"GOLDEN RICE" GM VITAMIN-A RICE

Golden Rice is the name of a rice that has been genetically modified (GM, or genetically engineered) to produce beta-carotene, which the body can convert into vitamin A. This beta-carotene gives the rice grains the yellowish colour that has inspired its name.

Golden Rice was developed by two European scientists, Ingo Potrykus and Peter Beyer, who later licensed the technology to the major biotechnology and seed company Syngenta (at that time Zeneca) for commercial use. As per the agreement, the company could develop Golden Rice commercially, but had to offer it free for "humanitarian use" (use in low-income, food-deficit countries, and for the use of farmers who earn $10,000 or less per year from farming). Syngenta negotiated licenses with other institutions and biotechnology companies, including Monsanto, to access the numerous patents and technologies needed to develop Golden Rice.[1,i] In 2004, Syngenta donated its research to the "Golden Rice Humanitarian Board" and ended its commercial involvement in Golden Rice, though it retains the commercial rights.[2,3]

The ongoing research and development of Golden Rice is now managed by the Golden Rice Project. The Project is governed by the Golden Rice Humanitarian Board, and involves various partner institutions across Asia through the Golden Rice Network, which is responsible for technology transfer.[4] The International Rice Research Institute (IRRI), in the Philippines, is the hub of this network. Funding for the Golden Rice Project comes from the Rockefeller Foundation, Harvest Plus (which is funded by the Bill and Melinda Gates Foundation and the World Bank), the Swiss Development and Collaboration Agency, the U.S. Agency for International Development (USAID), the Syngenta Foundation, and a number of other national agencies and institutions.[5,6]

Golden Rice has been under development for over 20 years, and is still being tested in the Philippines. In these years, over a hundred million dollars has been spent on development and advertising.[7] IRRI researchers do not specify when it will be ready for commercial planting.[8]

i 70 Intellectual Property Rights and Technical Property Rights, belonging to 32 different companies and universities, were used in the initial experiments.

VITAMIN A DEFICIENCY

The biotechnology industry claims that Golden Rice will be an important intervention to address vitamin A deficiency, or VAD.

VAD is a serious problem in communities facing malnutrition and food insecurity. Its impacts are particularly severe for children and, if not dealt with, VAD can lead to blindness, and in severe cases, even death. The UN World Health Organization (WHO) estimates that 250 million preschool-age children in the world are deficient in vitamin A. Approximately 250,000 to 500,000 of these children become blind every year.[9]

VAD can be addressed through a combination of strategies, including dietary diversification, food fortification and supplementation. According to the WHO, supplementation programs around the world have averted approximately 1.25 million deaths since 1998,[10] and have reduced the risk of xerophthalmia[ii] by approximately 90% and mortality by approximately 23–30% in young children.[11]

HOW GOLDEN RICE FAILS

Golden Rice is being field-tested and has not yet been submitted to any government for approval for human consumption or growing. Field tests have been permitted in the Philippines.

There is currently no GM rice on the market anywhere in the world.

1. Golden Rice has not yet lived up to its promise

The first version of Golden Rice that was developed produced 1.6 micrograms of carotenoids per gram of rice[12] (only half of which was beta-carotene).[13] This meant that a 2-year-old would need to eat 7 kilos of cooked golden rice a day to meet their required daily intake of vitamin A, and a breastfeeding mother would need to eat 9 kilos of cooked rice.[14]

In 2005, Syngenta announced "Golden Rice 2", claiming that they had solved this initial problem. The company's researchers estimated that a child could obtain half of their required vitamin A intake from eating 72 g of dry Golden Rice 2 every day.[15]

In 2013, the IRRI confirmed that "it has not yet been determined whether daily consumption of Golden Rice does improve the vitamin A status of people who are vitamin A deficient and could therefore reduce related conditions such as night blindness."[16]

According to IRRI, the yields of Golden Rice that have been tested "were not consistent across locations and seasons."[17] Researchers are now working to develop varieties that are suitable for Asian agricultural systems, and are as productive as their non-GM counterparts.[18] Proponents of Golden Rice often claim that opposition has prevented the crop from helping millions of people, but in reality Golden Rice is still in development, and will not be ready for several years.[19]

2. Golden Rice has not been adequately tested for bioavailability

Vitamin A can only be absorbed by the body when it is consumed along with fat. Children and adults suffering from VAD, which is most commonly caused by malnutrition, often do not have access to fat in their diets.

Two studies have been conducted to assess the bioavailability of vitamin A in Golden Rice.

The first study, published in 2012, fed Golden Rice to five American adults, and concluded that beta-carotene in Golden Rice was effectively converted to vitamin A in humans.[20] However, the study has been critiqued for having several inconsistencies, including the carotenoid levels in the rice used, the small number of test persons, and the high amount of variability in the results.[21,22] In addition, the study participants were given the rice along with butter, meat,

ii Used by the WHO to denote the set of disorders resulting from VAD, and often used to measure the prevalence of VAD. See, for instance, WHO 2009.[11]

nuts and vegetables, and none of them were suffering from any of the disorders commonly faced by malnourished children or adults. These results do not reflect the conditions of those suffering from VAD.[23]

The second study, also in 2012 and authored by some of the same scientists, fed Golden Rice to 72 Chinese children between the ages of 6 and 8.[24] The study concluded that one serving of Golden Rice could provide half a child's recommended intake of vitamin A. However, this study also fed children balanced meals with fats, demonstrating, as professors Dominic Glover and Glenn Stone point out, "only that Golden Rice worked in children who did not need it."[25]

The researchers of this study also violated both U.S. federal regulations and Tufts University's ethics policies. Among other violations, researchers fed Golden Rice to children in China without informing their parents that the rice their children were eating was genetically modified, and changed the study protocol after it had been approved.[26] Due to these violations, in 2013, Tufts University barred the lead researcher from conducting human research for two years.[27]

3. Golden Rice has not been adequately tested for storage and degradation

No tests have been done to assess the shelf life of the carotenoids in Golden Rice. This is especially important because rice is often stored for long periods of time before it is consumed, and carotenoids can break down in the presence of light, heat and oxygen.[28] Further, detailed studies also need to be conducted on the effects of various kinds of cooking methods on the beta-carotene levels in the rice.

4. Golden Rice has not been adequately tested for safety

There has been one assessment of potential allergenicity but no other toxicological studies or animal feeding trials have been carried out to assess possible health risks of Golden Rice.[29] IRRI has announced that animal feeding trials will be conducted in the US, but no details or results have been published so far.

Proponents and developers of the genetically modified rice argue that such testing is not needed. In fact, when facing criticism about the study that tested Golden Rice on Chinese children, Adrian Dubock, the manager of the Golden Rice Project and a former Syngenta employee, said, "Golden Rice contains the food colours found everywhere in coloured, natural foods and the environment. There is no possible way the trials could do any harm to the participants."[30]

5. Golden Rice poses environmental risks

Proponents argue that since rice is largely self-pollinating, Golden Rice will not contaminate non-GM rice varieties. However, studies in China have shown that GM rice can in fact cross-pollinate with some common varieties of wild and weedy rice.[31] This contamination could affect both wild rice populations and the cultivated rice seed supply, and it would be very difficult – or impossible – to reverse such contamination. GM rice could also contaminate the rice supply after harvest, by mixing with the non-GM rice supply. The environmental, economic and social impacts of any contamination would be particularly serious in Asia, which is the centre of origin for rice and where rice is often a staple food in daily diets.

6. Golden Rice is expensive and unnecessary

Millions of dollars have been spent on developing Golden Rice, and on promoting it. By 2001, $100-million dollars had already been spent on developing the rice, and another $50-million on ads for it.[32] This number has grown significantly since then, as more research funds have been injected into the project.[33] These important resources could have gone towards developing and expanding existing and proven approaches to addressing VAD, and implementing them for the communities that urgently need them.

> "The best way to avoid micronutrient deficiencies is by way of a varied diet, rich in vegetables, fruits and animal products. The second best approach, especially for those who cannot afford a balanced diet, is by way of nutrient-dense staple crops."[34]
>
> — The Golden Rice Project

"To successfully combat VAD, short-term interventions and proper infant feeding must be backed up by long-term sustainable solutions. The arsenal of nutritional "well-being weapons" includes a combination of breastfeeding and vitamin A supplementation, coupled with enduring solutions, such as promotion of vitamin A-rich diets and food fortification."[47]

— World Health Organization

Solutions that support people to grow vitamin-A rich foods, on small-scale farms and home gardens, are accessible, affordable, provide multiple benefits, and can be community-owned and managed. Perhaps most importantly, along with effectively countering VAD, such a strategy also helps address the root problem of poverty and hunger.

THE REAL PROBLEM

Golden Rice does not address the real problem. Vitamin A deficiency is not an isolated issue: it is a symptom of hunger and malnutrition, which in turn are caused by poverty and inequality. These are deep-rooted and complex socio-economic problems.

Because VAD is a symptom of inadequate nutrition, children who suffer from VAD are often also lacking in other micronutrients.[35] Furthermore, the body effectively absorbs vitamin A only when it has sufficient levels of other nutrients, such as zinc and vitamin E, as well as fat and protein.[36,37] In this context, intervention strategies that target more than one nutrient deficiency, and those that go deeper to target the root cause of malnutrition and hunger are effective in the longer-term.

THE REAL SOLUTION

Complex socio-economic problems like hunger and poverty call for long-term, sustainable and broad-based solutions. Ensuring that people have access to a diverse and healthy diet, as well as the means to produce food, addresses a whole host of micronutrient deficiencies and health problems, while also being responsive to social and economic problems.

VAD, in particular, can be addressed with several existing and proven measures. In fact, there are a number of examples of highly successful intervention programs from around the world, which are targeted to suit the needs of the communities they are working with. The massive resources being spent on developing and marketing Golden Rice would be better used to help improve such initiatives and expand their reach.

The WHO and the United Nations Standing Committee on Nutrition (UNSCN) both recommend a multi-tiered and integrated approach to combatting VAD. This includes supplementation and breast-feeding, which are effective in the short term, as well as food fortification, which helps maintain adequate nutrient levels, and diet diversification, which is a lasting approach to building food security.[38]

Vitamin A supplementation and breastfeeding

Several countries have had fast success with Vitamin A supplementation programs. Supplementation involves administering 1 or 2 doses of high-dose vitamin A capsules to children every year. These capsules are effective, easy to administer, and a single dose costs just a couple of cents.[39] According to the WHO, "For deficient children, the periodic supply of high-dose vitamin A in swift, simple, low-cost, high-benefit interventions has [...] produced remarkable results, reducing mortality by 23% overall."[40] In 2014, 69% of targeted children in priority countries were protected with two doses of supplementation.[41]

The Philippines introduced a vitamin A supplementation program in 1999. The supplementation was combined with food fortification, nutrition education programs and encouraging home and school food production.[42] VAD in preschool children was reduced from 40% in 2003 to 15% in 2008.[43] The WHO considers 15% the level at or below which deficiency is no longer considered a public health problem.[44] Levels of VAD in the Philippines are now below 5%.[45]

The promotion of breastfeeding is another important way to reduce VAD. According to the WHO, "since breast milk is a natural source of vitamin A, promoting breastfeeding is the best way to protect babies from VAD."[46]

Food fortification

Food fortification plays a complementary role in addressing VAD. While supplementation can reduce VAD levels rapidly and effectively in the short-term, food fortification can help maintain these improvements by providing regular intake of vitamin A.[48] Food fortification has proven to be a very effective way of providing micronutrients to populations in developed countries as well; in some European countries, fortified foods like margarine contribute approximately 20% of the required vitamin A intake. [49]

Along with vitamin A, micronutrients such as iron, iodine, zinc and other vitamins are also added to flours, cereals, oils, salt and sugar. Several countries in Latin America, including Guatemala, El Salvador and Cuba, fortify sugar supplies with vitamin A and have reduced levels of VAD.[50]

Programs supporting the use of conventionally bred crops that have high levels of vitamin A have also been beneficial. Initiatives encouraging families to grow orange-flesh sweet potatoes instead of the more common white-flesh ones have greatly reduced VAD in some African countries. Eating just one small orange-fleshed sweet potato a day provides enough vitamin A for a young child.[51]

Access to a healthy and diverse diet

The Golden Rice Project itself states that, "the best way to avoid micronutrient deficiencies is by way of a varied diet, rich in vegetables, fruits and animal products." This is true. For instance, a child can, on average, get their daily requirement of vitamin A from:

- 75 gms (approx. 2.6 oz) of spinach
- 50 gms of cassava leaves
- 133 gms of taro leaves
- 2 tablespoons of yellow sweet potatoes
- ½ cup of most dark leafy vegetables
- 2/3rd of a medium size mango[52]

or for that matter, even very small quantities of several crops native to Asia and Africa, such as jute, mustard, drumstick, pumpkin, yam and carrots.[53,54,55]

In addition, for the body to absorb beta-carotene, it must be receiving fat, protein and other nutrients.[56] Few children who are severely malnourished are getting either. A more sustainable solution would be to commit resources to support home gardening, nutrition education, diverse crop production, and strengthening agricultural systems and infrastructure to make food security attainable. Such solutions are significantly more cost-effective than the multi-million-dollar Golden Rice project. Homestead gardens, for instance, have been found to be very successful in reducing night blindness in children, at a cost of approximately $8 per garden.[57] In addition, these approaches are sustainable in the long-term, address multiple nutrient deficiencies simultaneously, strengthen food security, and can help supplement family sources of income. The UNSCN recommends supporting local, small-scale agriculture as a promising and effective long-term approach to maintain agricultural diversity, improve nutrition levels and minimize the ecological impact of agriculture.[58]

Bangladesh's Homestead Food Production Program, implemented by several organizations and supported by Helen Keller International, is one example of a highly successful approach to eradicating VAD. The program encourages and supports families to set up home gardens and small-scale animal husbandry projects, most often tended by women. It has been effective in reducing VAD and other micronutrient deficiencies, while also empowering women and creating approximately 60,000 rural jobs.[59] Families who had home gardens were found to be consuming significantly higher levels of vegetables and eggs, and had an increased intake of vitamin A.[60] Combined with nutrition education, this approach has increased vitamin A consumption, as well as broader food security and empowerment of women, for millions of people.[61,62]

These examples point to a number of effective strategies to reduce VAD. Such programs are affordable and effective and, taken together, present an integrated approach for addressing the short- and long-term health impacts of micronutrient deficiencies. There is, however, a need to continue to strengthen these programs, and expand them to have greater coverage. Hunger and malnutrition remain significant problems, and micronutrient deficiencies affect a large number of children globally, especially in Africa and South Central Asia.

The millions of dollars that have been poured into developing and marketing Golden Rice over the past 20 years could have been much more effectively and immediately used to expand less costly, proven, and long-lasting solutions with multiple benefits.

OTHER REPORTS AND RESOURCES:

Disembedding grain: Golden Rice, the Green Revolution, and heirloom seeds in the Philippines. By Glenn Davis Stone and Dominic Glover. 2016. *Agriculture and Human Values*, 33: 1-16. Available at https://link.springer.com/article/10.1007/s10460-016-9696-1

Golden Lies: No credibility for Golden Rice Campaign by Christoph Then for Testbiotech. 2014. Available at: http://www.testbiotech.org/en

(Com)promised Charity: Golden Rice and the Children of the Poor by the Third World Network. 2013. Available at: http://www.biosafety-info.net/article.php?aid=1008

Golden Lies: The Seed Industry's Questionable Golden Rice Project by Foodwatch and Testbiotech. 2012. Available at: http://www.testbiotech.de/en/node/605

Golden Rice's Lack of Lustre: Addressing Vitamin A Deficiency without genetic engineering by Greenpeace International. 2010. Available at: http://www.greenpeace.org/international/Global/international/publications/agriculture/2010/Golden%20rices%20lack%20of%20lustre.pdf

GE Rice – The Genetic Engineering of the World's Leading Staple Crop by Pesticide Action Network-Asia Pacific. 2008. Econexus. Available at: http://www.econexus.info/sites/econexus/files/ENx_GE_rice_PAN-AP_2008.pdf

REFERENCES

1 Ingo Potrykus, The Golden Rice "Tale", AgBioView, 2001.

2 Syngenta. 2004. Syngenta to donate Golden Rice to Humanitarian Board.

3 Golden Rice Humanitarian Board. Golden Rice Licensing Arrangements. Golden Rice Project. http://www.goldenrice.org/Content1-Who/who4_IP.php

4 Golden Rice Project. Frequently Asked Questions. http://www.goldenrice.org/Content3-Why/why3_FAQ.php - Syngenta

5 Golden Rice Project. Frequently Asked Questions. http://www.goldenrice.org/Content3-Why/why3_FAQ.php - Syngenta

6 Greenpeace International. 2010. Golden Rice's Lack of Lustre: Addressing Vitamin A Deficiency without genetic engineering. http://www.greenpeace.org/international/Global/international/publications/agriculture/2010/Golden%20rices%20lack%20of%20lustre.pdf.

7 For details about funding and more information on the various members of the Golden Rice project, see Greenpeace International. 2010. Golden Rice's Lack of Lustre: Addressing Vitamin A Deficiency without genetic engineering.

8 IRRI. 2016. When will Golden Rice be available to farmers and consumers? http://irri.org/golden -rice/faqs/when-will-golden-rice-be-available-to-farmers-and-consumers

9 UN World Health Organization (WHO). 2013. Micronutrient Deficiencies: Vitamin A Deficiency. http://www.who.int/nutrition/topics/vad/en/

10 Ibid

11 UN World Health Organization (WHO). 2009. Global Prevalence of Vitamin A Deficiency in populations as risk 1995-2005. WHO Global Database on Vitamin A Deficiency. Geneva. http://apps.who.int/iris/bitstream/10665/44110/1/9789241598019_eng.pdf

12 Nestle, Marion. 2010. Safe Food: The Politics of Food Safety. University of California Press.

13 Grusak, Michael. 2005. Golden Rice gets a boost from maize. *Nature Biotechnology* **23**: 429 - 430.

14 Greenpeace International. 2001. Vitamin A: Natural Sources vs "Golden Rice." http://www.greenpeace.org/international/Global/international/planet-2/report/2001/1/vitamin-a-natural-sources-vs.pdf

15 Paine, Jacqueline A; Shipton, Catherine A; Chaggar, Sunandha; Howells, Rhian M; Kennedy, Mike J; Vernon, Gareth; Wright, Susan Y; Hinchliffe, Edward et al. 2005. Improving the nutritional value of Golden Rice through increased pro-vitamin A content. *Nature Biotechnology* **23** (4): 482–7.

16 IRRI. 2013. Clarifying recent news about Golden Rice. http://www.irri.org/index.php%3Foption=com_k2%26view=item%26id=12483.

17 IRRI. 2014. What is the status of the Golden Rice project coordinated by IRRI? http://irri.org/golden-rice/faqs/what-is-the-status-of-the-golden-rice-project-coordinated-by-irri

18 Philpott, Tom. 2016. WTF happened to Golden Rice? *Mother Jones*. http://www.motherjones.com/tom-philpott/2016/02/golden-rice-still-showing-promise-still-not-field-ready

19 Stone, Glenn David and Dominic Glover. 2016. Disembedding grain: Golden Rice, the Green Revolution, and heirloom seeds in the Philippines. *Agriculture and Human Values*, **33**: 1-16.

20 Guangwen Tang, Jian Qin, Gregory G. Dolnikowski, Robert M. Rusell and Micheal Grusack. 2009. Golden Rice is an Effective Source of Vitamin A. *American Journal of Clinical Nutrition* **96**: 1776-1783.

21 Krawinkel, M. 2009. b-Carotene from rice for human nutrition? *American Journal of Clinical Nutrition* **90**:695-696.

22 Foodwatch and Testbiotech. 2012. Golden Lies: The Seed Industry's Questionable Golden Rice Project. http://www.testbiotech.de/en/node/605

23 Third World Network. 2013. *(Com)promised Charity: Golden Rice and the Children of the Poor*. http://www.biosafety-info.net/article.php?aid=1008

24 Guangwen Tang, Yuming Hu, Shi-an Yin, Yin Wang, Gerard E. Dallal, Michael A. Grusak, and Robert M Russell. 2012. b-Carotene in Golden Rice is as good as b-carotene in oil at providing vitamin A to children. *American Journal of Clinical Nutrition* **96**.

25 Stone, Glenn David and Dominic Glover. 2016. Disembedding grain: Golden Rice, the Green Revolution, and heirloom seeds in the Philippines. *Agriculture and Human Values*, **33**: 1-16.

26 Enserink, Martin. 2013. Golden Rice Not So Golden for Tufts. *Science Insider*. http://www.sciencemag.org/news/2013/09/golden-rice-not-so-golden-tufts

27 Zheng, Sarah. 2013. University Admits Golden Rice Ethics Violation. *The Tufts Daily*. http://www.tuftsdaily.com/mobile/news/university-admits-golden-rice-ethics-violation-1.2838537

28 Pénicaud, C., N. Achir, C. Dhuique-Mayer, M. Dornier, and P. Bohuon. 2011. Degradation of b-carotene during fruit and vegetable processing or storage: Reaction mechanisms and kinetic aspects: A review. *Fruits* 66: 417–440.

29 RRI. 2016. What safety studies are being done for Golden Rice? http://irri.org/golden-rice/faqs/what-safety-studies-are-being-done-for-golden-rice

30 Poulter, Sean. 2009. British scientists condemn using children in GM food trials as unacceptable. *Daily Mail*. http://www.dailymail.co.uk/news/article-1147635/British-scientists-condemn-using-children-GM-food-trials-unacceptable.html#ixzz2j2eboJfv

31 Chen, L.J., Lee, D.S., Song, Z.P., Suh, H.S. and Lu, B-R. 2004. Gene flow from cultivated rice (*Oryza sativa*) to its weedy and wild relatives. *Annals of Botany* **93**: 67-73.

32 Pollan, Michael. 2001. The Great Yellow Hype. *The New York Times*. March 4. http://www.nytimes.com/2001/03/04/magazine/04WWLN.html.

33 Greenpeace International. 2013. Golden Illusion: The Broken Promises of GE 'Golden' Rice. http://www.greenpeace.org/international/en/publications/Campaign-reports/Genetic-engineering/Golden-Illusion/

34 Golden Rice Project. http://www.goldenrice.org/

35 Ferraz IS, Daneluzzi JC, Vannucchi H, Jordao AA, Ricco RG, Del Ciampo LA, Martinelli CE, Engelberg AAD, Bonilha LRCM & Custodio VIC. 2007. Zinc serum levels and their association with vitamin A deficiency in preschool children. *Jornal de Pediatria* **83**: 512-517.

36 Greenpeace International. 2010. Golden Rice's Lack of Lustre: Addressing Vitamin A Deficiency without genetic engineering. http://www.greenpeace.org/international/Global/international/publications/agriculture/2010/Golden%20rices%20lack%20of%20lustre.pdf.

37 Rahman MM, Wahed MA, Fuchs GJ, Baqui AH & Alvarez JO. 2002. Synergistic effect of zinc and vitamin A on the biochemical indexes of vitamin A nutrition in children. Am*erican Journal of Clinical Nutrition* **75**: 92-98.

38 UN World Health Organization (WHO). 2009. Global Prevalance of Vitamin A Deficiency in populations as risk 1995-2005. WHO Global Database on Vitamin A Deficiency. Geneva. http://whqlibdoc.who.int/publications/2009/9789241598019_eng.pdf

39 World Health Organization (WHO). 2013. Micronutrient Deficiencies: Vitamin A Deficiency. http://www.who.int/nutrition/topics/vad/en/

40 Ibid

41 UNICEF. 2016. Vitamin A deficiency: Current status and progress. http://data.unicef.org/nutrition/vitamin-a.html

42 Greenpeace International. 2010. Golden Rice's Lack of Lustre: Addressing Vitamin A Deficiency without genetic engineering. http://www.greenpeace.org/international/Global/international/publications/agriculture/2010/Golden%20rices%20lack%20of%20lustre.pdf.

43 Department of Health. 2011. Chapter 5 of the National Objectives for Health 2011-2016. http://www.doh.gov.ph/sites/default/files/7%20Chapter5.pdf

44 UN Standing Committee on Nutrition. 2010. Sixth report on the World Nutrition Situation. http://www.unscn.org/files/Publications/RWNS6/report/SCN_report.pdf

45 Greenpeace International. 2010. Golden Rice's Lack of Lustre: Addressing Vitamin A Deficiency without genetic engineering. http://www.greenpeace.org/international/Global/international/publications/agriculture/2010/Golden%20rices%20lack%20of%20lustre.pdf

46 World Health Organization (WHO). 2013. Micronutrient Deficiencies: Vitamin A Deficiency. http://www.who.int/nutrition/topics/vad/en/

47 Ibid

48 UN Standing Committee on Nutrition. 2010. Sixth report on the World Nutrition Situation. http://www.unscn.org/files/Publications/RWNS6/report/SCN_report.pdf

49 European Commission, 2006. Questions and Answers on Fortified Foods. Memo 06/199. Europa Press Releases Database. http://europa.eu/rapid/press-release_MEMO-06-199_en.htm.

50 Greenpeace International. 2010. Golden Rice's Lack of Lustre: Addressing Vitamin A Deficiency without genetic engineering. http://www.greenpeace.org/international/Global/international/publications/agriculture/2010/Golden%20rices%20lack%20of%20lustre.pdf.

51 Hellen Keller International. 2014. Our Sweet Potato Solution. http://www.hki.org/sweetpotato#.V448Aq7c1cI

52 Gilbert C., 1997. Preventing blindness. Child Health Dialogue. Appropriate Health Resources and Technologies Action Group. http://www.who.int/chd/publications/newslet/dialog/7/blind.htm

53 FAO. 1990. Roots, tubers, plantains and bananas in human nutrition. http://www.fao.org/inpho/vlibrary/t0207e/T0207E06.HTM

54 Haskell, M.J., Jamil, K.M., Hassan, F., Peerson, J.M., Hossain, M.I., Fuchs, G.J., & Brown, K.H. 2004. Daily consumption of Indian spinach (*Basella alba*) or sweet potatoes has a positive effect on total-body vitamin A stores in Bangladeshi men. *American Journal of Clinical Nutrition* 80: 705-714.

55 Gilbert C. 1997. Preventing blindness, Child Health Dialogue. Appropriate Health Resources and Technologies Action Group

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

57 Bushamaka, V.N., S. de Pee, A. Talukder, L. Kiess, D. Panagides, A. Taher, and M. Bloem. 2005. Impact of a homestead gardening program on household food security and empowerment of women in Bangladesh. *Food and Nutrition Bulletin* **26**(1): 17-25. United Nations University.

58 UN Standing Committee on Nutrition. 2010. Sixth report on the World Nutrition Situation. http://www.unscn.org/files/Publications/RWNS6/report/SCN_report.pdf

59 Iannotti, Lora, Kenda Cunningham and Marie Ruel. Diversifying into Healthy Diets. Homestead Food Production in Bangladesh. International Food Policy Research Institute (IFPRI). http://www.ifpri.org/sites/default/files/publications/oc64ch21.pdf

60 De Pee S & Bloem MW. 2007. The bioavailability of (pro) vitamin A carotenoids and maximising the contribution of homestead food production to combating vitamin A deficiency. *International Journal for Vitamin and Nutrition Research* **77**: 182-192.

61 Iannotti, Lora, Kenda Cunningham and Marie Ruel. Diversifying into Healthy Diets. Homestead Food Production in Bangladesh. International Food Policy Research Institute (IFPRI). http://www.ifpri.org/sites/default/files/publications/oc64ch21.pdf

62 Bushamuka, Victor N., Saskia de Pee, Aminuzzaman Talukder, Lynnda Kiess, Dora Panagides, Abu Taher, and Martin Bloem. 2005. Impact of a homestead gardening program on household food security and empowerment of women in Bangladesh. *Food and Nutrition Bulletin* **26**(1): 17-25.

This factsheet and other resources and updates are posted at **www.cban.ca/GoldenRice**

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Collaborative Campaigning for Food Sovereignty and Environmental Justice

CBAN brings together 17 organizations working to research, monitor and raise awareness about issues relating to genetic engineering in food and farming, including farmer associations, environmental and social justice organizations, and regional coalitions of grassroots groups. CBAN is a project on Tides Canada's shared platform.