assistance. In the past ten years, the rich organization has collected around one billion dollars (!) worldwide. So far it has spent some 20 million dollars on its campaign against genetic engineering. That is about three times as much as Ingo Potrykus and Peter Beyer together spent on the development of "golden rice."". (Copy of translation or original article available on request.)

Similar criticism of Greenpeace is not uncommon (eg Kleckner, 2005.).

Nature Biotechnology, (2005) in an editorial commented further : "Greenpeace, Friends of the Earth and their political allies in European governments and nongovernmental organizations will not welcome Golden Rice 2. They will continue to reject and stall biotech products at the mere hint of a transgene, no matter what the humanitarian value of the crop and no matter how spurious the environmental concerns. But there comes a time when arguments against a GM product that could help prevent blindness in hundreds of thousands and death in millions each year should be seen for what they are: ideological bigotry. Golden Rice ……..can change for the better the plight of the worlds malnourished, if only those rigidly opposed to GM crops would let it."

Is this the start of the loss of credibility of at least one leading NGO opponent of GMO's? Is it the start of the 'perfect storm' anticipated by Sustainability?

Causes for hope

There are some further positive signs about GMO acceptance.

Dubock (2003) reported that one rich foundation was not prepared to fund GMO work. The Bill and Melinda Gates Foundation is now supporting grant applications, "to be managed and administered by the Foundation for the National Institutes of Health". Grand Challenge # 9 is "to use transgenesis, biochemistry, selective breeding of plants, …….to provide combinations of micronutrients, vitamins, and essential amino acids in a bioavailable form in local crops". Dubock (2003) also reported that the EU commission's rules for funding research projects disallowed humanitarian projects with no European industrial application. It seems that that stance is softening too (H Nowotny, 2005, pers.com.)

Technical progress with GoldenRice field trials and expression levels also resulted in interest from the nutritionalist community, previously disinterested in genetic approaches to micronutrient deficiency alleviation. As a result of discussion of the SGR1 field trials and SGR2 breakthrough at the World Food Prize meeting in Iowa the month before, Prof. Potrykus was invited to present an unscheduled paper on Golden Rice at the meeting of the International Vitamin A Consultative Group in Lima, Peru in November 2004 http://ivacg.ilsi.org (Potrykus pers. com.)

Potrykus, in a series of presentations internationally, (for example Potrykus, 2005) argues that GMO regulation as currently designed is irrational, and immoral. His arguments include the fact that there is more unpredictable genome alteration in traditional plant breeding, which is unregulated, than in GMO crops, as well as history of GMO use.

There is a growing realization that the current, unfortunate, interpretations of the CBD, the Cartagena Protocol, and the precautionary principle, act against the interests of the poor and disadvantaged in society, even more than they do against the interests of the private sector. Public Sector scientists involved in biotechnology research are coming to this realization, and mobilized to have their voices heard, for the first time, at the Montreal 'Meeting of the Parties' [to the CBD] in June 2005.(van der Meer, pers. com.)

Perhaps the 20th Century attitude of confrontation of issues by NGO's will change to the 21st Century spirit of cooperation, including with business, as anticipated by the Sustainability report (2005). It can't be too soon for Golden Rice. Vitamin A Deficiency kills, every month, and largely the same countries as many people as the total death toll in the December 26 2005 Tsunami disaster which so resonated with global sympathy and support for those affected.

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