**Golden Rice – Evaluating the Pros and Cons**[[1]](#footnote-1)

People who do not consume enough vitamin A (from animal foods) or pro-vitamin A (from plant foods) develop vitamin A deficiency. Vitamin A deficiency can result in serious health problems such as blindness, severe infectious diseases, and even death, especially for young children.

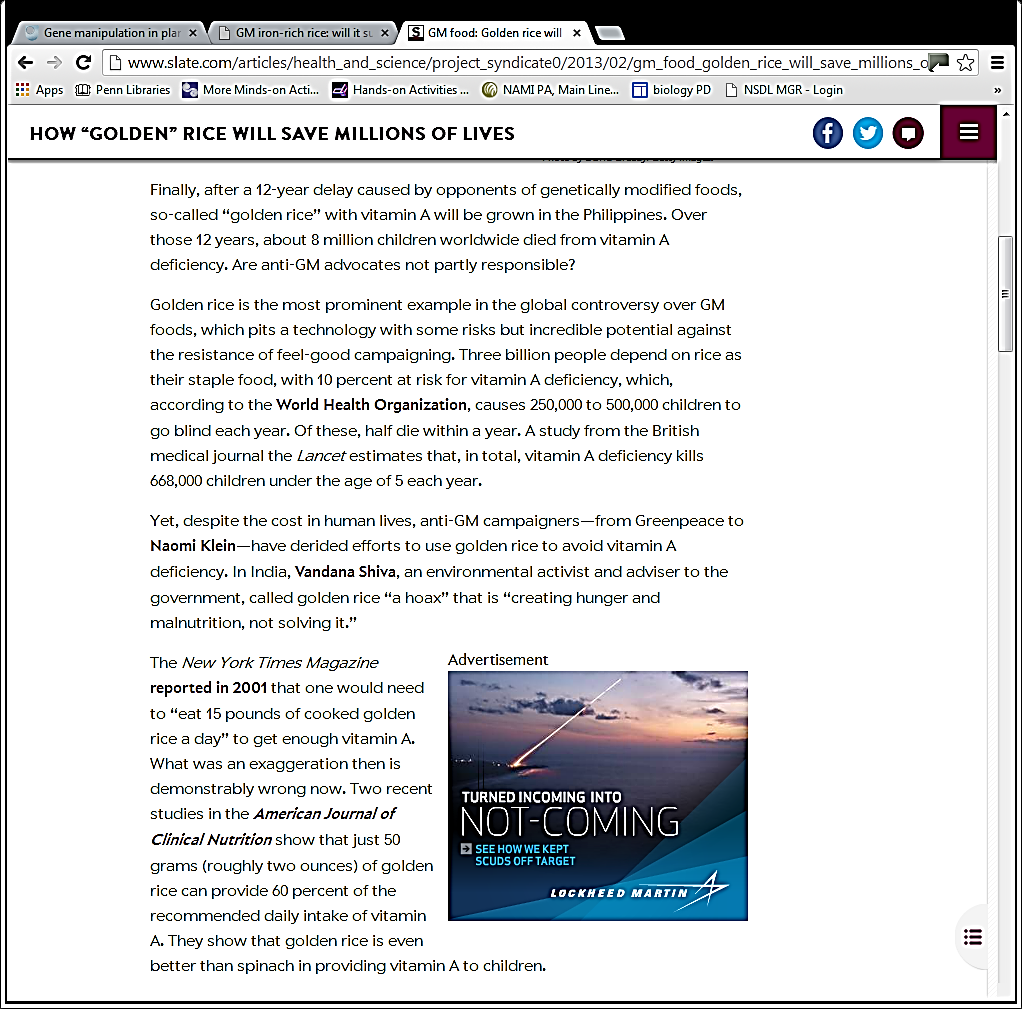
Rice does not have pro-vitamin A, so poor people who eat mainly rice often develop vitamin A deficiency. To address this problem, scientists have developed Golden Rice, a genetically modified (GM) type of rice plant that produces pro-vitamin A in the rice grains that people eat. Specifically, two genes for enzymes that enable the rice grains to synthesize pro-vitamin A have been inserted in the DNA of Golden Rice plants.

In this activity you will read an article in favor of Golden Rice and another opposed to Golden Rice. Then you will answer the questions on pages 7-9 to evaluate the opposing arguments.

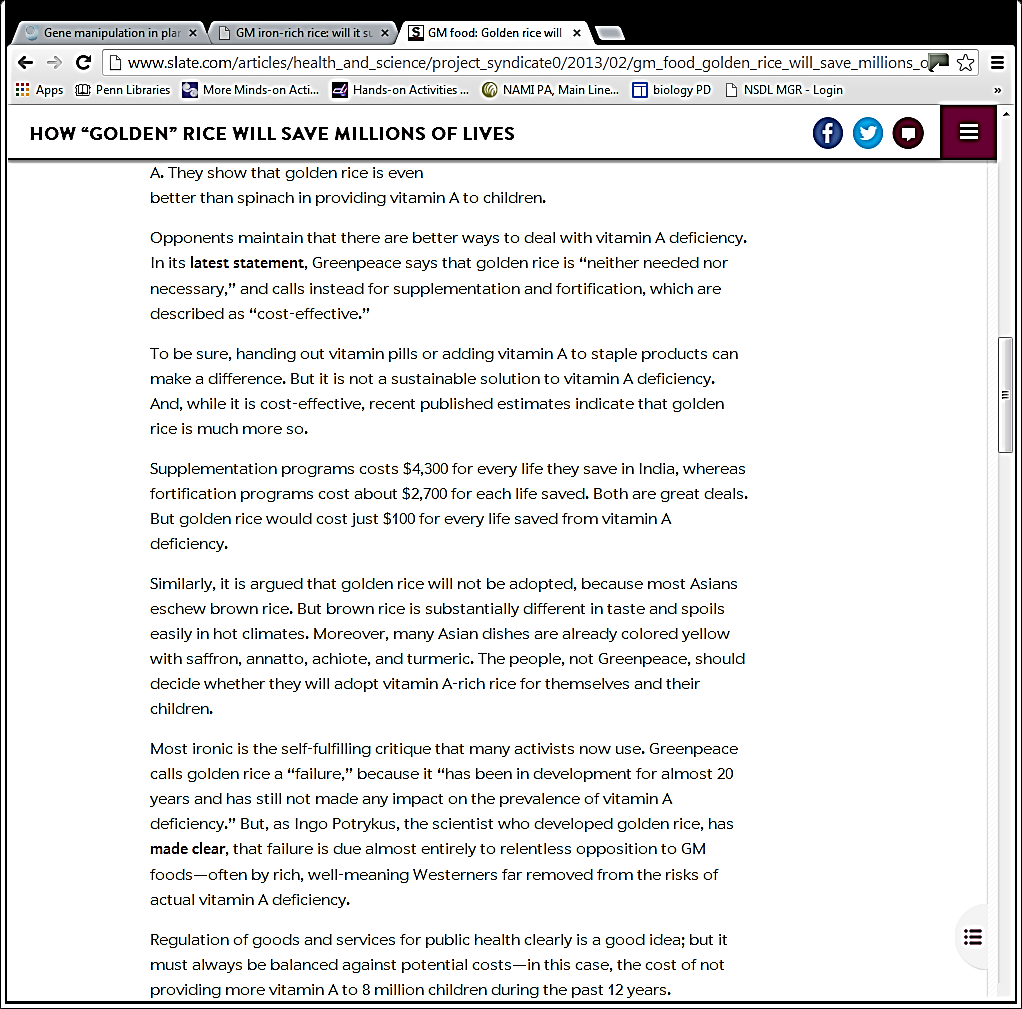
As you read:

* Identify the arguments for and against Golden Rice, the evidence for each argument, and any counter-arguments.
* Identify proposals for other approaches to preventing vitamin A deficiency and the advantages and disadvantages of each proposed approach.

"The Deadly Opposition to Genetically Modified Food"[[2]](#footnote-2)

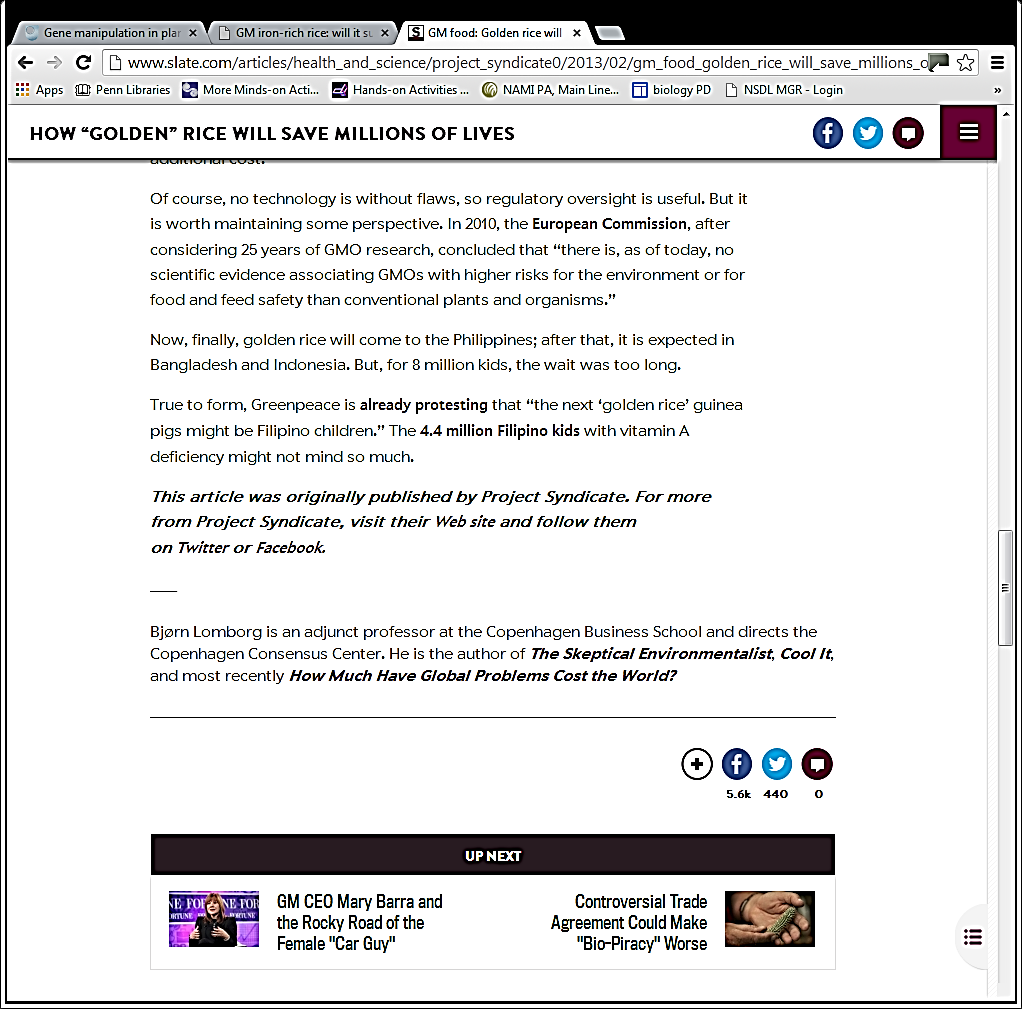
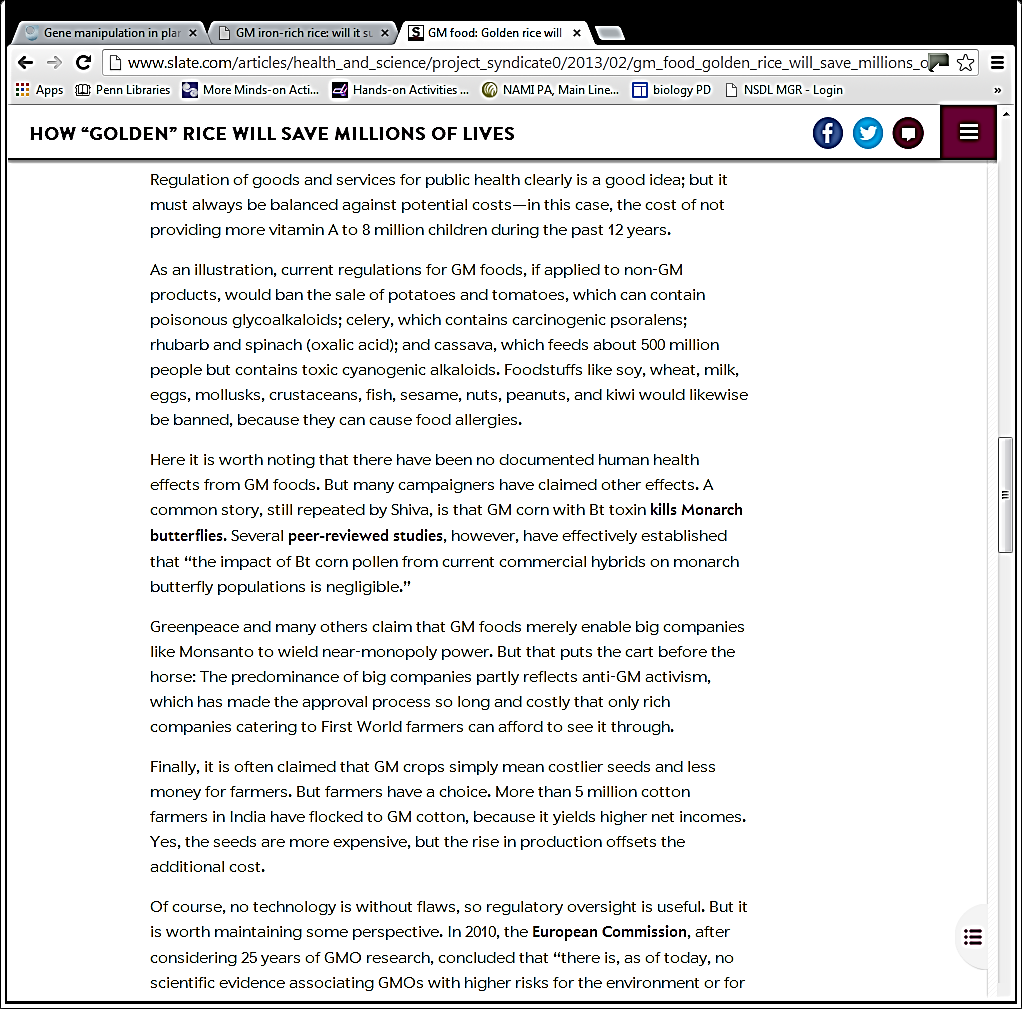


The New York Times Magazine reported in 2001 that one would need to "eat 15 pounds of cooked golden rice a day" to get enough vitamin A. What was an exaggeration then is demonstrably wrong now. Two recent studies in the American Journal of Clinical Nutrition show that just 50 g (roughly 2 ounces) of Golden Rice can provide 50% of the recommended daily intake of vitamin A. They show that Golden Rice is even better than spinach in providing vitamin A to children.



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Note: Supplementation refers to providing capsules or pills that contain pro-vitamin A or vitamin A (or another needed vitamin or mineral). Fortification refers to adding pro-vitamin A or vitamin A (or another vitamin or mineral) to food products before they are sold.



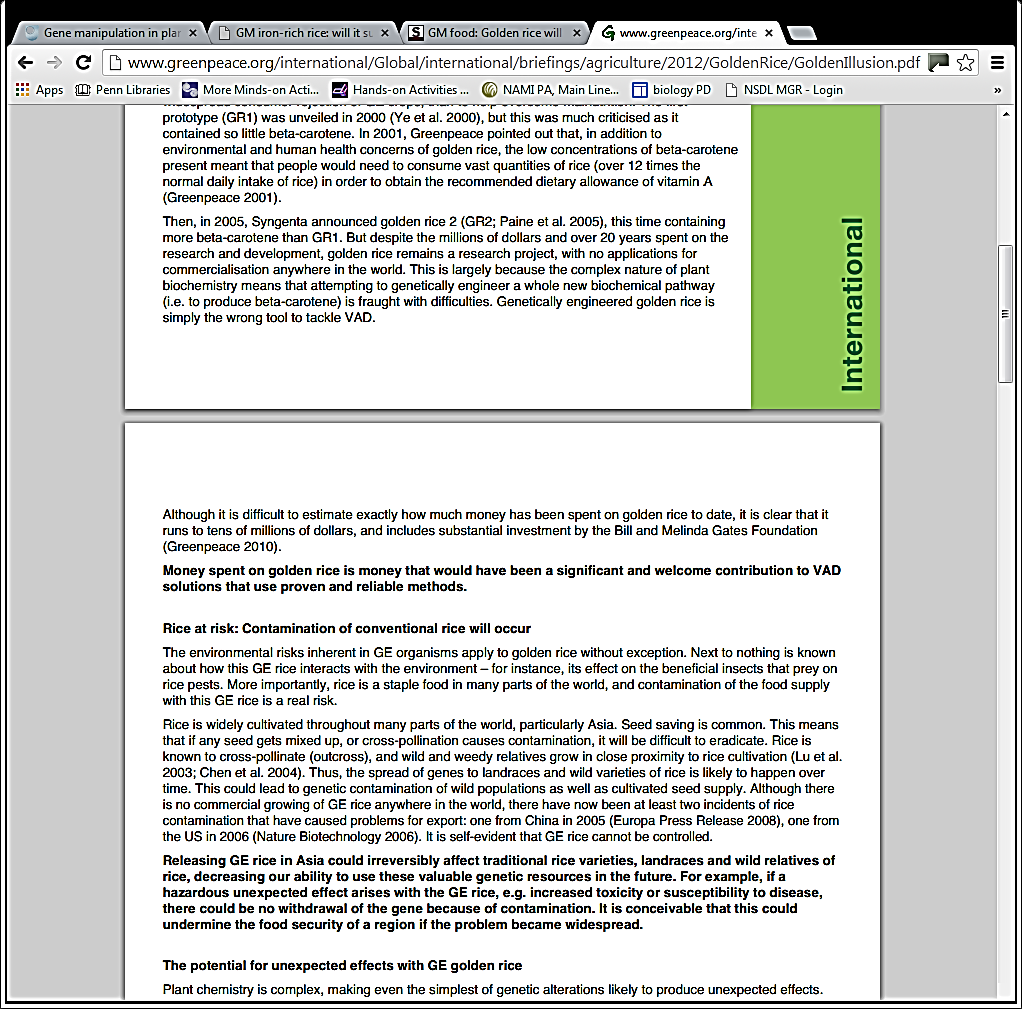
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Note: With respect to cost of the seeds, the developers and distributor of Golden Rice have arranged that, for farmers who make less than $10,000 per year, the farmer will not need to pay royalties on the GM technology used to make the seeds and the farmer can keep and replant Golden Rice seeds.

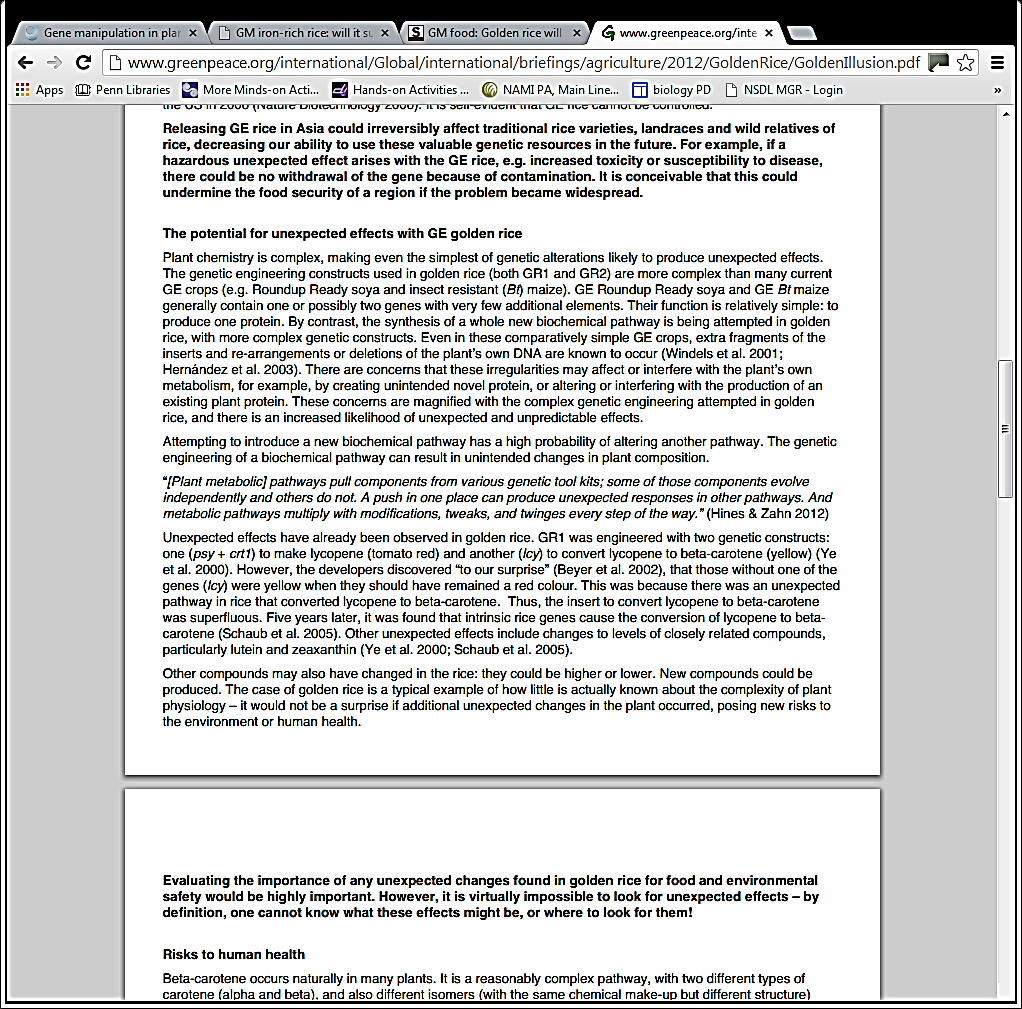
"Golden Illusion: the Broken Promises of Golden Rice"[[3]](#footnote-3)

This article uses the term genetically engineered (GE) instead of genetically modified (GM) and also uses the term beta-carotene, which is another name for pro-vitamin A.

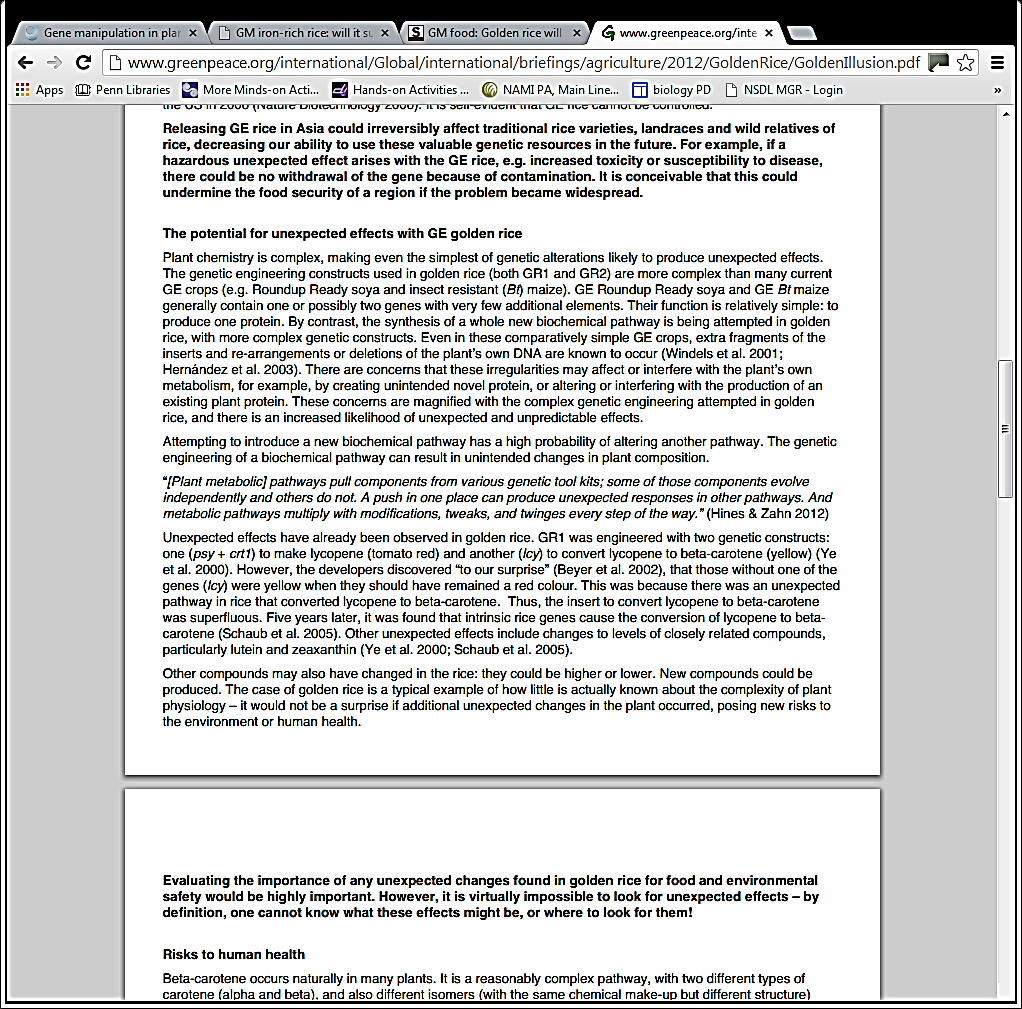
[](http://www.greenpeace.org/international/Global/international/briefings/agriculture/2012/GoldenRice/GoldenIllusion.pdf))

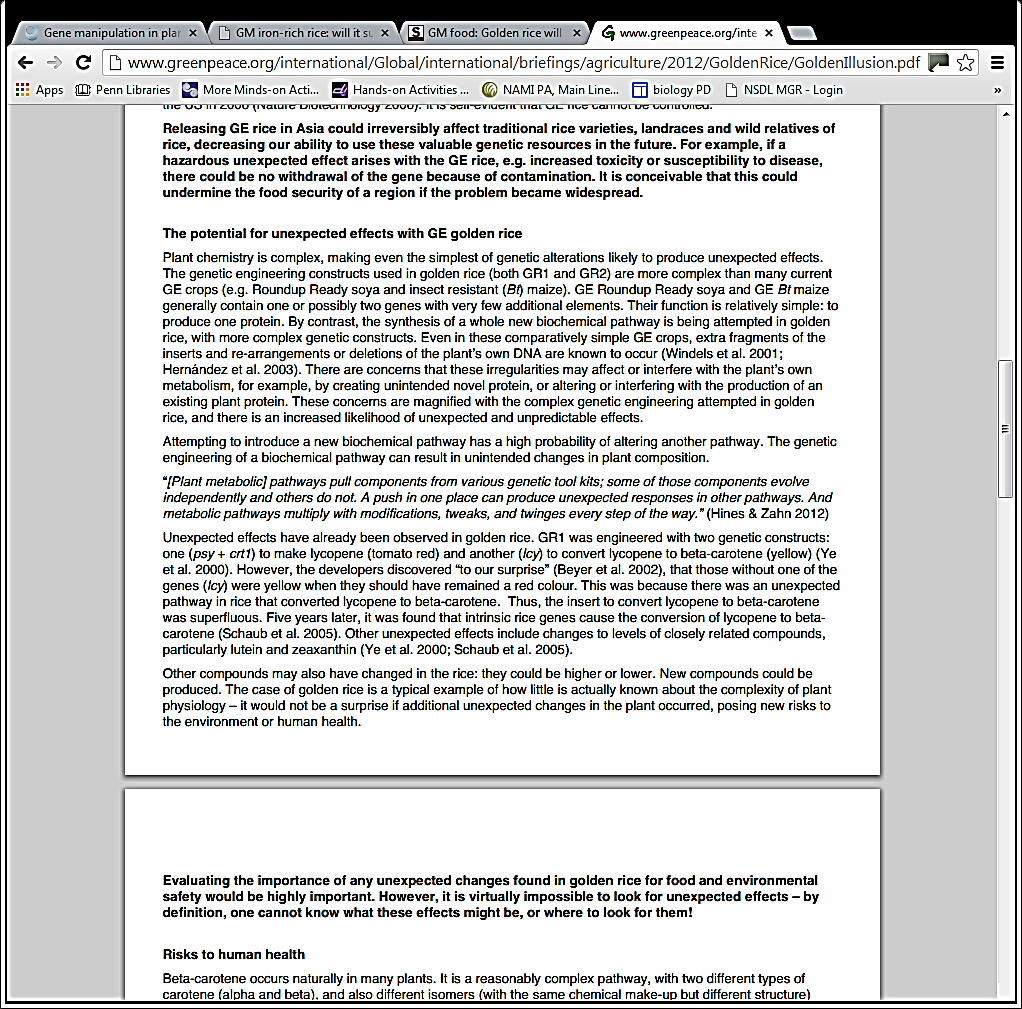


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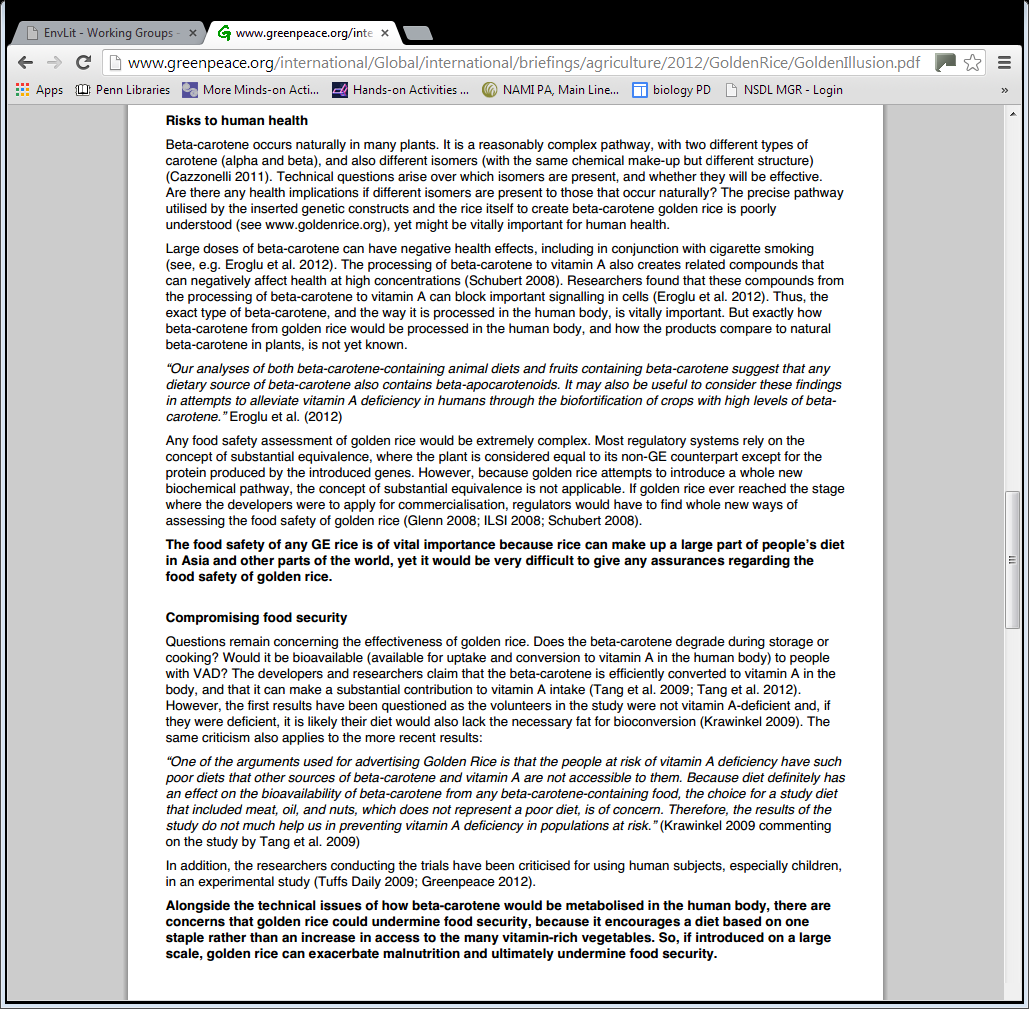


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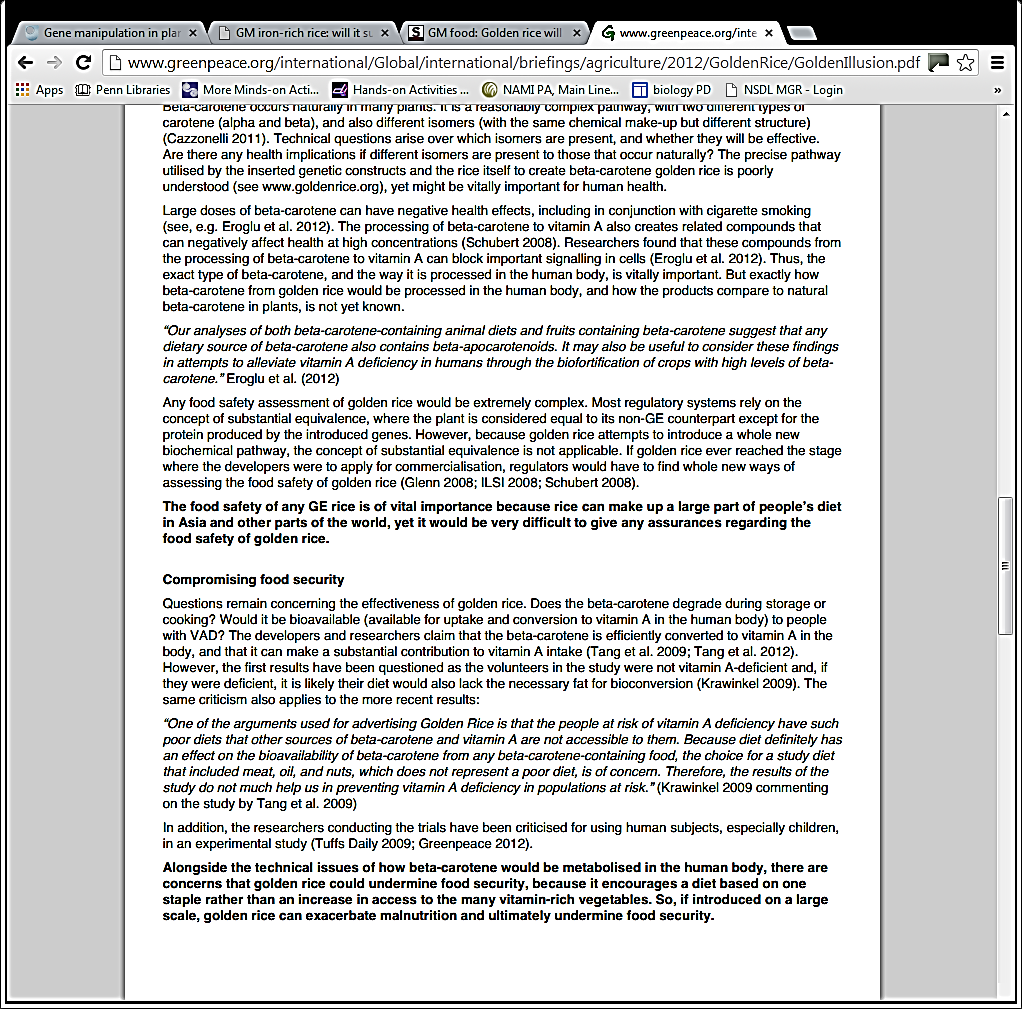




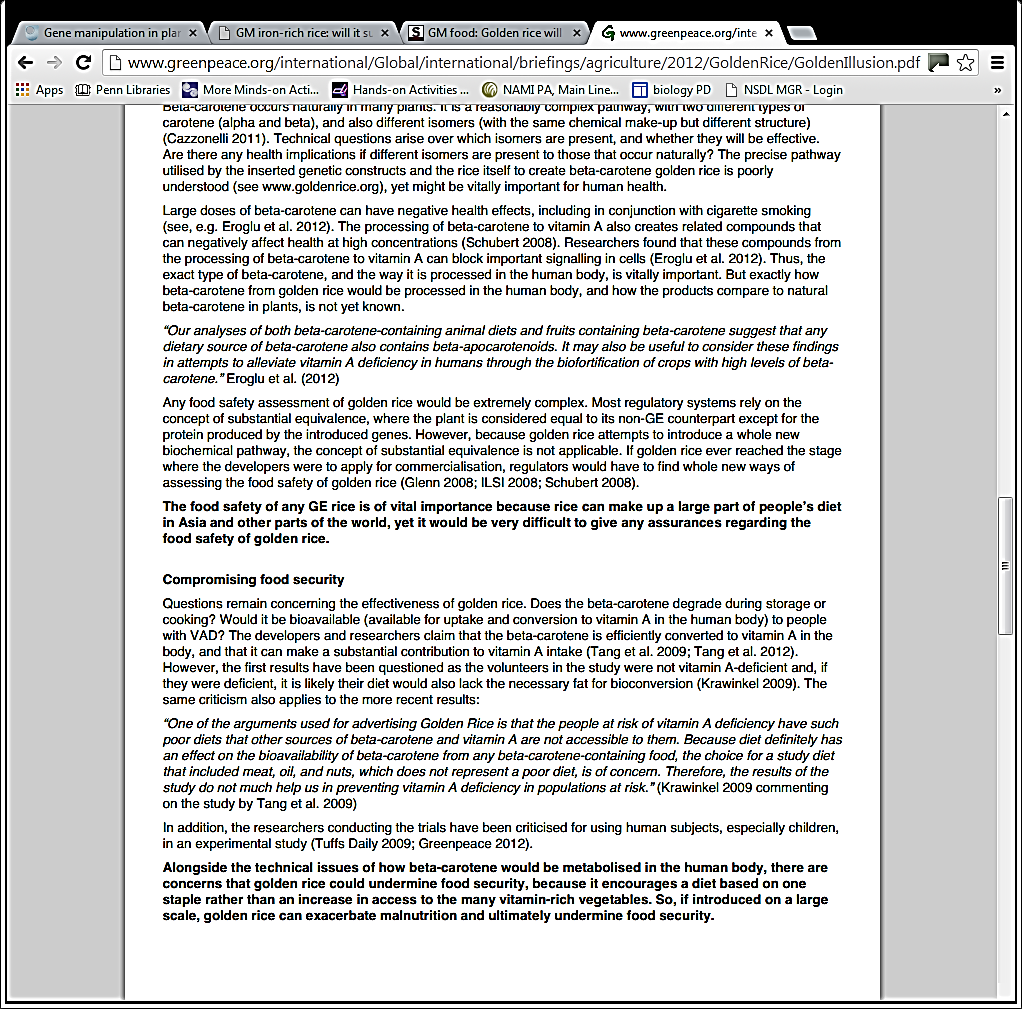
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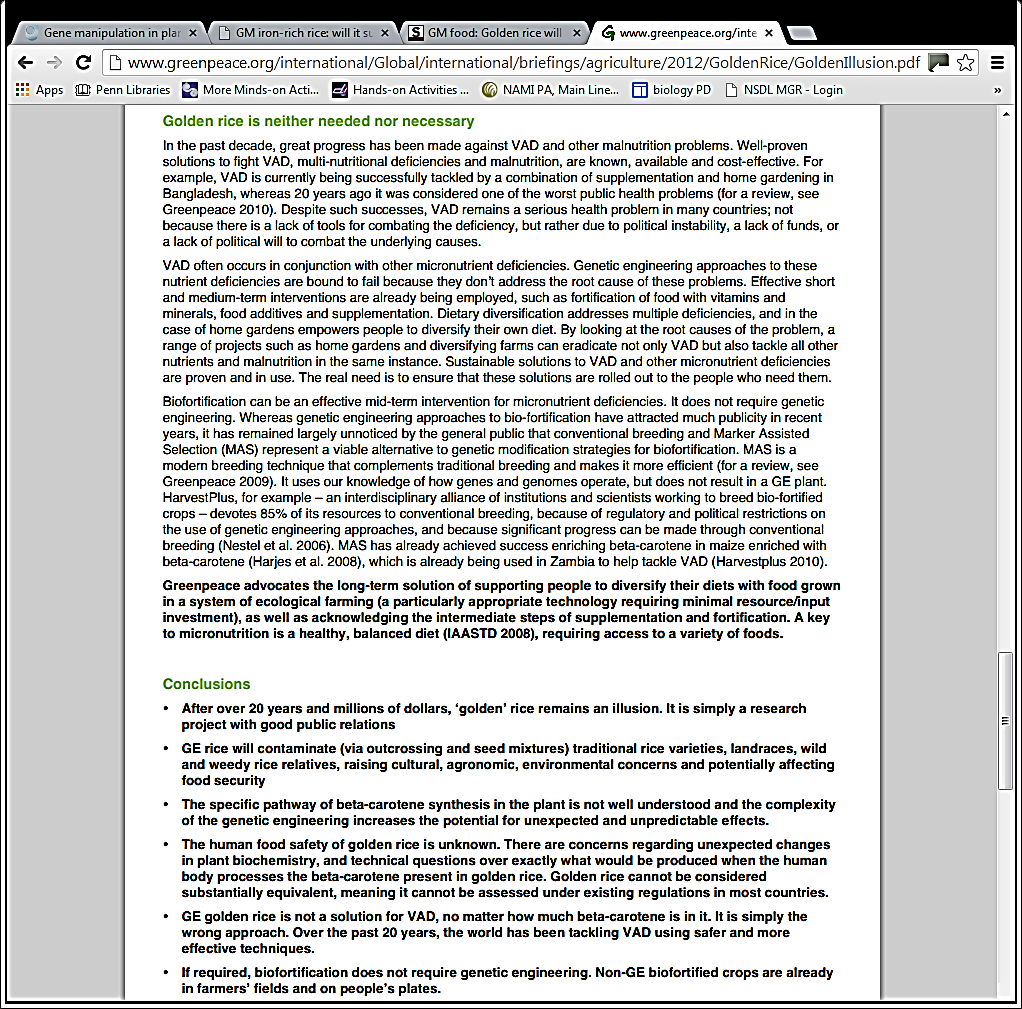


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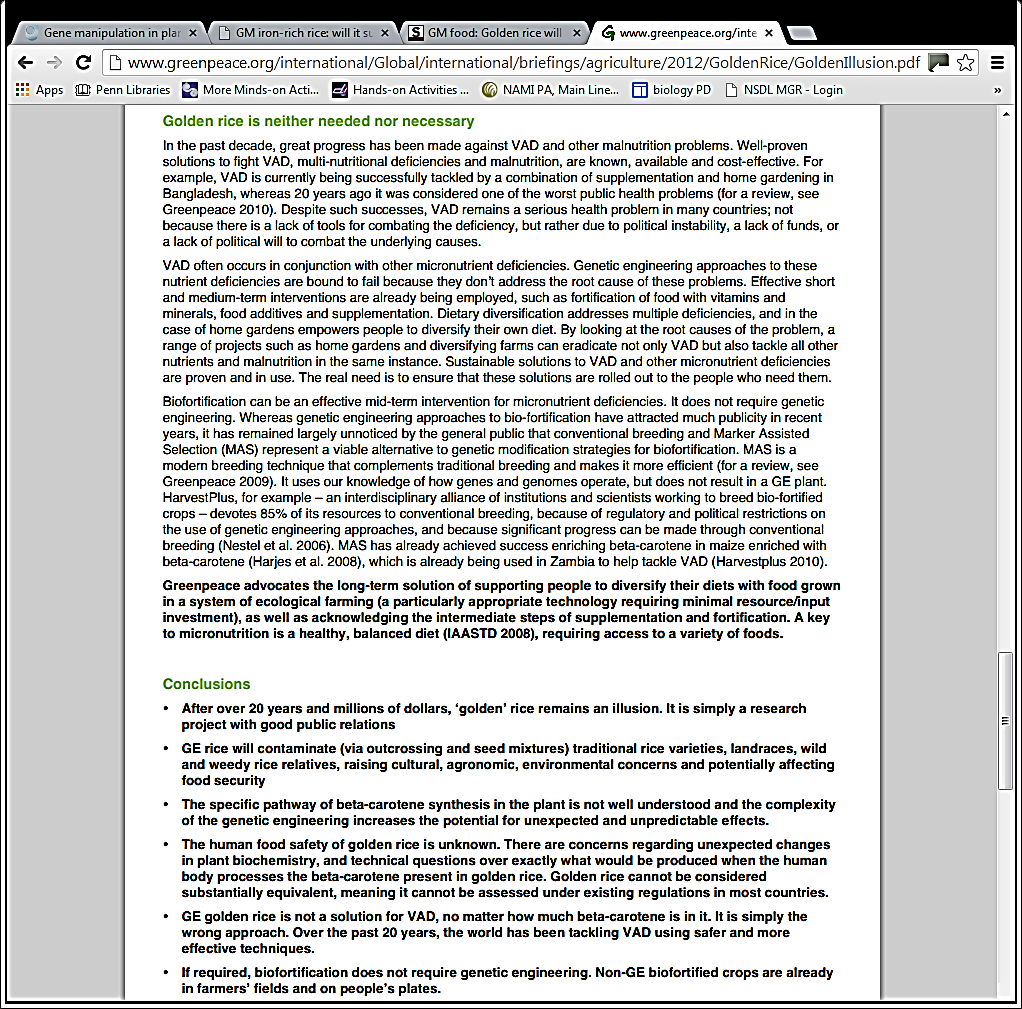


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Note: Biofortification refers to increasing the amount of pro-vitamin A or vitamin A (or other vitamin or mineral) produced and stored by a plant in the part of the plant that is eaten. Although scientists have been able to produce some types of biofortified foods by non-GE methods, scientists have not been able to produce rice plants that have pro-vitamin A in their rice grains by non-GE methods.

In your answers to questions 1-4:

* Label information from the first reading with DO (for Deadly Opposition) and information from the second reading with GI (for Golden Illusion). Identifying the sources for the information in your answers to questions 1-3 will help you to answer question 5.
* In the last box of each row in these tables, include at least one question that could provide information that would help you to evaluate the argument (questions 1 and 2), the other approach to preventing vitamin A deficiency (question 3), or the approach to policymaking (question 4).

**1.** Complete the following table to summarize and evaluate the main argument in favor of Golden Rice.

|  |  |  |  |
| --- | --- | --- | --- |
| **Argument for Golden Rice** | **Evidence** | **Counterargument** | **Your Conclusion and Questions** |
|  |  |  |  |

**2.** Complete the following table to summarize and evaluate two arguments against Golden Rice.

|  |  |  |  |
| --- | --- | --- | --- |
| **Argument against**  **Golden Rice** | **Evidence** | **Counterargument**  (if available) | **Your Conclusion and Questions** |
|  |  |  |  |
|  |  |  |  |

**3.** What other approaches could be used to prevent vitamin A deficiency? Complete the following table.

|  |  |  |  |
| --- | --- | --- | --- |
| **Another Approach** | **Advantages** | **Disadvantages** | **Your Conclusion and Questions** |
|  |  |  |  |
|  |  |  |  |

**4.** There is a great deal of disagreement about the best approach to policy-making on issues like genetically modified food plants where there is considerable uncertainty about the potential benefits, risks and costs of a new technology. Complete the table to evaluate the advantages and disadvantages of three major approaches to policy-making and propose questions that could help to evaluate each approach.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Advantage** | **Disadvantage** | **Question** |
| The European Union has adopted the Precautionary Principle, which means that those who favor a new technology (e.g. GM foods like Golden Rice) must establish the safety of the new technology. |  |  |  |
| The US FDA has taken a less cautious approach, approving a GM food if it is considered to be largely the same as a conventional food and therefore "generally recognized as safe". |  |  |  |
| Cost-benefit analysis evaluates the balance between the potential benefits vs. the potential costs and risks. |  |  |  |

**5.** Explain how the two readings ("Deadly Opposition…" and "Golden Illusion…") can argue for opposite points of view concerning Golden Rice, even though the statements in both articles are reasonably accurate. (Hint: Review your answers to questions 1-3.)

**6.** Based on the information you have, what policies do you propose concerning Golden Rice, including development and testing of Golden Rice and possible approval for use by farmers? Summarize the arguments and evidence that support your policy proposals and any additional information you would want to have in order to propose the best policies.

**7.** Based on the information you have, what do you think would be the best approach or combination of approaches for preventing vitamin A deficiency? Summarize the arguments and evidence that support your conclusions and any additional information you would want to have in order to propose the best approaches.

1. by Dr. Ingrid Waldron, Department of Biology, University of Pennsylvania, © 2014. Teachers are encouraged to copy this Student Handout for classroom use. A Word file (which can be used to prepare a modified version if desired), Teacher Preparation Notes, and comments are available at <http://serendipstudio.org/exchange/bioactivities/GoldenRice>. [↑](#footnote-ref-1)
2. This reading refers to "’golden rice’ with vitamin A"; Golden Rice contains pro-vitamin A which our bodies can easily convert to vitamin A. This reading states that Golden Rice "will be grown in the Philippines", but thus far Golden Rice has only been grown in field trials and it has not been approved for use by farmers. This reading is quoted from <http://www.slate.com/articles/health_and_science/project_syndicate0/2013/02/gm_food_golden_rice_will_save_millions_of_people_from_vitamin_a_deficiency.html> [↑](#footnote-ref-2)
3. Excerpts from <http://www.greenpeace.org/international/Global/international/briefings/agriculture/2012/GoldenRice/GoldenIllusion.pdf> [↑](#footnote-ref-3)